upon any other person readily identifiable by the Secretary as one who is interested in or aggrieved by such order. The Secretary also shall publish in the FEDERAL REGISTER a notice of the grant or denial of the order and the reason therefor.

§ 430.57 Duration of temporary exemption.

A temporary exemption terminates according to its terms but not later than twenty-four months after the affective date of the rule for which the exemption is allowed.

Subpart F [Reserved]

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

Subpart A—General Provisions

Subpart B—Electric Motors

Subpart C—Commercial Refrigerators, Freezers and Refrigerator-Freezers

Subpart D—Commercial Warm Air Furnaces

Subpart E—Commercial Packaged Boilers

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Energy Conservation Standards

Subpart F—Commercial Air Conditioners and Heat Pumps

Test Procedures

Subpart G—Commercial Water Heaters, Hot Water Supply Boilers and Unfired Hot Water Storage Tanks

Test Procedures

Energy Conservation Standards

AUTHORITY: 42 U.S.C. 6291–6317; 28 U.S.C. 2461 note.

SOURCE: 64 FR 54141, Oct. 5, 1999, unless otherwise noted.

Subpart A—General Provisions

§ 431.1 Purpose and scope.

This part establishes the regulations for the implementation of provisions relating to commercial and industrial equipment in Part B of Title III of the Energy Policy and Conservation Act (42 U.S.C. 6291–6309) and in Part C of Title III of the Energy Policy and Conservation Act (42 U.S.C. 6311–6317), which establishes an energy conservation program for certain commercial and industrial equipment.

[70 FR 60414, Oct. 18, 2005]

§ 431.2 Definitions.

The following definitions apply for purposes of this part. Any words or terms not defined in this Section or elsewhere in this part shall be defined as provided in Section 340 of the Act.

Act means the Energy Policy and Conservation Act of 1975, as amended, 42 U.S.C. 6291–6316.

Alternate efficiency determination method or AEDM means a method of calculating the efficiency of a commercial HVAC and WH product, in terms of the descriptor used in or under section 342(a) of the Act to state the energy conservation standard for that product.

Btu means British thermal unit, which is the quantity of heat required to raise the temperature of one pound of water by one degree Fahrenheit.

Commercial HVAC & WH product means any small, large, or very large commercial package air-conditioning and heating equipment (as defined in § 431.92), packaged terminal air conditioner (as defined in § 431.92), packaged terminal heat pump (as defined in § 431.92), single package vertical air conditioner (as defined in § 431.92), single package vertical heat pump (as defined in § 431.92), computer room air conditioner (as defined in § 431.92), variable refrigerant flow multi-split air conditioner (as defined in § 431.92), variable refrigerant flow multi-split heat pump (as defined in § 431.92), unitary dedicated outdoor air system (as defined in § 431.92), commercial packaged boiler (as defined in § 431.82), hot water supply boiler (as defined in § 431.102), commercial warm air furnace (as defined in § 431.72), instantaneous water heater (as defined in § 431.102), storage water heater (as defined in § 431.102), or unfired hot water storage tank (as defined in § 431.102).

Covered equipment means any electric motor, as defined in § 431.12; commercial heating, ventilating, and air conditioning, and water heating product (HVAC & WH product), as defined in § 431.172; commercial refrigerator, freezer, or refrigerator-freezer, as defined in § 431.62; automatic commercial ice maker, as defined in § 431.132; commercial clothes washer, as defined in § 431.152; distribution transformer, as defined in § 431.192; illuminated exit sign, as defined in § 431.202; traffic signal module or pedestrian module, as defined in § 431.222; unit heater, as defined in § 431.242; commercial prerinse spray valve, as defined in § 431.262; mercury vapor lamp ballast, as defined in § 431.282; refrigerated bottled or canned beverage vending machine, as defined in § 431.292; walk-in cooler and walk-in freezer, as defined in § 431.302; metal halide ballast and metal halide lamp fixture, as defined in § 431.322.

DOE or *the Department* means the U.S. Department of Energy.

Energy conservation standard means any standards meeting the definitions of that term in 42 U.S.C. 6291(6) and 42 U.S.C. 6311(18) as well as any other water conservation standards and design requirements found in this part or parts 430 or 431.

EPCA means the Energy Policy and Conservation Act, as amended, 42 U.S.C. 6291–6316.

Flue loss means the sum of the sensible heat and latent heat above room temperature of the flue gases leaving the appliance.

Gas means propane or natural gas as defined by the Federal Power Commission.

Import means to import into the customs territory of the United States.

Independent laboratory means a laboratory or test facility not controlled by, affiliated with, having financial ties with, or under common control with the manufacturer or distributor of the covered equipment being evaluated.

Industrial equipment means an article of equipment, regardless of whether it is in fact distributed in commerce for industrial or commercial use, of a type which:

(1) In operation consumes, or is designed to consume energy;

(2) To any significant extent, is distributed in commerce for industrial or commercial use; and

(3) Is not a ''covered product'' as defined in Section 321(2) of EPCA, 42 U.S.C. 6291(2), other than a component of a covered product with respect to which there is in effect a determination under Section 341(c) of EPCA, 42 U.S.C. 6312(c).

ISO means International Organization for Standardization.

Manufacture means to manufacture, produce, assemble, or import.

Manufacturer means any person who manufactures industrial equipment, including any manufacturer of a commercial packaged boiler.

Manufacturer's model number means the identifier used by a manufacturer to uniquely identify the group of identical or essentially identical commercial equipment to which a particular unit belongs. The manufacturer's model number typically appears on equipment nameplates, in equipment catalogs and in other product advertising literature.

Private labeler means, with respect to any product covered under this part, an owner of a brand or trademark on the label of a covered product which bears a private label. A covered product bears a private label if:

(1) Such product (or its container) is labeled with the brand or trademark of a person other than a manufacturer of such product;

(2) The person with whose brand or trademark such product (or container) is labeled has authorized or caused such product to be so labeled; and

(3) The brand or trademark of a manufacturer of such product does not appear on such label.

Secretary means the Secretary of Energy.

State means a State, the District of Columbia, Puerto Rico, or any territory or possession of the United States.

State regulation means a law or regulation of a State or political subdivision thereof.

[69 FR 61923, Oct. 21, 2004, as amended at 71 FR 71369, Dec. 8, 2006; 74 FR 12071, Mar. 23, 2009; 75 FR 666, Jan. 5, 2010; 76 FR 12503, Mar. 7, 2011; 77 FR 28987, May 16, 2012; 79 FR 26601, May 9, 2014; 87 FR 45197, July 27, 2022]

§ 431.3 Error Correction procedure for energy conservation standards rules.

Requests for error corrections pertaining to an energy conservation standard rule for commercial or industrial equipment shall follow those procedures and provisions detailed in 10 CFR 430.5 of this chapter.

[81 FR 57758, Aug. 24, 2016]

§ 431.4 Procedures, interpretations, and policies for consideration of new or revised energy conservation standards and test procedures for commercial/industrial equipment.

The procedures, interpretations, and policies for consideration of new or revised energy conservation standards and test procedures set forth in appendix A to subpart C of part 430 of this chapter shall apply to the consideration of new or revised energy conservation standards and test procedures considered for adoption under this part.

[85 FR 8711, Feb. 14, 2020]

Subpart B—Electric Motors

SOURCE: 69 FR 61923, Oct. 21, 2004, unless otherwise noted.

§ 431.11 Purpose and scope.

This subpart contains energy conservation requirements for electric motors. It contains test procedures that EPCA requires DOE to prescribe, related requirements, energy conservation standards prescribed by EPCA, labeling rules, and compliance procedures. It also identifies materials incorporated by reference in this part. This subpart does not cover "small electric motors," which are addressed in subpart X of this part. This subpart does not cover electric motors that are "dedicated-purpose pool pump motors," which are addressed in subpart Z of this part.

[77 FR 26633, May 4, 2012, as amended at 86 FR 40774, July 29, 2021]

§ 431.12 Definitions.

The following definitions apply for purposes of this subpart, and of subparts U and V of this part. Any words or terms not defined in this Section or elsewhere in this part shall be defined as provided in Section 340 of the Act.

Accreditation means recognition by an accreditation body that a laboratory is competent to test the efficiency of electric motors according to the scope and procedures given in IEEE 112–2017 Test Method B, CSA C390–10, or IEC 60034–2–1:2014 Method 2–1–1B (incorporated by reference, see § 431.15).

Accreditation body means an organization or entity that conducts and administers an accreditation system and grants accreditation.

Accreditation system means a set of requirements to be fulfilled by a testing laboratory, as well as rules of procedure and management, that are used to accredit laboratories.

Accredited laboratory means a testing laboratory to which accreditation has been granted.

Air-over electric motor means an electric motor that does not reach thermal equilibrium (*i.e.*, thermal stability), during a rated load temperature test according to section 2 of appendix B, without the application of forced cooling by a free flow of air from an external device not mechanically connected to the motor within the motor enclosure.

Alternative efficiency determination method or *AEDM* means, with respect to an electric motor, a method of calculating the total power loss and average full load efficiency.

Average full load efficiency means the arithmetic mean of the full load efficiencies of a population of electric motors of duplicate design, where the full load efficiency of each motor in the population is the ratio (expressed as a percentage) of the motor's useful power output to its total power input when the motor is operated at its full rated load, rated voltage, and rated frequency.

Basic model means all units of electric motors manufactured by a single manufacturer, that are within the same equipment class, have electrical characteristics that are essentially identical, and do not have any differing physical or functional characteristics that affect energy consumption or efficiency.

Brake electric motor means a motor that contains a dedicated mechanism for speed reduction, such as a brake, either within or external to the motor enclosure

Certificate of conformity means a document that is issued by a certification program, and that gives written assurance that an electric motor complies with the energy efficiency standard applicable to that motor, as specified in §431.25.

Certification program means a certification system that determines conformity by electric motors with the energy efficiency standards prescribed by and pursuant to the Act.

Certification system means a system, that has its own rules of procedure and management, for giving written assurance that a product, process, or service conforms to a specific standard or other specified requirements, and that is operated by an entity independent of both the party seeking the written assurance and the party providing the product, process or service.

Component set means a combination of motor parts that require the addition of more than two endshields (and their associated bearings) to create an operable motor. These parts may consist of any combination of a stator frame, wound stator, rotor, shaft, or endshields. For the purpose of this definition, the term "operable motor" means an electric motor engineered for performing in accordance with nameplate ratings.

CSA means Canadian Standards Association.

Definite purpose electric motor means any electric motor that cannot be used in most general purpose applications and is designed either:

(1) To standard ratings with standard operating characteristics or standard mechanical construction for use under service conditions other than usual, such as those specified in NEMA MG 1–2016, Paragraph 14.3, "Unusual Service Conditions," (incorporated by reference, *see* §431.15); or

(2) For use on a particular type of application.

Definite purpose motor means any electric motor that cannot be used in most general purpose applications and is designed either:

(1) To standard ratings with standard operating characteristics or standard mechanical construction for use under service conditions other than usual, such as those specified in NEMA MG 1–2016, Paragraph 14.3, "Unusual Service Conditions," (incorporated by reference, *see* §431.15); or

(2) For use on a particular type of application.

Electric motor means a machine that converts electrical power into rotational mechanical power.

Electric motor with encapsulated windings means an electric motor capable of passing the conformance test for water resistance described in NEMA MG 1–2016, Paragraph 12.62 (incorporated by reference, *see* §431.15).

Electric motor with moisture resistant windings means an electric motor that is capable of passing the conformance test for moisture resistance generally described in NEMA MG 1–2016, paragraph 12.63 (incorporated by reference, *see* §431.15).

Electric motor with sealed windings means an electric motor capable of passing the conformance test for water resistance described in NEMA MG 1–2016, paragraph 12.62 (incorporated by reference, *see* §431.15).

Enclosed motor means an electric motor so constructed as to prevent the free exchange of air between the inside and outside of the case but not sufficiently enclosed to be termed airtight.

Equipment class means one of the combinations of an electric motor's horsepower (or standard kilowatt equivalent), number of poles, and open or enclosed construction, with respect to a category of electric motor for which §431.25 prescribes nominal full-load efficiency standards.

Fire pump electric motor means an electric motor, including any IEC-equivalent, that meets the requirements of section 9.5 of NFPA 20 (incorporated by reference, see § 431.15).

General purpose electric motor means any electric motor that is designed in standard ratings with either:

(1) Standard operating characteristics and mechanical construction for use under usual service conditions, such as those specified in NEMA MG 1–2016, paragraph 14.2, ''Usual Service Conditions,'' (incorporated by reference, *see* § 431.15) and without restriction to a particular application or type of application; or

(2) Standard operating characteristics or standard mechanical construction for use under unusual service conditions, such as those specified in NEMA MG 1–2016, paragraph 14.3, ''Unusual Service Conditions,'' (incorporated by reference, *see* § 431.15) or for a particular type of application, and which can be used in most general purpose applications.

General purpose electric motor (subtype I) means a general purpose electric motor that:

(1) Is a single-speed, induction motor;

(2) Is rated for continuous duty (MG1) operation or for duty type S1 (IEC);

(3) Contains a squirrel-cage (MG1) or cage (IEC) rotor;

(4) Has foot-mounting that may include foot-mounting with flanges or detachable feet;

(5) Is built in accordance with NEMA T-frame dimensions or their IEC metric equivalents, including a frame size that is between two consecutive NEMA frame sizes or their IEC metric equivalents;

(6) Has performance in accordance with NEMA Design A (MG1) or B (MG1) characteristics or equivalent designs such as IEC Design N (IEC);

(7) Operates on polyphase alternating current 60-hertz sinusoidal power, and:

(i) Is rated at 230 or 460 volts (or both) including motors rated at multiple voltages that include 230 or 460 volts (or both), or

(ii) Can be operated on 230 or 460 volts (or both); and

(8) Includes, but is not limited to, explosion-proof construction.

NOTE 1 TO DEFINITION OF ''GENERAL PURPOSE ELECTRIC MOTOR (SUBTYPE I)'': References to ''MG1'' above refer to NEMA Standards Publication MG 1–2016 (incorporated by reference in § 431.15). References to ''IEC'' above refer to IEC 60034–1, 60034–12:2016, 60050–411, and 60072–1 (incorporated by reference in § 431.15), as applicable.

General purpose electric motor (subtype II) means any general purpose electric motor that incorporates design elements of a general purpose electric motor (subtype I) but, unlike a general purpose electric motor (subtype I), is configured in one or more of the following ways:

(1) Is built in accordance with NEMA U-frame dimensions as described in NEMA MG 1–1967 (incorporated by reference, *see* § 431.15) or in accordance with the IEC metric equivalents, including a frame size that is between two consecutive NEMA frame sizes or their IEC metric equivalents;

(2) Has performance in accordance with NEMA Design C characteristics as described in MG1 or an equivalent IEC design(s) such as IEC Design H;

(3) Is a close-coupled pump motor;

(4) Is a footless motor;

(5) Is a vertical solid shaft normal thrust motor (as tested in a horizontal configuration) built and designed in a manner consistent with MG1;

(6) Is an eight-pole motor (900 rpm); or

(7) Is a polyphase motor with a voltage rating of not more than 600 volts, is not rated at 230 or 460 volts (or both), and cannot be operated on 230 or 460 volts (or both).

NOTE 2 TO DEFINITION OF ''GENERAL PURPOSE ELECTRIC MOTOR (SUBTYPE II)'': With the exception of the NEMA Motor Standards MG1–1967 (incorporated by reference in § 431.15), references to ''MG1'' above refer to NEMA MG 1–2016 (incorporated by reference in § 431.15). References to ''IEC'' above refer to IEC 60034–1, 60034–12, 60050–411, and 60072–1 (incorporated by reference in § 431.15), as applicable.

IEC means the International Electrotechnical Commission.

IEC Design H motor means an electric motor that:

(1) Is an induction motor designed for use with three-phase power;

(2) Contains a cage rotor;

(3) Is capable of direct-on-line starting

(4) Has 4, 6, or 8 poles;

(5) Is rated from 0.12 kW to 160 kW at a frequency of 60 Hz; and

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(6) Conforms to Sections 9.1, 9.2, and 9.3 of the IEC 60034–12:2016 (incorporated by reference, *see* § 431.15) specifications for starting torque, locked rotor apparent power, and starting requirements, respectively.

IEC Design HE means an electric motor that:

(1) Is an induction motor designed for use with three-phase power;

(2) Contains a cage rotor;

(3) Is capable of direct-on-line starting;

(4) Has 4, 6, or 8 poles;

(5) Is rated from 0.12 kW to 160 kW at a frequency of 60 Hz; and

(6) Conforms to section 9.1, Table 3, and Section 9.3 of the IEC 60034–12:2016 (incorporated by reference, *see* § 431.15) specifications for starting torque, locked rotor apparent power, and starting requirements, respectively.

IEC Design HEY means an electric motor that:

(1) Is an induction motor designed for use with three-phase power;

(2) Contains a cage rotor;

(3) Is capable of star-delta starting;

(4) Has 4, 6, or 8 poles;

(5) Is rated from 0.12 kW to 160 kW at a frequency of 60 Hz; and

(6) Conforms to section 5.7, Table 3 and Section 9.3 of the IEC 60034–12:2016 (incorporated by reference, *see* § 431.15) specifications for starting torque, locked rotor apparent power, and starting requirements, respectively.

IEC Design HY means an electric motor that:

(1) Is an induction motor designed for use with three-phase power;

(2) Contains a cage rotor;

(3) Is capable of star-delta starting;

(4) Has 4, 6, or 8 poles;

(5) Is rated from 0.12 kW to 160 kW at a frequency of 60 Hz; and

(6) Conforms to Section 5.7, Section 9.2 and Section 9.3 of the IEC 60034–12:2016 (incorporated by reference, *see* § 431.15) specifications for starting torque, locked rotor apparent power, and starting requirements, respectively.

IEC Design N motor means an electric motor that:

(1) Is an induction motor designed for use with three-phase power;

(2) Contains a cage rotor;

(3) Is capable of direct-on-line starting;

(4) Has 2, 4, 6, or 8 poles;

(5) Is rated from 0.12 kW to 1600 kW at a frequency of 60 Hz; and

(6) Conforms to Sections 6.1, 6.2, and 6.3 of the IEC 60034–12:2016 (incorporated by reference, *see* § 431.15) specifications for torque characteristics, locked rotor apparent power, and starting requirements, respectively. If a motor has an increased safety designation of type ''e,'', the locked rotor apparent power shall be in accordance with the appropriate values specified in IEC 60079–7:2015 (incorporated by reference, *see* § 431.15).

IEC Design NE means an electric motor that:

(1) Is an induction motor designed for use with three-phase power;

(2) Contains a cage rotor;

(3) Is capable of direct-on-line starting;

(4) Has 2, 4, 6, or 8 poles;

(5) Is rated from 0.12 kW to 1600 kW at a frequency of 60 Hz; and

(6) Conforms to section 6.1, Table 3 and Section 6.3 of the IEC 60034–12:2016 (incorporated by reference, *see* § 431.15) specifications for starting torque, locked rotor apparent power, and starting requirements, respectively.

IEC Design NEY means an electric motor that:

(1) Is an induction motor designed for use with three-phase power;

(2) Contains a cage rotor;

(3) Is capable of star-delta starting;

(4) Has 2, 4, 6, or 8 poles;

(5) Is rated from 0.12 kW to 1600 kW at a frequency of 60 Hz; and

(6) Conforms to section 5.4, Table 3 and Section 6.3 of the IEC 60034–12:2016 (incorporated by reference, *see* § 431.15) specifications for starting torque, locked rotor apparent power, and starting requirements, respectively.

IEC Design NY means an electric motor that:

(1) Is an induction motor designed for use with three-phase power;

(2) Contains a cage rotor;

(3) Is capable of star-delta starting;

(4) Has 2, 4, 6, or 8 poles;

(5) Is rated from 0.12 kW to 1600 kW at a frequency of 60 Hz; and

(6) Conforms to Section 5.4, Section 6.2 and Section 6.3 of the IEC 60034–

12:2016 (incorporated by reference, *see* § 431.15) specifications for starting torque, locked rotor apparent power, and starting requirements, respectively.

IEEE means the Institute of Electrical and Electronics Engineers, Inc.

Immersible electric motor means an electric motor primarily designed to operate continuously in free-air, but is also capable of temporarily withstanding complete immersion in liquid for a continuous period of no less than 30 minutes.

Inverter means an electronic device that converts an input AC or DC power into a controlled output AC or DC voltage or current. An inverter may also be called a converter.

Inverter-capable electric motor means an electric motor designed for direct online starting and is suitable for operation on an inverter without special filtering.

Inverter-only electric motor means an electric motor designed specifically for operation fed by an inverter with a temperature rise within the specified insulation thermal class or thermal limits.

Liquid-cooled electric motor means a motor that is cooled by liquid circulated using a designated cooling apparatus such that the liquid or liquid-filled conductors come into direct contact with the parts of the motor but is not submerged in a liquid during operation.

NEMA means the National Electrical Manufacturers Association.

NEMA Design A motor means a squirrel-cage motor that:

(1) Is designed to withstand full-voltage starting and developing locked-rotor torque as shown in NEMA MG 1–2016, paragraph 12.38.1 (incorporated by reference, *see* § 431.15);

(2) Has pull-up torque not less than the values shown in NEMA MG 1–2016, paragraph 12.40.1;

(3) Has breakdown torque not less than the values shown in NEMA MG 1–2016, paragraph 12.39.1;

(4) Has a locked-rotor current higher than the values shown in NEMA MG 1–2016, Paragraph 12.35.2 for 60 hertz and NEMA MG 1–2016, Paragraph 12.35.4 for 50 hertz; and

(5) Has a slip at rated load of less than 5 percent for motors with fewer than 10 poles.

NEMA Design B motor means a squirrel-cage motor that is:

(1) Designed to withstand full-voltage starting;

(2) Develops locked-rotor, breakdown, and pull-up torques adequate for general application as specified in Sections 12.38, 12.39 and 12.40 of NEMA MG 1–2016 (incorporated by reference, *see* § 431.15);

(3) Draws locked-rotor current not to exceed the values shown in Section 12.35.2 for 60 hertz and 12.35.4 for 50 hertz of NEMA MG 1–2016; and

(4) Has a slip at rated load of less than 5 percent for motors with fewer than 10 poles.

NEMA Design C motor means a squirrel-cage motor that:

(1) Is designed to withstand full-voltage starting and developing locked-rotor torque for high-torque applications up to the values shown in NEMA MG 1–2016, paragraph 12.38.2 (incorporated by reference, *see* § 431.15);

(2) Has pull-up torque not less than the values shown in NEMA MG 1–2016, paragraph 12.40.2;

(3) Has breakdown torque not less than the values shown in NEMA MG 1–2016, paragraph 12.39.2;

(4) Has a locked-rotor current not to exceed the values shown in NEMA MG 1–2016, paragraphs 12.35.2 for 60 hertz and 12.35.4 for 50 hertz; and

(5) Has a slip at rated load of less than 5 percent.

Nominal full-load efficiency means, with respect to an electric motor, a representative value of efficiency selected from the ''nominal efficiency'' column of Table 12–10, NEMA MG 1–2016, (incorporated by reference, *see* § 431.15), that is not greater than the average full-load efficiency of a population of motors of the same design.

Open motor means an electric motor having ventilating openings which permit passage of external cooling air over and around the windings of the machine.

Partial electric motor means an assembly of motor components necessitating the addition of no more than two

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endshields, including bearings, to create an electric motor capable of operation in accordance with the applicable nameplate ratings.

Rated frequency means 60 Hz and corresponds to the frequency of the electricity supplied either:

(1) Directly to the motor, in the case of electric motors capable of operating without an inverter; or

(2) To the inverter in the case on inverter-only electric motors.

Rated load (or *full-load, full rated load,* or *rated full-load*) means the rated output power of an electric motor.

Rated voltage means the input voltage of a motor or inverter used when making representations of the performance characteristics of a given electric motor and selected by the motor's manufacturer to be used for testing the motor's efficiency.

Special purpose motor means any motor, other than a general purpose motor or definite purpose motor, which has special operating characteristics or special mechanical construction, or both, designed for a particular application.

Special purpose electric motor means any electric motor, other than a general purpose motor or definite electric purpose motor, which has special operating characteristics or special mechanical construction, or both, designed for a particular application.

Submersible electric motor means an electric motor that:

(1) Is intended to operate continuously only while submerged in liquid;

(2) Is capable of operation while submerged in liquid for an indefinite period of time; and

(3) Has been sealed to prevent ingress of liquid from contacting the motor's internal parts.

Total power loss means that portion of the energy used by an electric motor not converted to rotational mechanical power, expressed in percent.

Totally enclosed non-ventilated (TENV) electric motor means an electric motor that is built in a frame-surface cooled, totally enclosed configuration that is designed and equipped to be cooled only by free convection.

[69 FR 61923, Oct. 21, 2004, as amended at 74 FR 12071, Mar. 23, 2009; 77 FR 26633, May 4, 2012; 78 FR 75993, Dec. 13, 2013; 79 FR 31009, May 29, 2014; 86 FR 21, Jan. 4, 2021; 87 FR 63654, Oct. 19, 2022; 87 FR 64689, Oct. 26, 2022]

TEST PROCEDURES, MATERIALS INCORPORATED AND METHODS OF DETERMINING EFFICIENCY

§ 431.14 [Reserved]

§ 431.15 Materials incorporated by reference.

(a) Certain material is incorporated by reference into this subpart with the approval of the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. To enforce any edition other than that specified in this section, the U.S. Department of Energy (DOE) must publish a document in the FEDERAL REGISTER and the material must be available to the public. All approved incorporation by reference (IBR) material is available for inspection at DOE and at the National Archives and Records Administration (NARA). Contact DOE at: the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Program, Sixth Floor, 950 L'Enfant Plaza SW, Washington, DC 20024, (202) 586–9127, *Buildings@ee.doe.gov*, *https://www.energy.gov/eere/buildings/building-technologies-office*. For information on the availability of this material at NARA, email: *fr.inspection@nara.gov*, or go to: *www.archives.gov/federal-register/cfr/ibr-locations.html*. The material may be obtained from the sources in the following paragraphs:

(b) *CSA*. Canadian Standards Association, Sales Department, 5060 Spectrum Way, Suite 100, Mississauga, Ontario, L4W 5N6, Canada; (800) 463–6727; *www.shopcsa.ca/onlinestore/welcome.asp*.

(1) CSA C390–10 (reaffirmed 2019), (''CSA C390–10''), *Test methods, marking requirements, and energy efficiency levels for three-phase induction motors*, including Updates No. 1 through 3, Revised January 2020; IBR approved for § 431.12 and appendix B to this subpart.

(2) CSA C747–09 (reaffirmed 2019) (''CSA C747–09''), *Energy efficiency test*

methods for small motors, including Update No. 1 (August 2016), October 2009; IBR approved for appendix B to this subpart.

(c) *IEC*. International Electrotechnical Commission Central Office, 3, rue de Varembé, P.O. Box 131, CH–1211 GENEVA 20, Switzerland; + 41 22 919 02 11; *webstore.iec.ch*.

(1) IEC 60034–1 Edition 12.0 2010–02, (''IEC 60034–1''), Rotating Electrical Machines, Part 1: Rating and Performance, February 2010, IBR approved as follows: section 4: Duty, clause 4.2.1 and Figure 1, IBR approved for § 431.12.

(2) IEC 60034–1, Edition 12.0 2010–02, (''IEC 60034–1:2010''), Rotating Electrical Machines—Part 1: Rating and Performance, IBR approved for appendix B to this subpart.

(3) IEC 60034–2–1:2014, *Rotating electrical machines—Part 2–1: Standard methods for determining losses and efficiency from tests (excluding machines for traction vehicles)*, Edition 2.0, 2014–06; IBR approved for § 431.12 and appendix B to this subpart.

(4) IEC 60034–12:2016, *Rotating electrical machines, Part 12: Starting performance of single-speed three-phase cage induction motors*, Edition 3.0, 2016–11; IBR approved for § 431.12.

(5) IEC 60050–411, International Electrotechnical Vocabulary Chapter 411: Rotating machines, 1996, IBR approved as follows: sections 411–33–07 and 411–37–26, IBR approved for § 431.12.

(6) IEC 60051–1:2016, Edition 6.0 2016–02, (''IEC 60051–1:2016''), Direct acting indicating analogue electrical measuring instruments and their accessories—Part 1: Definitions and general requirements common to all parts, IBR approved for appendix B to this subpart.

(7) IEC 60072–1, *Dimensions and Output Series for Rotating Electrical Machines—Part 1: Frame numbers 56 to 400 and flange numbers 55 to 1080*, Sixth edition, 1991–02; IBR approved as follows: clauses 2, 3, 4.1, 6.1, 7, and 10, and Tables 1, 2 and 4; IBR approved for § 431.12 and appendix B to this subpart.

(8) IEC 60079–7:2015, *Explosive atmospheres—Part 7: Equipment protection by increased safety ''e''*, Edition 5.0, 2015–06; IBR approved for § 431.12.

(9) IEC 61800–9–2:2017, *Adjustable speed electrical power drive systems—Part 9–2: Ecodesign for power drive systems, motor starters, power electronics and their driven applications—Energy efficiency indicators for power drive systems and motor starters*, Edition 1.0, 2017–03; IBR approved for appendix B to this subpart.

(d) *IEEE*. Institute of Electrical and Electronics Engineers, Inc., 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855–1331; (800) 678–IEEE (4333); *www.ieee.org/web/publications/home/index.html*.

(1) IEEE Std 112–2017 (''IEEE 112–2017''), *IEEE Standard Test Procedure for Polyphase Induction Motors and Generators*, approved December 6, 2017; IBR approved for § 431.12 and appendix B to this subpart.

(2) IEEE Std 114–2010 (''IEEE 114–2010''), *Test Procedure for Single-Phase Induction Motors*, December 23, 2010; IBR approved for appendix B to this subpart.

(e) *NEMA*. National Electrical Manufacturers Association, 1300 North 17th Street, Suite 1752, Rosslyn, Virginia 22209; (703) 841–3200; *www.nema.org/*.

(1) ANSI/NEMA MG 1–2016 (Revision 1, 2018) (''NEMA MG 1–2016''), *Motors and Generators*, ANSI-approved June 15, 2021; IBR approved for § 431.12 and appendix B to this subpart.

(2) NEMA Standards Publication MG1–1967 (''NEMA MG1–1967''), *Motors and Generators*, January 1968; as follows:

(i) *Part 11, Dimension;* IBR approved for § 431.12.

(ii) *Part 13, Frame Assignments—A–C Integral-Horsepower Motors;* IBR approved for § 431.12.

(f) *NFPA*. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169–7471; (617) 770–3000; *www.nfpa.org/*.

(1) NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*, 2022 Edition, ANSI-approved April 8, 2021. IBR approved for § 431.12.

(2) [Reserved]

[77 FR 26634, May 4, 2012, as amended at 78 FR 75994, Dec. 13, 2013; 86 FR 21, Jan. 4, 2021; 87 FR 63656, Oct. 19, 2022]

§ 431.16 Test procedures for the measurement of energy efficiency.

For purposes of 10 CFR part 431 and EPCA, the test procedures for measuring the energy efficiency of an electric motor shall be the test procedures specified in appendix B to this subpart B.

§ 431.17 [Reserved]

§ 431.18 Testing laboratories.

(a) Testing pursuant to § 431.17(a)(5)(ii) must be conducted in an accredited laboratory for which the accreditation body was:

(1) The National Institute of Standards and Technology/National Voluntary Laboratory Accreditation Program (NIST/NVLAP); or

(2) A laboratory accreditation body having a mutual recognition arrangement with NIST/NVLAP; or

(3) An organization classified by the Department, pursuant to § 431.19, as an accreditation body.

(b) NIST/NVLAP is under the auspices of the National Institute of Standards and Technology (NIST)/National Voluntary Laboratory Accreditation Program (NVLAP), which is part of the U.S. Department of Commerce. NIST/NVLAP accreditation is granted on the basis of conformance with criteria published in 15 CFR part 285. The National Voluntary Laboratory Accreditation Program, ''Procedures and General Requirements,'' NIST Handbook 150–10, April 2020, (referenced for guidance only, *see* § 429.3 of this subchapter) present the technical requirements of NVLAP for the Efficiency of Electric Motors field of accreditation. This handbook supplements NIST Handbook 150, National Voluntary Laboratory Accreditation Program ''Procedures and General Requirements,'' which contains 15 CFR part 285 plus all general NIST/NVLAP procedures, criteria, and policies. Information regarding NIST/NVLAP and its Efficiency of Electric Motors Program (EEM) can be obtained from NIST/NVLAP, 100 Bureau Drive, Mail Stop 2140, Gaithersburg, MD 20899–2140, (301) 975–4016 (telephone), or (301) 926–2884 (fax).

[69 FR 61923, Oct. 21, 2004, as amended at 77 FR 26635, May 4, 2012; 87 FR 63657, Oct. 19, 2022]

ENERGY CONSERVATION STANDARDS

§ 431.25 Energy conservation standards and effective dates.

(a) Except as provided for fire pump electric motors in paragraph (b) of this section, each general purpose electric motor (subtype I) with a power rating of 1 horsepower or greater, but not greater than 200 horsepower, including a NEMA Design B or an equivalent IEC Design N motor that is a general purpose electric motor (subtype I), manufactured (alone or as a component of another piece of equipment) on or after December 19, 2010, but before June 1, 2016, shall have a nominal full-load efficiency that is not less than the following:

TABLE 1—NOMINAL FULL-LOAD EFFICIENCIES OF GENERAL PURPOSE ELECTRIC MOTORS (SUBTYPE I), EXCEPT FIRE PUMP ELECTRIC MOTORS

Motor horsepower/Standard kilowatt equivalent	Nominal full-load efficiency					
	Open motors (number of poles)			Enclosed motors (number of poles)		
	6	4	2	6	4	2
1/.75	82.5	85.5	77.0	82.5	85.5	77.0
1.5/1.1	86.5	86.5	84.0	87.5	86.5	84.0
2/1.5	87.5	86.5	85.5	88.5	86.5	85.5
3/2.2	88.5	89.5	85.5	89.5	89.5	86.5
5/3.7	89.5	89.5	86.5	89.5	89.5	88.5
7.5/5.5	90.2	91.0	88.5	91.0	91.7	89.5
10/7.5	91.7	91.7	89.5	91.0	91.7	90.2
15/11	91.7	93.0	90.2	91.7	92.4	91.0
20/15	92.4	93.0	91.0	91.7	93.0	91.0
25/18.5	93.0	93.6	91.7	93.0	93.6	91.7
30/22	93.6	94.1	91.7	93.0	93.6	91.7
40/30	94.1	94.1	92.4	94.1	94.1	92.4
50/37	94.1	94.5	93.0	94.1	94.5	93.0
60/45	94.5	95.0	93.6	94.5	95.0	93.6

TABLE 1—NOMINAL FULL-LOAD EFFICIENCIES OF GENERAL PURPOSE ELECTRIC MOTORS (SUBTYPE I), EXCEPT FIRE PUMP ELECTRIC MOTORS—Continued

Motor horsepower/Standard kilowatt equivalent	Nominal full-load efficiency					
	Open motors (number of poles)			Enclosed motors (number of poles)		
	6	4	2	6	4	2
75/55	94.5	95.0	93.6	94.5	95.4	93.6
100/75	95.0	95.4	93.6	95.0	95.4	94.1
125/90	95.0	95.4	94.1	95.0	95.4	95.0
150/110	95.4	95.8	94.1	95.8	95.8	95.0
200/150	95.4	95.8	95.0	95.8	96.2	95.4

(b) Each fire pump electric motor that is a general purpose electric motor (subtype I) or general purpose electric motor (subtype II) manufactured (alone or as a component of another piece of equipment) on or after December 19, 2010, but before June 1, 2016, shall have a nominal full-load efficiency that is not less than the following:

TABLE 2—NOMINAL FULL-LOAD EFFICIENCIES OF FIRE PUMP ELECTRIC MOTORS

Motor horsepower/standard kilowatt equivalent	Nominal full-load efficiency							
	Open motors (number of poles)				Enclosed motors (number of poles)			
	8	6	4	2	8	6	4	2
1/.75	74.0	80.0	82.5	....	74.0	80.0	82.5	75.5
1.5/1.1	75.5	84.0	84.0	82.5	77.0	85.5	84.0	82.5
2/1.5	85.5	85.5	84.0	84.0	82.5	86.5	84.0	84.0
3/2.2	86.5	86.5	86.5	84.0	84.0	87.5	87.5	85.5
5/3.7	87.5	87.5	87.5	85.5	85.5	87.5	87.5	87.5
7.5/5.5	88.5	88.5	88.5	87.5	85.5	89.5	89.5	88.5
10/7.5	89.5	90.2	89.5	88.5	88.5	89.5	89.5	89.5
15/11	89.5	90.2	91.0	89.5	88.5	90.2	91.0	90.2
20/15	90.2	91.0	91.0	90.2	89.5	90.2	91.0	90.2
25/18.5	90.2	91.7	91.7	91.0	89.5	91.7	92.4	91.0
30/22	91.0	92.4	92.4	91.0	91.0	91.7	92.4	91.0
40/30	91.0	93.0	93.0	91.7	91.0	93.0	93.0	91.7
50/37	91.7	93.0	93.0	92.4	91.7	93.0	93.0	92.4
60/45	92.4	93.6	93.6	93.0	91.7	93.6	93.6	93.0
75/55	93.6	93.6	94.1	93.0	93.0	93.6	94.1	93.0
100/75	93.6	94.1	94.1	93.0	93.0	94.1	94.5	93.6
125/90	93.6	94.1	94.5	93.6	93.6	94.1	94.5	94.5
150/110	93.6	94.5	95.0	93.6	93.6	95.0	95.0	94.5
200/150	93.6	94.5	95.0	94.5	94.1	95.0	95.0	95.0
250/186	94.5	95.4	95.4	94.5	94.5	95.0	95.0	95.4
300/224	....	95.4	95.4	95.0	....	95.0	95.4	95.4
350/261	....	95.4	95.4	95.0	....	95.0	95.4	95.4
400/298	....	....	95.4	95.4	....	....	95.4	95.4
450/336	....	....	95.8	95.8	....	....	95.4	95.4
500/373	....	....	95.8	95.8	....	....	95.8	95.4

(c) Except as provided for fire pump electric motors in paragraph (b) of this section, each general purpose electric motor (subtype II) with a power rating of 1 horsepower or greater, but not greater than 200 horsepower, including a NEMA Design B or an equivalent IEC Design N motor that is a general purpose electric motor (subtype II), manufactured (alone or as a component of another piece of equipment) on or after December 19, 2010, but before June 1, 2016, shall have a nominal full-load efficiency that is not less than the following:

TABLE 3—NOMINAL FULL-LOAD EFFICIENCIES OF GENERAL PURPOSE ELECTRIC MOTORS (SUBTYPE II), EXCEPT FIRE PUMP ELECTRIC MOTORS

Motor horsepower/ Standard kilowatt equivalent	Nominal full-load efficiency							
	Open motors (number of poles)				Enclosed motors (number of poles)			
	8	6	4	2	8	6	4	2
1/.75	74.0	80.0	82.5	....	74.0	80.0	82.5	75.5
1.5/1.1	75.5	84.0	84.0	82.5	77.0	85.5	84.0	82.5
2/1.5	85.5	85.5	84.0	84.0	82.5	86.5	84.0	84.0
3/2.2	86.5	86.5	86.5	84.0	84.0	87.5	87.5	85.5
5/3.7	87.5	87.5	87.5	85.5	85.5	87.5	87.5	87.5
7.5/5.5	88.5	88.5	88.5	87.5	85.5	89.5	89.5	88.5
10/7.5	89.5	90.2	89.5	88.5	88.5	89.5	89.5	89.5
15/11	89.5	90.2	91.0	89.5	88.5	90.2	91.0	90.2
20/15	90.2	91.0	91.0	90.2	89.5	90.2	91.0	90.2
25/18.5	90.2	91.7	91.7	91.0	89.5	91.7	92.4	91.0
30/22	91.0	92.4	92.4	91.0	91.0	91.7	92.4	91.0
40/30	91.0	93.0	93.0	91.7	91.0	93.0	93.0	91.7
50/37	91.7	93.0	93.0	92.4	91.7	93.0	93.0	92.4
60/45	92.4	93.6	93.6	93.0	91.7	93.6	93.6	93.0
75/55	93.6	93.6	94.1	93.0	93.0	93.6	94.1	93.0
100/75	93.6	94.1	94.1	93.0	93.0	94.1	94.5	93.6
125/90	93.6	94.1	94.5	93.6	93.6	94.1	94.5	94.5
150/110	93.6	94.5	95.0	93.6	93.6	95.0	95.0	94.5
200/150	93.6	94.5	95.0	94.5	94.1	95.0	95.0	95.0

(d) Each NEMA Design B or an equivalent IEC Design N motor that is a general purpose electric motor (subtype I) or general purpose electric motor (subtype II), excluding fire pump electric motors, with a power rating of more than 200 horsepower, but not greater than 500 horsepower, manufactured (alone or as a component of another piece of equipment) on or after December 19, 2010, but before June 1, 2016 shall have a nominal full-load efficiency that is not less than the following:

TABLE 4—NOMINAL FULL-LOAD EFFICIENCIES OF NEMA DESIGN B GENERAL PURPOSE ELECTRIC MOTORS (SUBTYPE I AND II), EXCEPT FIRE PUMP ELECTRIC MOTORS

Motor horsepower/ standard kilowatt equivalent	Nominal full-load efficiency							
	Open motors (number of poles)				Enclosed motors (number of poles)			
	8	6	4	2	8	6	4	2
250/186	94.5	95.4	95.4	94.5	94.5	95.0	95.0	95.4
300/224	....	95.4	95.4	95.0	....	95.0	95.4	95.4
350/261	....	95.4	95.4	95.0	....	95.0	95.4	95.4
400/298	....	....	95.4	95.4	....	....	95.4	95.4
450/336	....	....	95.8	95.8	....	....	95.4	95.4
500/373	....	....	95.8	95.8	....	....	95.8	95.4

(e) For purposes of determining the required minimum nominal full-load efficiency of an electric motor that has a horsepower or kilowatt rating between two horsepower or two kilowatt ratings listed in any table of energy conservation standards in paragraphs (a) through (d) of this section, each such motor shall be deemed to have a listed horsepower or kilowatt rating, determined as follows:

(1) A horsepower at or above the midpoint between the two consecutive horsepowers shall be rounded up to the higher of the two horsepowers;

(2) A horsepower below the midpoint between the two consecutive horsepowers shall be rounded down to the lower of the two horsepowers; or

(3) A kilowatt rating shall be directly converted from kilowatts to horsepower using the formula 1 kilowatt = ($^{1}/_{0.746}$) horsepower. The conversion

should be calculated to three significant decimal places, and the resulting horsepower shall be rounded in accordance with paragraph (e)(1) or (e)(2) of this section, whichever applies.

(f) The standards in Table 1 through Table 4 of this section do not apply to definite purpose electric motors, special purpose electric motors, or those motors exempted by the Secretary.

(g) The standards in Table 5 through Table 7 of this section apply only to electric motors, including partial electric motors, that satisfy the following criteria:

(1) Are single-speed, induction motors;

(2) Are rated for continuous duty (MG 1) operation or for duty type S1 (IEC);

(3) Contain a squirrel-cage (MG 1) or cage (IEC) rotor;

(4) Operate on polyphase alternating current 60-hertz sinusoidal line power;

(5) Are rated 600 volts or less;

(6) Have a 2-, 4-, 6-, or 8-pole configuration,

(7) Are built in a three-digit or four-digit NEMA frame size (or IEC metric equivalent), including those designs between two consecutive NEMA frame sizes (or IEC metric equivalent), or an enclosed 56 NEMA frame size (or IEC metric equivalent),

(8) Produce at least one horsepower (0.746 kW) but not greater than 500 horsepower (373 kW), and

(9) Meet all of the performance requirements of one of the following motor types: A NEMA Design A, B, or C motor or an IEC Design N, NE, NEY, NY or H, HE, HEY, HY motor.

(h) Starting on June 1, 2016, each NEMA Design A motor, NEMA Design B motor, and IEC Design N (including NE, NEY, or NY variants) motor that is an electric motor meeting the criteria in paragraph (g) of this section and with a power rating from 1 horsepower through 500 horsepower, but excluding fire pump electric motors, manufactured (alone or as a component of another piece of equipment) shall have a nominal full-load efficiency of not less than the following:

TABLE 5 TO PARAGRAPH (h)—NOMINAL FULL-LOAD EFFICIENCIES OF NEMA DESIGN A, NEMA DESIGN B AND IEC DESIGN N, NE, NEY OR NY MOTORS (EXCLUDING FIRE PUMP ELECTRIC MOTORS) AT 60 HZ

Motor horsepower/ standard kilowatt equivalent	Nominal full-load efficiency (%)							
	2 Pole		4 Pole		6 Pole		8 Pole	
	Enclosed	Open	Enclosed	Open	Enclosed	Open	Enclosed	Open
1/.75	77.0	77.0	85.5	85.5	82.5	82.5	75.5	75.5
1.5/1.1	84.0	84.0	86.5	86.5	87.5	86.5	78.5	77.0
2/1.5	85.5	85.5	86.5	86.5	88.5	87.5	84.0	86.5
3/2.2	86.5	85.5	89.5	89.5	89.5	88.5	85.5	87.5
5/3.7	88.5	86.5	89.5	89.5	89.5	89.5	86.5	88.5
7.5/5.5	89.5	88.5	91.7	91.0	91.0	90.2	86.5	89.5
10/7.5	90.2	89.5	91.7	91.7	91.0	91.7	89.5	90.2
15/11	91.0	90.2	92.4	93.0	91.7	91.7	89.5	90.2
20/15	91.0	91.0	93.0	93.0	91.7	92.4	90.2	91.0
25/18.5	91.7	91.7	93.6	93.6	93.0	93.0	90.2	91.0
30/22	91.7	91.7	93.6	94.1	93.0	93.6	91.7	91.7
40/30	92.4	92.4	94.1	94.1	94.1	94.1	91.7	91.7
50/37	93.0	93.0	94.5	94.5	94.1	94.1	92.4	92.4
60/45	93.6	93.6	95.0	95.0	94.5	94.5	92.4	93.0
75/55	93.6	93.6	95.4	95.0	94.5	94.5	93.6	94.1
100/75	94.1	93.6	95.4	95.4	95.0	95.0	93.6	94.1
125/90	95.0	94.1	95.4	95.4	95.0	95.0	94.1	94.1
150/110	95.0	94.1	95.8	95.8	95.8	95.4	94.1	94.1
200/150	95.4	95.0	96.2	95.8	95.8	95.4	94.5	94.1
250/186	95.8	95.0	96.2	95.8	95.8	95.8	95.0	95.0
300/224	95.8	95.4	96.2	95.8	95.8	95.8		
350/261	95.8	95.4	96.2	95.8	95.8	95.8		
400/298	95.8	95.8	96.2	95.8				
450/336	95.8	96.2	96.2	96.2				
500/373	95.8	96.2	96.2	96.2	....	....	....	....

(i) Starting on June 1, 2016, each NEMA Design C motor and IEC Design H (including HE, HEY, or HY variants) motor that is an electric motor meeting the criteria in paragraph (g) of this section and with a power rating from 1 horsepower through 200 horsepower manufactured (alone or as a component of another piece of equipment) shall have a nominal full-load efficiency that is not less than the following:

TABLE 6 TO PARAGRAPH (i)—NOMINAL FULL-LOAD EFFICIENCIES OF NEMA DESIGN C AND IEC DESIGN H, HE, HEY OR HY MOTORS AT 60 HZ

Motor horsepower/standard kilowatt equivalent	Nominal full-load efficiency (%)					
	4 Pole		6 Pole		8 Pole	
	Enclosed	Open	Enclosed	Open	Enclosed	Open
1/.75	85.5	85.5	82.5	82.5	75.5	75.5
1.5/1.1	86.5	86.5	87.5	86.5	78.5	77.0
2/1.5	86.5	86.5	88.5	87.5	84.0	86.5
3/2.2	89.5	89.5	89.5	88.5	85.5	87.5
5/3.7	89.5	89.5	89.5	89.5	86.5	88.5
7.5/5.5	91.7	91.0	91.0	90.2	86.5	89.5
10/7.5	91.7	91.7	91.0	91.7	89.5	90.2
15/11	92.4	93.0	91.7	91.7	89.5	90.2
20/15	93.0	93.0	91.7	92.4	90.2	91.0
25/18.5	93.6	93.6	93.0	93.0	90.2	91.0
30/22	93.6	94.1	93.0	93.6	91.7	91.7
40/30	94.1	94.1	94.1	94.1	91.7	91.7
50/37	94.5	94.5	94.1	94.1	92.4	92.4
60/45	95.0	95.0	94.5	94.5	92.4	93.0
75/55	95.4	95.0	94.5	94.5	93.6	94.1
100/75	95.4	95.4	95.0	95.0	93.6	94.1
125/90	95.4	95.4	95.0	95.0	94.1	94.1
150/110	95.8	95.8	95.8	95.4	94.1	94.1
200/150	96.2	95.8	95.8	95.4	94.5	94.1

(j) Starting on June 1, 2016, each fire pump electric motor meeting the criteria in paragraph (g) of this section and with a power rating of 1 horsepower through 500 horsepower, manufactured (alone or as a component of another piece of equipment) shall have a nominal full-load efficiency that is not less than the following:

TABLE 7—NOMINAL FULL-LOAD EFFICIENCIES OF FIRE PUMP ELECTRIC MOTORS AT 60 HZ

Motor horsepower/ standard kilowatt equivalent	Nominal full-load efficiency (%)							
	2 Pole		4 Pole		6 Pole		8 Pole	
	Enclosed	Open	Enclosed	Open	Enclosed	Open	Enclosed	Open
1/.75	75.5	....	82.5	82.5	80.0	80.0	74.0	74.0
1.5/1.1	82.5	82.5	84.0	84.0	85.5	84.0	77.0	75.5
2/1.5	84.0	84.0	84.0	84.0	86.5	85.5	82.5	85.5
3/2.2	85.5	84.0	87.5	86.5	87.5	86.5	84.0	86.5
5/3.7	87.5	85.5	87.5	87.5	87.5	87.5	85.5	87.5
7.5/5.5	88.5	87.5	89.5	88.5	89.5	88.5	85.5	88.5
10/7.5	89.5	88.5	89.5	89.5	89.5	90.2	88.5	89.5
15/11	90.2	89.5	91.0	91.0	90.2	90.2	88.5	89.5
20/15	90.2	90.2	91.0	91.0	90.2	91.0	89.5	90.2
25/18.5	91.0	91.0	92.4	91.7	91.7	91.7	89.5	90.2
30/22	91.0	91.0	92.4	92.4	91.7	92.4	91.0	91.0
40/30	91.7	91.7	93.0	93.0	93.0	93.0	91.0	91.0
50/37	92.4	92.4	93.0	93.0	93.0	93.0	91.7	91.7
60/45	93.0	93.0	93.6	93.6	93.6	93.6	91.7	92.4
75/55	93.0	93.0	94.1	94.1	93.6	93.6	93.0	93.6
100/75	93.6	93.0	94.5	94.1	94.1	94.1	93.0	93.6
125/90	94.5	93.6	94.5	94.5	94.1	94.1	93.6	93.6
150/110	94.5	93.6	95.0	95.0	95.0	94.5	93.6	93.6
200/150	95.0	94.5	95.0	95.0	95.0	94.5	94.1	93.6
250/186	95.4	94.5	95.0	95.4	95.0	95.4	94.5	94.5
300/224	95.4	95.0	95.4	95.4	95.0	95.4		
350/261	95.4	95.0	95.4	95.4	95.0	95.4		

TABLE 7—NOMINAL FULL-LOAD EFFICIENCIES OF FIRE PUMP ELECTRIC MOTORS AT 60 HZ—Continued

Motor horsepower/ standard kilowatt equivalent	Nominal full-load efficiency (%)							
	2 Pole		4 Pole		6 Pole		8 Pole	
	Enclosed	Open	Enclosed	Open	Enclosed	Open	Enclosed	Open
400/298	95.4	95.4	95.4	95.4				
450/336	95.4	95.8	95.4	95.8				
500/373	95.4	95.8	95.8	95.8	....	....	....	....

(k) For purposes of determining the required minimum nominal full-load efficiency of an electric motor that has a horsepower or kilowatt rating between two horsepower or two kilowatt ratings listed in any table of energy conservation standards in paragraphs (h) through (l) of this section, each such motor shall be deemed to have a listed horsepower or kilowatt rating, determined as follows:

(1) A horsepower at or above the midpoint between the two consecutive horsepowers shall be rounded up to the higher of the two horsepowers;

(2) A horsepower below the midpoint between the two consecutive horsepowers shall be rounded down to the lower of the two horsepowers; or

(3) A kilowatt rating shall be directly converted from kilowatts to horsepower using the formula 1 kilowatt = ($^1/_{0.746}$) horsepower. The conversion should be calculated to three significant decimal places, and the resulting horsepower shall be rounded in accordance with paragraph (k)(1) or (k)(2) of this section, whichever applies.

(l) The standards in Table 5 through Table 7 of this section do not apply to the following electric motors exempted by the Secretary, or any additional electric motors that the Secretary may exempt:

(1) Air-over electric motors;

(2) Component sets of an electric motor;

(3) Liquid-cooled electric motors;

(4) Submersible electric motors; and

(5) Inverter-only electric motors.

[79 FR 31010, May 29, 2014, as amended at 87 FR 63657, Oct. 19, 2022]

§431.26 Preemption of State regulations.

Any State regulation providing for any energy conservation standard, or other requirement with respect to the energy efficiency or energy use, of an electric motor that is not identical to a Federal standard in effect under this subpart is preempted by that standard, except as provided for in Section 345(a) and 327(b) and (c) of the Act.

LABELING

§431.31 Labeling requirements.

(a) *Electric motor nameplate*—(1) *Required information.* The permanent nameplate of an electric motor for which standards are prescribed in §431.25 must be marked clearly with the following information:

(i) The motor's nominal full load efficiency (as of the date of manufacture), derived from the motor's average full load efficiency as determined pursuant to this subpart; and

(ii) A Compliance Certification number (''CC number'') supplied by DOE to the manufacturer or private labeler, pursuant to §431.36(f), and applicable to that motor. Such CC number must be on the nameplate of a motor beginning 90 days after either:

(A) The manufacturer or private labeler has received the number upon submitting a Compliance Certification covering that motor, or

(B) The expiration of 21 days from DOE's receipt of a Compliance Certification covering that motor, if the manufacturer or private labeler has not been advised by DOE that the Compliance Certification fails to satisfy §431.36.

(2) *Display of required information.* All orientation, spacing, type sizes, type faces, and line widths to display this required information shall be the same as or similar to the display of the other performance data on the motor's permanent nameplate. The nominal full-

load efficiency shall be identified either by the term ''Nominal Efficiency'' or ''Nom. Eff.'' or by the terms specified in paragraph 12.58.2 of NEMA MG1–2009, (incorporated by reference, see § 431.15) as for example ''NEMA Nom. Eff. ____.'' The Compliance Certification number issued pursuant to § 431.36 shall be in the form ''CC ____.''

(3) *Optional display*. The permanent nameplate of an electric motor, a separate plate, or decalcomania, may be marked with the encircled lower case letters ''ee'', for example,

or with some comparable designation or logo, if the motor meets the applicable standard prescribed in § 431.25, as determined pursuant to this subpart, and is covered by a Compliance Certification that satisfies § 431.36.

(b) *Disclosure of efficiency information in marketing materials*. (1) The same information that must appear on an electric motor's permanent nameplate pursuant to paragraph (a)(1) of this section, shall be prominently displayed:

(i) On each page of a catalog that lists the motor; and

(ii) In other materials used to market the motor.

(2) The ''ee'' logo, or other similar logo or designations, may also be used in catalogs and other materials to the same extent they may be used on labels under paragraph (a)(3) of this section.

[69 FR 61923, Oct. 21, 2004, as amended at 77 FR 26637, May 4, 2012]

§ 431.32 Preemption of State regulations.

The provisions of § 431.31 supersede any State regulation to the extent required by Section 327 of the Act. Pursuant to the Act, all State regulations that require the disclosure for any electric motor of information with respect to energy consumption, other than the information required to be disclosed in accordance with this part, are superseded.

CERTIFICATION

§ 431.35 Applicability of certification requirements.

Section 431.36 sets forth the procedures for manufacturers to certify that electric motors comply with the applicable energy efficiency standards set forth in this subpart.

§ 431.36 Compliance Certification.

(a) *General*. A manufacturer or private labeler shall not distribute in commerce any basic model of an electric motor which is subject to an energy efficiency standard set forth in this subpart unless it has submitted to the Department a Compliance Certification certifying, in accordance with the provisions of this section, that the basic model meets the requirements of the applicable standard. The representations in the Compliance Certification must be based upon the basic model's energy efficiency as determined in accordance with the applicable requirements of this subpart. This means, in part, that either:

(1) The representations as to the basic model must be based on use of a certification organization; or

(2) Any testing of the basic model on which the representations are based must be conducted at an accredited laboratory.

(b) *Required contents*—(1) *General representations*. Each Compliance Certification must certify that:

(i) The nominal full load efficiency for each basic model of electric motor distributed is not less than the minimum nominal full load efficiency required for that motor by § 431.25;

(ii) All required determinations on which the Compliance Certification is based were made in compliance with the applicable requirements prescribed in this subpart;

(iii) All information reported in the Compliance Certification is true, accurate, and complete; and

(iv) The manufacturer or private labeler is aware of the penalties associated with violations of the Act and the regulations thereunder, and of 18 U.S.C. 1001 which prohibits knowingly making false statements to the Federal Government.

(2) *Specific data.* (i) For each rating of electric motor (as the term "rating" is defined in the definition of basic model) which a manufacturer or private labeler distributes, the Compliance Certification must report the nominal full load efficiency, determined pursuant to §§ 431.16 and 431.17, of the least efficient basic model within that rating.

(ii) The Compliance Certification must identify the basic models on which actual testing has been performed to meet the requirements of § 431.17.

(iii) The format for a Compliance Certification is set forth in appendix C of this subpart.

(c) *Optional contents.* In any Compliance Certification, a manufacturer or private labeler may at its option request that DOE provide it with a unique Compliance Certification number ("CC number") for any brand name, trademark or other label name under which the manufacturer or private labeler distributes electric motors covered by the Certification. Such a Compliance Certification must also identify all other names, if any, under which the manufacturer or private labeler distributes electric motors, and to which the request does not apply.

(d) *Signature and submission.* A manufacturer or private labeler must submit the Compliance Certification either on its own behalf, signed by a corporate official of the company, or through a third party (for example, a trade association or other authorized representative) acting on its behalf. Where a third party is used, the Compliance Certification must identify the official of the manufacturer or private labeler who authorized the third party to make representations on the company's behalf, and must be signed by a corporate official of the third party. The Compliance Certification must be submitted to the Department electronically at *https://www.regulations.doe.gov/ccms.* Alternatively, the Compliance Certification may be submitted by certified mail to: Certification and Compliance Reports, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Program, EE–2J, Forrestal Building, 1000 Independence Avenue, SW., Washington, DC 20585–0121.

(e) *New basic models.* For electric motors, a Compliance Certification must be submitted for a new basic model only if the manufacturer or private labeler has not previously submitted to DOE a Compliance Certification, that meets the requirements of this section, for a basic model that has the same rating as the new basic model, and that has a lower nominal full load efficiency than the new basic model.

(f) *Response to Compliance Certification; Compliance Certification Number (CC number)*—(1) DOE processing of Certification. Promptly upon receipt of a Compliance Certification, the Department will determine whether the document contains all of the elements required by this section, and may, in its discretion, determine whether all or part of the information provided in the document is accurate. The Department will then advise the submitting party in writing either that the Compliance Certification does not satisfy the requirements of this section, in which case the document will be returned, or that the Compliance Certification satisfies this section. The Department will also advise the submitting party of the basis for its determination.

(2) *Issuance of CC number(s).* (i) Initial Compliance Certification. When DOE advises that the initial Compliance Certification submitted by or on behalf of a manufacturer or private labeler is acceptable, either:

(A) DOE will provide a single unique CC number, "CC_______," to the manufacturer or private labeler, and such CC number shall be applicable to all electric motors distributed by the manufacturer or private labeler, or

(B) When required by paragraph (f)(3) of this section, DOE will provide more than one CC number to the manufacturer or private labeler.

(ii) Subsequent Compliance Certification. When DOE advises that any other Compliance Certification is acceptable, it will provide a unique CC number for any brand name, trademark or other name when required by paragraph (f)(3) of this section.

(iii) When DOE declines to provide a CC number as requested by a manufacturer or private labeler in accordance with § 431.36(c), DOE will advise the requester of the reasons for such refusal.

(3) *Issuance of two or more CC numbers.* (i) DOE will provide a unique CC number for each brand name, trademark or other label name for which a manufacturer or private labeler requests such a number in accordance with § 431.36(c), except as follows. DOE will not provide a CC number for any brand name, trademark or other label name

(A) For which DOE has previously provided a CC number, or

(B) That duplicates or overlaps with other names under which the manufacturer or private labeler sells electric motors.

(ii) Once DOE has provided a CC number for a particular name, that shall be the only CC number applicable to all electric motors distributed by the manufacturer or private labeler under that name.

(iii) If the Compliance Certification in which a manufacturer or private labeler requests a CC number is the initial Compliance Certification submitted by it or on its behalf, and it distributes electric motors not covered by the CC number(s) DOE provides in response to the request(s), DOE will also provide a unique CC number that shall be applicable to all of these other motors.

[69 FR 61923, Oct. 21, 2004, as amended at 76 FR 59006, Sept. 23, 2011; 77 FR 26638, May 4, 2012]

Appendix A to Subpart B of Part 431 [Reserved]

Appendix B to Subpart B of Part 431—Uniform Test Method for Measuring the Efficiency of Electric Motors

NOTE: Manufacturers of electric motors subject to energy conservation standards in § 431.25 must test in accordance with this appendix.

For any other electric motor that is not currently covered by the energy conservation standards at § 431.25, manufacturers of this equipment must test in accordance with this appendix 180 days after the effective date of the final rule adopting energy conservation standards for such motor. For any other electric motor that is not currently covered by the energy conservation standards at § 431.25, manufacturers choosing to make any representations respecting of energy efficiency for such motors must test in accordance with this appendix.

0. Incorporation by Reference

In § 431.15, DOE incorporated by reference the entire standard for CSA C390–10, CSA C747–09, IEC 60034–1:2010, IEC 60034–2–1:2014, IEC 60051–1:2016, IEC 61800–9–2:2017, IEEE 112–2017, IEEE 114–2010, and NEMA MG 1–2016; however, only enumerated provisions of those documents are applicable as follows. In cases where there is a conflict, the language of this appendix takes precedence over those documents. Any subsequent amendment to a referenced document by the standard-setting organization will not affect the test procedure in this appendix, unless and until the test procedure is amended by DOE.

0.1. CSA C390–10

(a) Section 1.3 ‘‘Scope,’’ as specified in sections 2.1.1 and 2.3.3.2 of this appendix;

(b) Section 3.1 ‘‘Definitions,’’ as specified in sections 2.1.1 and 2.3.3.2 of this appendix;

(c) Section 5 ‘‘General test requirements—Measurements,’’ as specified in sections 2.1.1 and 2.3.3.2 of this appendix;

(d) Section 7 ‘‘Test method,’’ as specified in sections 2.1.1 and 2.3.3.2 of this appendix;

(e) Table 1 ‘‘Resistance measurement time delay,’’ as specified in sections 2.1.1 and 2.3.3.2 of this appendix;

(f) Annex B ‘‘Linear regression analysis,’’ as specified in sections 2.1.1 and 2.3.3.2 of this appendix; and

(g) Annex C ‘‘Procedure for correction of dynamometer torque readings’’ as specified in sections 2.1.1 and 2.3.3.2 of this appendix.

0.2. CSA C747–09

(a) Section 1.6 ‘‘Scope’’ as specified in sections 2.3.1.2 and 2.3.2.2 of this appendix;

(b) Section 3 ‘‘Definitions’’ as specified in sections 2.3.1.2 and 2.3.2.2 of this appendix;

(c) Section 5 ‘‘General test requirements’’ as specified in sections 2.3.1.2 and 2.3.2.2 of this appendix; and

(d) Section 6 ‘‘Test method’’ as specified in sections 2.3.1.2 and 2.3.2.2 of this appendix.

0.3. IEC 60034–1:2010

(a) Section 4.2.1 as specified in section 1.2 of this appendix;

(b) Section 7.2 as specified in sections 2.1.2, 2.3.1.3, 2.3.2.3, and 2.3.3.3 of this appendix;

(c) Section 8.6.2.3.3 as specified in sections 2.1.2, 2.3.1.3, 2.3.2.3, and 2.3.3.3 of this appendix; and

(d) Table 5 as specified in sections 2.1.2, 2.3.1.3, 2.3.2.3, and 2.3.3.3 of this appendix.

0.4. IEC 60034–2–1:2014

(a) Method 2–1–1A (which also includes paragraphs (b) through (f) of this section) as specified in sections 2.3.1.3 and 2.3.2.3 of this appendix;

(b) Method 2–1–1B (which also includes paragraphs (b) through (e), (g), and (i) of this section) as specified in sections 2.1.2 and 2.3.3.3 of this appendix;

(c) Section 3 ''Terms and definitions'' as specified in sections 2.1.2, 2.3.1.3, 2.3.2.3, 2.3.3.3, and 2.4.1 of this appendix;

(d) Section 4 ''Symbols and abbreviations'' as specified in sections 2.1.2, 2.3.1.3, 2.3.2.3, 2.3.3.3 and 2.4.1 of this appendix;

(e) Section 5 ''Basic requirements'' as specified in sections 2.1.2, 2.3.1.3, 2.3.2.3, 2.3.3.3, and 2.4.1 of this appendix;

(f) Section 6.1.2 ''Method 2–1–1A—Direct measurement of input and output'' (except Section 6.1.2.2, ''Test Procedure'') as specified in sections 2.3.1.3 and 2.3.2.3 of this appendix;

(g) Section 6.1.3 ''Method 2–1–1B—Summations of losses, additional load losses according to the method of residual losses'' as specified in sections 2.1.2 and 2.3.3.3 of this appendix; and

(h) Section 7.1. ''Preferred Testing Methods'' as specified in section 2.4.1 of this appendix;

(i) Annex D, ''Test report template for 2–1–1B'' as specified in sections 2.1.2 and 2.3.3.3 of this appendix.

0.5. IEC 60051–1:2016

(a) Section 5.2 as specified in sections 2.1.2, 2.3.1.3, 2.3.2.3, and 2.3.3.3 of this appendix; and

(b) [Reserved].

0.6. IEC 61800–9–2:2017

(a) Section 3 ''Terms, definitions, symbols, and abbreviated terms'' as specified in sections 2.4.2 and 2.4.3 of this appendix;

(b) Section 7.7.2, ''Input-output measurement of PDS losses'' as specified in sections 2.4.2 and 2.4.3 of this appendix;

(c) Section 7.7.3.1, ''General'' as specified in sections 2.4.2 and 2.4.3 of this appendix;

(d) Section 7.7.3.2. ''Power analyser and transducers'' as specified in sections 2.4.2 and 2.4.3 of this appendix;

(e) Section 7.7.3.3, ''Mechanical Output of the motor'' as specified in sections 2.4.2 and 2.4.3 of this appendix;

(f) Section 7.7.3.5, ''PDS loss determination according to input-output method'' as specified in sections 2.4.2 and 2.4.3 of this appendix;

(g) Section 7.10 ''Testing Conditions for PDS testing'' as specified in sections 2.4.2 and 2.4.3 of this appendix.

0.7. IEEE 112–2017

(a) Test Method A (which also includes paragraphs (c) through (g), (i), and (j) of this section) as specified in section 2.3.2.1 of this appendix;

(b) Test Method B (which also includes paragraphs (c) through (f), (h), (k) and (l) of this section) as specified in sections 2.1.3 and 2.3.3.1 of this appendix;

(c) Section 3, ''General'' as specified in sections 2.1.3, 2.3.2.1, and 2.3.3.1 of this appendix;

(d) Section 4, ''Measurements'' as specified in sections 2.1.3, 2.3.2.1, and 2.3.3.1 of this appendix;

(e) Section 5, ''Machine losses and tests for losses'' as specified in sections 2.1.3, 2.3.2.1, and 2.3.3.1 of this appendix;

(f) Section 6.1, ''General'' as specified in sections 2.1.3, 2.3.2.1, and 2.3.3.1 of this appendix;

(g) Section 6.3, ''Efficiency test method A—Input-output'' as specified in section 2.3.2.1 of this appendix;

(h) Section 6.4, ''Efficiency test method B—Input-output'' as specified in sections 2.1.3 and 2.3.3.1 of this appendix;

(i) Section 9.2, ''Form A—Method A'' as specified in section 2.3.2.1 of this appendix;

(j) Section 9.3, ''Form A2—Method A calculations'' as specified in section 2.3.2.1 of this appendix;

(k) Section 9.4, ''Form B—Method B'' as specified in sections 2.1.3, and 2.3.3.1 of this appendix; and

(l) Section 9.5, ''Form B2—Method B calculations'' as specified in sections 2.1.3 and 2.3.3.1 of this appendix.

0.8. IEEE 114–2010

(a) Section 3.2, ''Test with load'' as specified in section 2.3.1.1 of this appendix;

(b) Section 4, ''Testing Facilities as specified in section 2.3.1.1 of this appendix;

(c) Section 5, ''Measurements'' as specified in section 2.3.1.1 of this appendix;

(d) Section 6, ''General'' as specified in section 2.3.1.1 of this appendix;

(e) Section 7, ''Type of loss'' as specified in section 2.3.1.1 of this appendix;

(f) Section 8, ''Efficiency and Power Factor'' as specified in section 2.3.1.1 of this appendix;

(g) Section 10 ''Temperature Tests'' as specified in section 2.4.1.1 of this appendix;

(h) Annex A, Section A.3 ''Determination of Motor Efficiency'' as specified in section 2.4.1.1 of this appendix; and

(i) Annex A, Section A.4 ''Explanatory notes for form 3, test data'' as specified in section 2.4.1.1 of this appendix.

0.9. NEMA MG 1–2016

(a) Paragraph 1.40.1, ''Continuous Rating'' as specified in section 1.2 of this appendix;

(b) Paragraph 12.58.1, ''Determination of Motor Efficiency and Losses'' as specified in the introductory paragraph to section 2.1 of this appendix, and

(c) Paragraph 34.1, ''Applicable Motor Efficiency Test Methods'' as specified in section 2.2 of this appendix;

(d) Paragraph 34.2.2 ''AO Temperature Test Procedure 2—Target Temperature with Airflow'' as specified in section 2.2 of this appendix;

(e) Paragraph 34.4, ''AO Temperature Test Procedure 2—Target Temperature with Airflow'' as specified in section 2.2 of this appendix.

1. SCOPE AND DEFINITIONS

1.1 *Scope*. The test procedure applies to the following categories of electric motors: Electric motors that meet the criteria listed at §431.25(g); Electric motors above 500 horsepower; Small, non-small-electric-motor electric motor; and Electric motors that are synchronous motors; and excludes the following categories of motors: inverter-only electric motors that are air-over electric motors, component sets of an electric motor, liquid-cooled electric motors, and submersible electric motors.

1.2 *Definitions*. Definitions contained in §§431.2 and 431.12 are applicable to this appendix, in addition to the following terms (''MG1'' refers to NEMA MG 1–2016 and IEC refers to IEC 60034–1:2010 and IEC 60072–1):

Electric motors above 500 horsepower is defined as an electric motor having a rated horsepower above 500 and up to 750 hp that meets the criteria listed at §431.25(g), with the exception of criteria §431.25(g)(8).

Small, non-small-electric-motor electric motor (''SNEM'') means an electric motor that:

(a) Is not a small electric motor, as defined §431.442 and is not a dedicated-purpose pool pump motor as defined at §431.483;

(b) Is rated for continuous duty (MG 1) operation or for duty type S1 (IEC);

(c) Operates on polyphase or single-phase alternating current 60-hertz (Hz) sinusoidal line power; or is used with an inverter that operates on polyphase or single-phase alternating current 60-hertz (Hz) sinusoidal line power;

(d) Is rated for 600 volts or less;

(e) Is a single-speed induction motor capable of operating without an inverter or is an inverter-only electric motor;

(f) Produces a rated motor horsepower greater than or equal to 0.25 horsepower (0.18 kW); and

(g) Is built in the following frame sizes: any two-, or three-digit NEMA frame size (or IEC metric equivalent) if the motor operates on single-phase power; any two-, or three-digit NEMA frame size (or IEC metric equivalent) if the motor operates on polyphase power, and has a rated motor horsepower less than 1 horsepower (0.75 kW); or a two-digit NEMA frame size (or IEC metric equivalent), if the motor operates on polyphase power, has a rated motor horsepower equal to or greater than 1 horsepower (0.75 kW), and is not an enclosed 56 NEMA frame size (or IEC metric equivalent).

Synchronous Electric Motor means an electric motor that:

(a) Is not a dedicated-purpose pool pump motor as defined at §431.483 or is not an air-over electric motor;

(b) Is a synchronous electric motor;

(c) Is rated for continuous duty (MG 1) operation or for duty type S1 (IEC);

(d) Operates on polyphase or single-phase alternating current 60-hertz (Hz) sinusoidal line power; or is used with an inverter that operates on polyphase or single-phase alternating current 60-hertz (Hz) sinusoidal line power;

(e) Is rated 600 volts or less;

(f) Produces at least 0.25 hp (0.18 kW) but not greater than 750 hp (559 kW).

2. TEST PROCEDURES

2.1. Test Procedures for Electric Motors that meet the criteria listed at §431.25(g), and electric motors above 500 horsepower that are capable of operating without an inverter. Air-over electric motors must be tested in accordance with Section 2.2. Inverter-only electric motors must be tested in accordance with 2.4.

Efficiency and losses must be determined in accordance with NEMA MG 1–2016, Paragraph 12.58.1, ''Determination of Motor Efficiency and Losses,'' or one of the following testing methods:

2.1.1. CSA C390–10 (see section 0.1 of this appendix)

2.1.2. IEC 60034–2–1:2014, Method 2–1–1B (see section 0.4(b) of this appendix). The supply voltage shall be in accordance with Section 7.2 of IEC 60034–1:2010. The measured resistance at the end of the thermal test shall be determined in a similar way to the extrapolation procedure described in Section 8.6.2.3.3 of IEC 60034–1:2010, using the shortest possible time instead of the time interval specified in Table 5 to IEC 60034–1:2010, and extrapolating to zero. The measuring instruments for electrical quantities shall have the equivalent of an accuracy class of 0,2 in case of a direct test and 0,5 in case of an indirect test in accordance with Section 5.2 of IEC 60051–1:2016, or

2.1.3. IEEE 112–2017, Test Method B (see section 0.7(b) of this appendix).

2.2. Test Procedures for Air-Over Electric Motors

Except noted otherwise in section 2.2.1 and 2.2.2 of this appendix, efficiency and losses of air-over electric motors must be determined in accordance with NEMA MG 1–2016 (excluding Paragraph 12.58.1).

2.2.1. The provisions in Paragraph 34.4.1.a.1 of NEMA MG 1–2016 related to the determination of the target temperature for polyphase motors must be replaced by a single target temperature of 75 °C for all insulation classes.

2.2.2. The industry standards listed in Paragraph 34.1 of NEMA MG 1–2016, ''Applicable Motor Efficiency Test Methods'' must correspond to the versions identified in section 0 of this appendix, specifically IEEE 112–2017, IEEE 114–2010, CSA C390–10, CSA C747–09, and IEC 60034–2–1:2014. In addition, when testing in accordance with IEC 60034–2–1:2014, the additional testing instructions in section 2.1.2 of this appendix apply.

2.3. Test Procedures for SNEMs capable of operating without an inverter. Air-over SNEMs must be tested in accordance with section 2.2. of this appendix. Inverter-only SNEMs must be tested in accordance with section 2.4. of this appendix.

2.3.1. The efficiencies and losses of single-phase SNEMs that are not air-over electric motors and are capable of operating without an inverter, are determined using one of the following methods:

2.3.1.1. IEEE 114–2010 (see section 0.8 of this appendix);

2.3.1.2. CSA C747–09 (see section 0.2 of this appendix), or

2.3.1.3. IEC 60034–2–1:2014 Method 2–1–1A (see section 0.4(a) of this appendix),. The supply voltage shall be in accordance with Section 7.2 of IEC 60034–1:2010. The measured resistance at the end of the thermal test shall be determined in a similar way to the extrapolation procedure described in Section 8.6.2.3.3 of IEC 60034–1:2010, using the shortest possible time instead of the time interval specified in Table 5 of IEC 60034–1:2010, and extrapolating to zero. The measuring instruments for electrical quantities shall have the equivalent of an accuracy class of 0,2 in case of a direct test and 0,5 in case of an indirect test in accordance with Section 5.2 of IEC 60051–1:2016.

2.3.1.3.1. *Additional IEC 60034–2–1:2014 Method 2–1–1A Torque Measurement Instructions.* If using IEC 60034–2–1:2014 Method 2–1–1A to measure motor performance, follow the instructions in section 2.3.1.3.2. of this appendix, instead of Section 6.1.2.2 of IEC 60034–2–1:2014;

2.3.1.3.2. Couple the machine under test to a load machine. Measure torque using an inline, shaft-coupled, rotating torque transducer or stationary, stator reaction torque transducer. Operate the machine under test at the rated load until thermal equilibrium is achieved (rate of change 1 K or less per half hour). Record U, I, Pel, n, T, θc.

2.3.2. The efficiencies and losses of polyphase electric motors considered with rated horsepower less than 1 that are not air-over electric motors, and are capable of operating without an inverter, are determined using one of the following methods:

2.3.2.1. IEEE 112–2017 Test Method A (see section 0.7(a) of this appendix);

2.3.2.2. CSA C747–09 (see section 0.2 of this appendix); or

2.3.2.3. IEC 60034–2–1:2014 Method 2–1–1A (see section 0.4(a) of this appendix). The supply voltage shall be in accordance with Section 7.2 of IEC 60034–1:2010. The measured resistance at the end of the thermal test shall be determined in a similar way to the extrapolation procedure described in Section 8.6.2.3.3 of IEC 60034–1:2010 using the shortest possible time instead of the time interval specified in Table 5 of IEC 60034–1:2010, and extrapolating to zero. The measuring instruments for electrical quantities shall have the equivalent of an accuracy class of 0,2 in case of a direct test and 0,5 in case of an indirect test in accordance with Section 5.2 of IEC 60051–1:2016.

2.3.2.3.1. *Additional IEC 60034–2–1:2014 Method 2–1–1A Torque Measurement Instructions.* If using IEC 60034–2–1:2014 Method 2–1–1A to measure motor performance, follow the instructions in section 2.3.2.3.2. of this appendix, instead of Section 6.1.2.2 of IEC 60034–2–1:2014;

2.3.2.3.2. Couple the machine under test to load machine. Measure torque using an inline shaft-coupled, rotating torque transducer or stationary, stator reaction torque transducer. Operate the machine under test at the rated load until thermal equilibrium is achieved (rate of change 1 K or less per half hour). Record U, I, Pel, n, T, θc.

2.3.3. The efficiencies and losses of polyphase SNEMs with rated horsepower equal to or greater than 1 that are not air-over electric motors, and are capable of operating without an inverter, are determined using one of the following methods:

2.3.3.1. IEEE 112–2017 Test Method B (see section 0.7(b) of this appendix);

2.3.3.2. CSA C390–10 (see section 0.1 of this appendix); or

2.3.3.3. IEC 60034–2–1:2014 Method 2–1–1B (see section 0.4(b) of this appendix). The supply voltage shall be in accordance with Section 7.2 of IEC 60034–1:2010. The measured resistance at the end of the thermal test shall be determined in a similar way to the extrapolation procedure described in Section 8.6.2.3.3 of IEC 60034–1:2010 using the shortest possible time instead of the time interval specified in Table 5 of IEC 60034–1:2010, and extrapolating to zero. The measuring instruments for electrical quantities shall have the equivalent of an accuracy class of 0,2 in case of a direct test and 0,5 in case of an indirect test in accordance with Section 5.2 of IEC 60051–1:2016.

2.4. Test Procedures for Electric Motors that are Synchronous Motors and Inverter-only Electric Motors

Section 2.4.1 of this appendix applies to electric motors that are synchronous motors that do not require an inverter to operate. Sections 2.4.2. and 2.4.3. of this appendix apply to electric motors that are synchronous motors and are inverter-only; and to induction electric motors that are inverter-only electric motors.

2.4.1. The efficiencies and losses of electric motors that are synchronous motors that do not require an inverter to operate, are determined in accordance with IEC 60034–2–1:2014, Section 3 ''Terms and definitions,'' Section 4 ''Symbols and abbreviations,'' Section 5 ''Basic requirements,'' and Section 7.1. ''Preferred Testing Methods.''

2.4.2. The efficiencies and losses of electric motors (inclusive of the inverter) that are that are inverter-only and do not include an inverter, are determined in accordance with IEC 61800–9–2:2017. Test must be conducted using an inverter that is listed as recommended in the manufacturer's catalog or that is offered for sale with the electric motor. If more than one inverter is available in manufacturer's catalogs or if more than one inverter is offered for sale with the electric motor, test using the least efficient inverter. Record the manufacturer, brand and model number of the inverter used for the test. If there are no inverters specified in the manufacturer catalogs or offered for sale with the electric motor, testing must be conducted using an inverter that meets the criteria described in section 2.4.2.2. of this appendix.

2.4.2.1. The inverter shall be set up according to the manufacturer's instructional and operational manual included with the product. Manufacturers shall also record switching frequency in Hz, max frequency in Hz, Max output voltage in V, motor control method (*i.e.*, V/f ratio, sensor less vector, etc.), load profile setting (constant torque, variable torque, etc.), and saving energy mode (if used). Deviation from the resulting settings, such as switching frequency or load torque curves for the purpose of optimizing test results shall not be permitted.

2.4.2.2. If there are no inverters specified in the manufacturer catalogs or offered for sale with the electric motor, test with a two-level voltage source inverter. No additional components influencing output voltage or output current shall be installed between the inverter and the motor, except those required for the measuring instruments. For motors with a rated speed up to 3 600 min–1, the switching frequency shall not be higher than 5 kHz. For motors with a rated speed above 3 600 min–1, the switching frequency shall not be higher than 10 kHz. Record the manufacturer, brand and model number of the inverter used for the test.

2.4.3. The efficiencies and losses of electric motors (inclusive of the inverter) that are inverter-only and include an inverter are determined in accordance with IEC 61800–9–2:2017.

2.4.3.1. The inverter shall be set up according to the manufacturer's instructional and operational manual included with the product. Manufacturers shall also record switching frequency in Hz, max frequency in Hz, Max output voltage in V, motor control method (*i.e.*, V/f ratio, sensor less vector, etc.), load profile setting (constant torque, variable torque, etc.), and saving energy mode (if used). Deviation from the resulting settings, such as switching frequency or load torque curves for the purpose of optimizing test results shall not be permitted.

3. Procedures for the Testing of Certain Electric Motor Categories

Prior to testing according to section 2 of this appendix, each basic model of the electric motor categories listed below must be set up in accordance with the instructions of this section to ensure consistent test results. These steps are designed to enable a motor to be attached to a dynamometer and run continuously for testing purposes. For the purposes of this appendix, a ''standard bearing'' is a 600- or 6000-series, either open or grease-lubricated double-shielded, single-row, deep groove, radial ball bearing.

3.1. Brake Electric Motors:

Brake electric motors shall be tested with the brake component powered separately from the motor such that it does not activate during testing. Additionally, for any 10-minute period during the test and while the brake is being powered such that it remains disengaged from the motor shaft, record the power consumed (*i.e.*, watts). Only power used to drive the motor is to be included in the efficiency calculation; power supplied to prevent the brake from engaging is not included in this calculation. In lieu of powering the brake separately, the brake may be disengaged mechanically, if such a mechanism exists and if the use of this mechanism does not yield a different efficiency value than separately powering the brake electrically.

3.2. Close-Coupled Pump Electric Motors and Electric Motors with Single or Double Shaft Extensions of Non-Standard Dimensions or Design:

To attach the unit under test to a dynamometer, close-coupled pump electric motors and electric motors with single or double shaft extensions of non-standard dimensions or design must be tested using a special coupling adapter.

3.3. Electric Motors with Non-Standard Endshields or Flanges:

If it is not possible to connect the electric motor to a dynamometer with the non-standard endshield or flange in place, the testing laboratory shall replace the non-standard endshield or flange with an endshield or flange meeting NEMA or IEC specifications. The replacement component should be obtained from the manufacturer or, if the manufacturer chooses, machined by the testing laboratory after consulting with the manufacturer regarding the critical characteristics of the endshield.

3.4. Electric Motors with Non-Standard Bases, Feet or Mounting Configurations:

An electric motor with a non-standard base, feet, or mounting configuration may be mounted on the test equipment using adaptive fixtures for testing as long as the mounting or use of adaptive mounting fixtures does not have an adverse impact on the performance of the electric motor, particularly on the cooling of the motor.

3.5. Electric Motors with a Separately-Powered Blower:

For electric motors furnished with a separately-powered blower, the losses from the blower's motor should not be included in any efficiency calculation. This can be done either by powering the blower's motor by a source separate from the source powering the electric motor under test or by connecting leads such that they only measure the power of the motor under test.

3.6. Immersible Electric Motors:

Immersible electric motors shall be tested with all contact seals removed but be otherwise unmodified.

3.7. Partial Electric Motors:

Partial electric motors shall be disconnected from their mated piece of equipment. After disconnection from the equipment, standard bearings and/or endshields shall be added to the motor, such that it is capable of operation. If an endshield is necessary, an endshield meeting NEMA or IEC specifications should be obtained from the manufacturer or, if the manufacturer chooses, machined by the testing laboratory after consulting with the manufacturer regarding the critical characteristics of the endshield.

3.8. Vertical Electric Motors and Electric Motors with Bearings Incapable of Horizontal Operation:

Vertical electric motors and electric motors with thrust bearings shall be tested in a horizontal or vertical configuration in accordance with the applicable test procedure under section 2 through section 2.4.3. of this appendix, depending on the testing facility's capabilities and construction of the motor, except if the motor is a vertical solid shaft normal thrust general purpose electric motor (subtype II), in which case it shall be tested in a horizontal configuration in accordance with the applicable test procedure under section 2 through section 2.4.3. of this appendix. Preference shall be given to testing a motor in its native orientation. If the unit under test cannot be reoriented horizontally due to its bearing construction, the electric motor's bearing(s) shall be removed and replaced with standard bearings. If the unit under test contains oil-lubricated bearings, its bearings shall be removed and replaced with standard bearings. If necessary, the unit under test may be connected to the dynamometer using a coupling of torsional rigidity greater than or equal to that of the motor shaft.

[87 FR 63657, Oct. 19, 2022]

APPENDIX C TO SUBPART B OF PART 431—COMPLIANCE CERTIFICATION

CERTIFICATION OF COMPLIANCE WITH ENERGY EFFICIENCY STANDARDS FOR ELECTRIC MOTORS (OFFICE OF MANAGEMENT AND BUDGET CONTROL NUMBER: 1910–1400. EXPIRES FEBRUARY 13, 2014)

An electronic form is available at *https://www.regulations.doe.gov/ccms/*.

1. Name and Address of Company (the ''company''):

____
____
____
____

2. Name(s) to be Marked on Electric Motors to Which this Compliance Certification Applies:

____
____
____
____

3. If manufacturer or private labeler wishes to receive a unique Compliance Certification number for use with any particular brand name, trademark, or other label name, fill out the following two items:

A. List each brand name, trademark, or other label name for which the company requests a Compliance Certification number:

____
____
____

B. List other name(s), if any, under which the company sells electric motors (if not listed in item 2 above):

____
____
____

Submit electronically at *https://www.regulations.doe.gov/ccms*.

Submit paper form by Certified Mail to: U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies (EE–2J), Forrestal Building, 1000 Independence Avenue, SW., Washington, DC 20585–0121.

This Compliance Certification reports on and certifies compliance with requirements contained in 10 CFR Part 431 (Energy Conservation Program for Certain Commercial and Industrial Equipment) and Part C of the Energy Policy and Conservation Act (Pub. L. 94–163), and amendments thereto. It is signed by a responsible official of the above named company. Attached and incorporated as part of this Compliance Certification is a Listing of Electric Motor Efficiencies. For each rating of electric motor* for which the Listing specifies the nominal full load efficiency of a basic model, the company distributes no less efficient basic model with that rating and all basic models with that rating comply with the applicable energy efficiency standard.

*For this purpose, the term ''rating'' means one of the combinations of an electric motor's horsepower (or standard kilowatt equivalent), number of poles, motor type, and open or enclosed construction, with respect to which §431.25 of 10 CFR Part 431 prescribes nominal full load efficiency standards.

Person to Contact for Further Information:

Name: ______

Address: ______

______

______

______

Telephone Number: ______

Facsimile Number: ______

If any part of this Compliance Certification, including the Attachment, was prepared by a third party organization under the provisions of 10 CFR 431.36, the company official authorizing third party representations:

Name: ______

Address: ______

______

______

______

Telephone Number: ______

Facsimile Number: ______

Third Party Organization Officially Acting as Representative:

Third Party Organization: ______

Responsible Person at the Organization: ______

______

Address: ______

______

______

______

Telephone Number: ______

Facsimile Number: ______

All required determinations on which this Compliance Certification is based were made in conformance with the applicable requirements in 10 CFR Part 431, subpart B. All information reported in this Compliance Certification is true, accurate, and complete. The company is aware of the penalties associated with violations of the Act and the regulations thereunder, and is also aware of the provisions contained in 18 U.S.C. 1001, which prohibits knowingly making false statements to the Federal Government.

Signature: ______

Date: ______

Name: ______

Title: ______

Firm or Organization: ______

ATTACHMENT OF CERTIFICATION OF COMPLIANCE WITH ENERGY EFFICIENCY STANDARDS FOR ELECTRIC MOTOR EFFICIENCIES

Date: ______

Name of Company: ______

Motor Type (i.e., general purpose electric motor (subtype I), fire pump electric motor, general purpose electric motor (subtype II), NEMA Design B general purpose electric motor)

______

Motor horsepower/standard kilowatt equivalent	Least efficient basic model—(model numbers(s)) Nominal full-load efficiency							
	Open motors (number of poles)				Enclosed motors (number of poles)			
	8	6	4	2	8	6	4	2
1/.75	____	____	____	____	____	____	____	____
	____	____	____	____	____	____	____	____
1.5/1.1	____	____	____	____	____	____	____	____
	____	____	____	____	____	____	____	____
2/1.5	____	____	____	____	____	____	____	____
	____	____	____	____	____	____	____	____
3/2.2	____	____	____	____	____	____	____	____
	____	____	____	____	____	____	____	____
5/3.7	____	____	____	____	____	____	____	____

Motor horsepower/standard kilowatt equivalent	Least efficient basic model—(model numbers(s)) Nominal full-load efficiency							
	Open motors (number of poles)				Enclosed motors (number of poles)			
	8	6	4	2	8	6	4	2
	____	____	____	____	____	____	____	____
	____	____	____	____	____	____	____	____
	____	____	____	____	____	____	____	____
Etc	____	____	____	____	____	____	____	____
	____	____	____	____	____	____	____	____

Note: Place an asterisk beside each reported nominal full load efficiency that is determined by actual testing rather than by application of an alternative efficiency determination method. Also list below additional basic models that were subjected to actual testing.

Basic Model means all units of a given type of electric motor (or class thereof) manufactured by a single manufacturer, and which (i) have the same rating, (ii) have electrical design characteristics that are essentially identical, and (iii) do not have any differing physical or functional characteristics that affect energy consumption or efficiency.

Rating means one of the combinations of an electric motor's horsepower (or standard kilowatt equivalent), number of poles, motor type, and open or enclosed construction, with respect to which §431.25 of 10 CFR Part 431 prescribes nominal full load efficiency standards.

MODELS ACTUALLY TESTED AND NOT PREVIOUSLY IDENTIFIED

Motor horsepower/standard kilowatt equivalent	Least efficient basic model—(model numbers(s)) Nominal full-load efficiency							
	Open motors (number of poles)				Enclosed motors (number of poles)			
	8	6	4	2	8	6	4	2
____	____	____	____	____	____	____	____	____
	____	____	____	____	____	____	____	____
____	____	____	____	____	____	____	____	____
	____	____	____	____	____	____	____	____
____	____	____	____	____	____	____	____	____
	____	____	____	____	____	____	____	____
____	____	____	____	____	____	____	____	____
	____	____	____	____	____	____	____	____
____	____	____	____	____	____	____	____	____
	____	____	____	____	____	____	____	____
____	____	____	____	____	____	____	____	____
	____	____	____	____	____	____	____	____
Etc	____	____	____	____	____	____	____	____
	____	____	____	____	____	____	____	____

[69 FR 61923, Oct. 21, 2004, as amended at 76 FR 59006, Sept. 23, 2011]

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Subpart C—Commercial Refrigerators, Freezers and Refrigerator-Freezers

SOURCE: 70 FR 60414, Oct. 18, 2005, unless otherwise noted.

§431.61 Purpose and scope.

This subpart contains energy conservation requirements for commercial refrigerators, freezers and refrigerator-freezers, pursuant to Part C of Title III of the Energy Policy and Conservation Act, as amended, 42 U.S.C. 6311–6317.

§431.62 Definitions concerning commercial refrigerators, freezers and refrigerator-freezers.

Air-curtain angle means:

(1) For equipment without doors and without a discharge air grille or discharge air honeycomb, the angle between a vertical line extended down from the highest point on the manufacturer's recommended load limit line and the load limit line itself, when the equipment is viewed in cross-section; and

(2) For all other equipment without doors, the angle formed between a vertical line and the straight line drawn by connecting the point at the inside edge of the discharge air opening with the point at the inside edge of the return air opening, when the equipment is viewed in cross-section.

Basic model means all commercial refrigeration equipment manufactured by one manufacturer within a single equipment class, having the same primary energy source, and that have essentially identical electrical, physical, and functional characteristics that affect energy consumption.

Chef base or griddle stand means commercial refrigeration equipment that is designed and marketed for the express purpose of having a griddle or other cooking appliance placed on top of it that is capable of reaching temperatures hot enough to cook food.

Closed solid means equipment with doors, and in which more than 75 percent of the outer surface area of all doors on a unit are not transparent.

Closed transparent means equipment with doors, and in which 25 percent or more of the outer surface area of all doors on the unit are transparent.

Commercial freezer means a unit of commercial refrigeration equipment in which all refrigerated compartments in the unit are capable of operating below 32 °F (±2 °F).

Commercial hybrid means a unit of commercial refrigeration equipment:

(1) That consists of two or more thermally separated refrigerated compartments that are in two or more different equipment families, and

(2) That is sold as a single unit.

Commercial refrigerator means a unit of commercial refrigeration equipment in which all refrigerated compartments in the unit are capable of operating at or above 32 °F (±2 °F).

Commercial refrigerator-freezer means a unit of commercial refrigeration equipment consisting of two or more refrigerated compartments where at least one refrigerated compartment is capable of operating at or above 32 °F (±2 °F) and at least one refrigerated compartment is capable of operating below 32 °F (±2 °F).

Commercial refrigerator, freezer, and refrigerator-freezer means refrigeration equipment that—

(1) Is not a consumer product (as defined in §430.2 of part 430);

(2) Is not designed and marketed exclusively for medical, scientific, or research purposes;

(3) Operates at a chilled, frozen, combination chilled and frozen, or variable temperature;

(4) Displays or stores merchandise and other perishable materials horizontally, semi-vertically, or vertically;

(5) Has transparent or solid doors, sliding or hinged doors, a combination of hinged, sliding, transparent, or solid doors, or no doors;

(6) Is designed for pull-down temperature applications or holding temperature applications; and

(7) Is connected to a self-contained condensing unit or to a remote condensing unit.

Door means a movable panel that separates the interior volume of a unit of commercial refrigeration equipment from the ambient environment and is designed to facilitate access to the refrigerated space for the purpose of loading and unloading product. This includes hinged doors, sliding doors, and drawers. This does not include night curtains.

Door angle means:

(1) For equipment with flat doors, the angle between a vertical line and the line formed by the plane of the door, when the equipment is viewed in cross-section; and

(2) For equipment with curved doors, the angle formed between a vertical line and the straight line drawn by connecting the top and bottom points where the display area glass joins the cabinet, when the equipment is viewed in cross-section.

Holding temperature application means a use of commercial refrigeration equipment other than a pull-down temperature application, except a blast chiller or freezer.

Horizontal Closed means equipment with hinged or sliding doors and a door angle greater than or equal to 45°.

Horizontal Open means equipment without doors and an air-curtain angle greater than or equal to 80° from the vertical.

Ice-cream freezer means a commercial freezer that is designed to operate at or below −5 °F (±2 °F) (−21 °C ±1.1 °C) and that the manufacturer designs, markets, or intends for the storing, displaying, or dispensing of ice cream.

Integrated average temperature means the average temperature of all test package measurements taken during the test.

Lighting occupancy sensor means a device which uses passive infrared, ultrasonic, or other motion-sensing technology to automatically turn off or dim lights within the equipment when no motion is detected in the sensor's coverage area for a certain preset period of time.

Lowest application product temperature means the lowest integrated average temperature at which a given basic model is capable of consistently operating (*i.e.*, maintaining so as to comply with the steady-state stabilization requirements specified in ASHRAE 72–2005 (incorporated by reference, see § 431.63) for the purposes of testing under the DOE test procedure).

Night curtain means a device which is temporarily deployed to decrease air exchange and heat transfer between the refrigerated case and the surrounding environment.

Operating temperature means the range of integrated average temperatures at which a self-contained commercial refrigeration unit or remote-condensing commercial refrigeration unit with a thermostat is capable of operating or, in the case of a remote-condensing commercial refrigeration unit without a thermostat, the range of integrated average temperatures at which the unit is marketed, designed, or intended to operate.

Pull-down temperature application means a commercial refrigerator with doors that, when fully loaded with 12 ounce beverage cans at 90 degrees F, can cool those beverages to an average stable temperature of 38 degrees F in 12 hours or less.

Rating temperature means the integrated average temperature a unit must maintain during testing (i.e., either as listed in the table at § 431.66(d)(1) or the lowest application product temperature).

Remote condensing unit means a factory-made assembly of refrigerating components designed to compress and liquefy a specific refrigerant that is remotely located from the refrigerated equipment and consists of 1 or more refrigerant compressors, refrigerant condensers, condenser fans and motors, and factory supplied accessories.

Scheduled lighting control means a device which automatically shuts off or dims the lighting in a display case at scheduled times throughout the day.

Self-contained condensing unit means a factory-made assembly of refrigerating components designed to compress and liquefy a specific refrigerant that is an integral part of the refrigerated equipment and consists of 1 or more refrigerant compressors, refrigerant condensers, condenser fans and motors, and factory supplied accessories.

Semivertical Open means equipment without doors and an air-curtain angle greater than or equal to 10° and less than 80° from the vertical.

Service over counter means equipment that has sliding or hinged doors in the back intended for use by sales personnel, with glass or other transparent material in the front for displaying merchandise, and that has a height not greater than 66 inches and is intended to serve as a counter for transactions between sales personnel and customers. ''*Service over the counter, self-contained, medium temperature commercial refrigerator*'', also defined in this section, is one specific equipment class within the service over counter equipment family.

Service over the counter, self-contained, medium temperature commercial refrigerator or *SOC–SC–M* means a commercial refrigerator—

(1) That operates at temperatures at or above 32 °F;

(2) With a self-contained condensing unit;

(3) Equipped with sliding or hinged doors in the back intended for use by sales personnel, and with glass or other transparent material in the front for displaying merchandise; and

(4) That has a height not greater than 66 inches and is intended to serve as a counter for transactions between sales personnel and customers.

Test package means a packaged material that is used as a standard product temperature-measuring device.

Transparent means greater than or equal to 45 percent light transmittance, as determined in accordance with the ASTM Standard E 1084–86 (Reapproved 2009), (incorporated by reference, see § 431.63) at normal incidence and in the intended direction of viewing.

Vertical Closed means equipment with hinged or sliding doors and a door angle less than 45°.

Vertical Open means equipment without doors and an air-curtain angle greater than or equal to 0° and less than 10° from the vertical.

Wedge case means a commercial refrigerator, freezer, or refrigerator-freezer that forms the transition between two regularly shaped display cases.

[70 FR 60414, Oct. 18, 2005, as amended at 71 FR 71369, Dec. 8, 2006; 74 FR 1139, Jan. 9, 2009; 76 FR 12503, Mar. 7, 2011; 77 FR 10318, Feb. 21, 2012; 78 FR 62993, Oct. 23, 2013; 78 FR 79598, Dec. 31, 2013; 79 FR 22307, Apr. 21, 2014; 79 FR 17816, Mar. 28, 2014]

TEST PROCEDURES

§ 431.63 Materials incorporated by reference.

(a) *General.* We incorporate by reference the following standards into subpart C of part 431. The material listed has been approved for incorporation by reference by the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR 51. Any subsequent amendment to a standard by the standard-setting organization will not affect the DOE regulations unless and until amended by DOE. Material is incorporated as it exists on the date of the approval and a notice of any change in the material will be published in the FEDERAL REGISTER. All approved material is available for inspection at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202–741–6030 or go to *http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html.* Also, this material is available for inspection at U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Program, 6th Floor, 950 L'Enfant Plaza, SW., Washington, DC 20024, 202–586–2945, or go to: *http://www1.eere.energy.gov/buildings/appliance_standards/.* Standards can be obtained from the sources listed below.

(b) *ANSI.* American National Standards Institute, 25 W. 43rd Street, 4th Floor, New York, NY 10036, 212–642–4900, or go to *http://www.ansi.org:*

(1) ANSI /AHAM HRF–1–2004, *Energy, Performance and Capacity of Household Refrigerators, Refrigerator-Freezers and Freezers*, approved July 7, 2004, IBR approved for § 431.64 and appendices A and B to subpart C to part 431.

(2) AHAM HRF–1–2008 (''HRF–1–2008''), Association of Home Appliance Manufacturers, *Energy and Internal Volume of Refrigerating Appliances* (2008) including *Errata to Energy and Internal Volume of Refrigerating Appliances*, Correction Sheet issued November 17, 2009, IBR approved for § 431.64 and appendices A and B to subpart C to part 431.

(c) AHRI. Air-Conditioning, Heating, and Refrigeration Institute, 2111 Wilson Blvd., Suite 500, Arlington, VA 22201, (703) 524–8800, *ahri@ahrinet.org*, or *http://www.ahrinet.org/Content/StandardsProgram_20.aspx.*

(1) ARI Standard 1200–2006, *Performance Rating of Commercial Refrigerated Display Merchandisers and Storage Cabinets*, 2006, IBR approved for §§431.64 and 431.66, and appendices A and B to subpart C of part 431.

(2) AHRI Standard 1200 (I–P)–2010 (''AHRI Standard 1200 (I–P)–2010''), *2010 Standard for Performance Rating of Commercial Refrigerated Display Merchandisers and Storage Cabinets*, 2010, IBR approved for §§431.64 and 431.66, and appendices A and B to subpart C of part 431.

(d) *ASHRAE*. The American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., 1971 Tullie Circle NE., Atlanta, GA 30329, or *http://www.ashrae.org/.*

(1) ANSI/ASHRAE Standard 72–2005, (ASHRAE 72–2005), ''Method of Testing Commercial Refrigerators and Freezers,'' Copyright 2005, IBR approved for §431.62, and appendices A and B to subpart C of part 431.

(2) [Reserved]

(e) *ASTM*. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428, (877) 909–2786, or go to *http://www.astm.org/.*

(1) ASTM E 1084 (Reapproved 2009), ''Standard Test Method for Solar Transmittance (Terrestrial) of Sheet Materials Using Sunlight,'' approved April 1, 2009, IBR approved for §431.62.

(2) [Reserved]

[74 FR 1139, Jan. 9, 2009, as amended at 77 FR 10318, Feb. 21, 2012; 78 FR 62993, Oct. 23, 2013; 79 FR 22308, Apr. 21, 2014]

§431.64 Uniform test method for the measurement of energy consumption of commercial refrigerators, freezers, and refrigerator-freezers.

(a) *Scope*. This section provides the test procedures for measuring, pursuant to EPCA, the daily energy consumption in kilowatt hours per day (kWh/day) for a given product category and volume or total display area of commercial refrigerators, freezers, and refrigerator-freezers.

(b) *Testing and calculations*. Determine the daily energy consumption of each covered commercial refrigerator, freezer, or refrigerator-freezer by conducting the appropriate test procedure set forth below, in appendix A or B to this subpart. The daily energy consumption of commercial refrigeration equipment shall be calculated using raw measured values and the final test results shall be reported in increments of 0.01 kWh/day.

[70 FR 60414, Oct. 18, 2005, as amended at 77 FR 10318, Feb. 21, 2012; 79 FR 22308, Apr. 21, 2014]

ENERGY CONSERVATION STANDARDS

§431.66 Energy conservation standards and their effective dates.

(a) In this section—

(1) The term ''AV'' means the adjusted volume (ft^3) (defined as 1.63 × frozen temperature compartment volume (ft^3) + chilled temperature compartment volume (ft^3)) with compartment volumes measured in accordance with the Association of Home Appliance Manufacturers Standard HRF1–1979.

(2) The term ''V'' means the chilled or frozen compartment volume (ft^3) (as defined in the Association of Home Appliance Manufacturers Standard HRF1–1979).

(3) For the purpose of paragraph (d) of this section, the term ''TDA'' means the total display area (ft^2) of the case, as defined in ARI Standard 1200–2006, appendix D (incorporated by reference, see §431.63). For the purpose of paragraph (e) of this section, the term ''TDA'' means the total display area (ft^2) of the case, as defined in AHRI Standard 1200 (I–P)–2010, appendix D (incorporated by reference, see §431.63).

(b)(1) Each commercial refrigerator, freezer, and refrigerator-freezer with a self-contained condensing unit designed for holding temperature applications manufactured on or after January 1, 2010 and before March 27, 2017 shall have a daily energy consumption (in kilowatt-hours per day) that does not exceed the following:

Category	Maximum daily energy consumption (kilowatt hours per day)
Refrigerators with solid doors	0.10V + 2.04.
Refrigerators with transparent doors.	0.12V + 3.34.
Freezers with solid doors	0.40V + 1.38.
Freezers with transparent doors.	0.75V + 4.10.

Category	Maximum daily energy consumption (kilowatt hours per day)
Refrigerator/freezers with solid doors.	the greater of 0.27AV–0.71 or 0.70.

(2) Each service over the counter, self-contained, medium temperature commercial refrigerator (SOC–SC–M) manufactured on or after January 1, 2012, shall have a total daily energy consumption (in kilowatt hours per day) of not more than 0.6 × TDA + 1.0. As used in the preceding sentence, ''TDA'' means the total display area (ft^2) of the case, as defined in the AHRI Standard 1200 (I–P)–2010, appendix D (incorporated by reference, see § 431.63).

(c) Each commercial refrigerator with a self-contained condensing unit designed for pull-down temperature applications and transparent doors manufactured on or after January 1, 2010 and before March 27, 2017 shall have a daily energy consumption (in kilowatt-hours per day) of not more than 0.126V + 3.51.

(d) Each commercial refrigerator, freezer, and refrigerator-freezer with a self-contained condensing unit and without doors; commercial refrigerator, freezer, and refrigerator-freezer with a remote condensing unit; and commercial ice-cream freezer manufactured on or after January 1, 2012 and before March 27, 2017 shall have a daily energy consumption (in kilowatt-hours per day) that does not exceed the levels specified:

(1) For equipment other than hybrid equipment, refrigerator-freezers or wedge cases:

Equipment category	Condensing unit configuration	Equipment family	Rating temp. (°F)	Operating temp. (°F)	Equipment class designation*	Maximum daily energy consumption (kWh/day)
Remote Condensing Commercial Refrigerators and Commercial Freezers.	Remote (RC)	Vertical Open (VOP).	38 (M)	≥32±2	VOP.RC.M	0.82 × TDA + 4.07
			0 (L)	<32±2	VOP.RC.L	2.27 × TDA + 6.85
		Semivertical Open (SVO).	38 (M)	≥32±2	SVO.RC.M	0.83 × TDA + 3.18
			0 (L)	<32±2	SVO.RC.L	2.27 × TDA + 6.85
		Horizontal Open (HZO).	38 (M)	≥32±2	HZO.RC.M	0.35 × TDA + 2.88
			0 (L)	<32±2	HZO.RC.L	0.57 × TDA + 6.88
		Vertical Closed Transparent (VCT).	38 (M)	≥32±2	VCT.RC.M	0.22 × TDA + 1.95
			0 (L)	<32±2	VCT.RC.L	0.56 × TDA + 2.61
		Horizontal Closed Transparent (HCT).	38 (M)	≥32±2	HCT.RC.M	0.16 × TDA + 0.13
			0 (L)	<32±2	HCT.RC.L	0.34 × TDA + 0.26
		Vertical Closed Solid (VCS).	38 (M)	≥32±2	VCS.RC.M	0.11 × V + 0.26
			0 (L)	<32±2	VCS.RC.L	0.23 × V + 0.54
		Horizontal Closed Solid (HCS).	38 (M)	≥32±2	HCS.RC.M	0.11 × V + 0.26
			0 (L)	<32±2	HCS.RC.L	0.23 × V + 0.54
		Service Over Counter (SOC).	38 (M)	≥32±2	SOC.RC.M	0.51 × TDA + 0.11
			0 (L)	<32±2	SOC.RC.L	1.08 × TDA + 0.22
Self-Contained Commercial Refrigerators and Commercial Freezers without Doors.	Self-Contained (SC).	Vertical Open (VOP).	38 (M)	≥32±2	VOP.SC.M	1.74 × TDA + 4.71
			0 (L)	<32±2	VOP.SC.L	4.37 × TDA + 11.82
		Semivertical Open (SVO).	38 (M)	≥32±2	SVO.SC.M	1.73 × TDA + 4.59
			0 (L)	<32±2	SVO.SC.L	4.34 × TDA + 11.51
		Horizontal Open	38 (M)	≥32±2	HZO.SC.M	0.77 × TDA + 5.55
			0 (L)	<32±2	HZO.SC.L	1.92 × TDA + 7.08
Commercial Ice-Cream Freezers.	Remote (RC)	Vertical Open (VOP).	−15 (I)	≤−5±2****	VOP.RC.I	2.89 × TDA + 8.7
		Semivertical Open (SVO).			SVO.RC.I	2.89 × TDA + 8.7
		Horizontal Open (HZO).			HZO.RC.I	0.72 × TDA + 8.74
		Vertical Closed Transparent (VCT).			VCT.RC.I	0.66 × TDA + 3.05
		Horizontal Closed Transparent (HCT).			HCT.RC.I	0.4 × TDA + 0.31
		Vertical Closed Solid (VCS).			VCS.RC.I	0.27 × V + 0.63
		Horizontal Closed Solid (HCS).			HCS.RC.I	0.27 × V + 0.63

Equipment category	Condensing unit configuration	Equipment family	Rating temp. (°F)	Operating temp. (°F)	Equipment class designation *	Maximum daily energy consumption (kWh/day)
		Service Over Counter (SVO).			SOC.RC.I	1.26 × TDA + 0.26
	Self-Contained (SC).	Vertical Open (VOP).			VOP.SC.I	5.55 × TDA + 15.02
		Semivertical Open (SVO).			SVO.SC.I	5.52 × TDA + 14.63
		Horizontal Open (HZO).			HZO.SC.I	2.44 × TDA + 9
		Vertical Closed Transparent (VCT).			VCT.SC.I	0.67 × TDA + 3.29
		Horizontal Closed Transparent (HCT).			HCT.SC.I	0.56 × TDA + 0.43
		Vertical Closed Solid (VCS).			VCS.SC.I	0.38 × V + 0.88
		Horizontal Closed Solid (HCS).			HCS.SC.I	0.38 × V + 0.88
		Service Over Counter (SVO).			SOC.SC.I	1.76 × TDA + 0.36

* The meaning of the letters in this column is indicated in the three columns to the left.
** Ice-cream freezer is defined in 10 CFR 431.62 as a commercial freezer that is designed to operate at or below −5 °F (−21 °C) and that the manufacturer designs, markets, or intends for the storing, displaying, or dispensing of ice cream.

(2) For commercial refrigeration equipment with two or more compartments (*i.e.*, hybrid refrigerators, hybrid freezers, hybrid refrigerator-freezers, and non-hybrid refrigerator-freezers), the maximum daily energy consumption (MDEC) for each model shall be the sum of the MDEC values for all of its compartments. For each compartment, measure the TDA or volume of that compartment, and determine the appropriate equipment class based on that compartment's equipment family, condensing unit configuration, and designed operating temperature. The MDEC limit for each compartment shall be the calculated value obtained by entering that compartment's TDA or volume into the standard equation in paragraph (d)(1) of this section for that compartment's equipment class. Measure the calculated daily energy consumption (CDEC) or total daily energy consumption (TDEC) for the entire case:

(i) For remote condensing commercial hybrid refrigerators, hybrid freezers, hybrid refrigerator-freezers, and non-hybrid refrigerator-freezers, where two or more independent condensing units each separately cool only one compartment, measure the total refrigeration load of each compartment separately according to the ARI Standard 1200–2006 test procedure (incorporated by reference, see §431.63). Calculate compressor energy consumption (CEC) for each compartment using Table 1 in ARI Standard 1200–2006 using the saturated evaporator temperature for that compartment. The CDEC for the entire case shall be the sum of the CEC for each compartment, fan energy consumption (FEC), lighting energy consumption (LEC), anti-condensate energy consumption (AEC), defrost energy consumption (DEC), and condensate evaporator pan energy consumption (PEC) (as measured in ARI Standard 1200–2006).

(ii) For remote condensing commercial hybrid refrigerators, hybrid freezers, hybrid refrigerator-freezers, and non-hybrid refrigerator-freezers, where two or more compartments are cooled collectively by one condensing unit, measure the total refrigeration load of the entire case according to the ARI Standard 1200–2006 test procedure (incorporated by reference, see §431.63). Calculate a weighted saturated evaporator temperature for the entire case by:

(A) Multiplying the saturated evaporator temperature of each compartment by the volume of that compartment (as measured in ARI Standard 1200–2006),

(B) Summing the resulting values for all compartments, and

(C) Dividing the resulting total by the total volume of all compartments.

Calculate the CEC for the entire case using Table 1 in ARI Standard 1200–2006 (incorporated by reference, see § 431.63), using the total refrigeration load and the weighted average saturated evaporator temperature. The CDEC for the entire case shall be the sum of the CEC, FEC, LEC, AEC, DEC, and PEC.

(iii) For self-contained commercial hybrid refrigerators, hybrid freezers, hybrid refrigerator-freezers, and non-hybrid refrigerator-freezers, measure the TDEC for the entire case according to the ARI Standard 1200–2006 test procedure (incorporated by reference, see § 431.63).

(3) For remote-condensing and self-contained wedge cases, measure the CDEC or TDEC according to the ARI Standard 1200–2006 test procedure (incorporated by reference, see § 431.63). The MDEC for each model shall be the amount derived by incorporating into the standards equation in paragraph (d)(1) of this section for the appropriate equipment class a value for the TDA that is the product of:

(i) The vertical height of the air-curtain (or glass in a transparent door) and (ii) The largest overall width of the case, when viewed from the front.

(e) Each commercial refrigerator, freezer, and refrigerator-freezer with a self-contained condensing unit designed for holding temperature applications and with solid or transparent doors; commercial refrigerator with a self-contained condensing unit designed for pull-down temperature applications and with transparent doors; commercial refrigerator, freezer, and refrigerator-freezer with a self-contained condensing unit and without doors; commercial refrigerator, freezer, and refrigerator-freezer with a remote condensing unit; and commercial ice-cream freezer manufactured on or after March 27, 2017, shall have a daily energy consumption (in kilowatt-hours per day) that does not exceed the levels specified:

(1) For equipment other than hybrid equipment, refrigerator/freezers, or wedge cases:

Equipment category	Condensing unit configuration	Equipment family	Rating temp. deg;F	Operating temp. deg;F	Equipment class designation *	Maximum daily energy consumption kWh/day
Remote Condensing Commercial Refrigerators and Commercial Freezers.	Remote (RC)	Vertical Open (VOP).	38 (M)	≥32	VOP.RC.M ..	0.64 × TDA + 4.07.
			0 (L)	<32	VOP.RC.L ...	2.2 × TDA + 6.85.
		Semivertical Open (SVO).	38 (M)	≥32	SVO.RC.M ..	0.66 × TDA + 3.18.
			0 (L)	<32	SVO.RC.L ...	2.2 × TDA + 6.85.
		Horizontal Open (HZO).	38 (M)	≥32	HZO.RC.M ..	0.35 × TDA + 2.88.
			0 (L)	<32	HZO.RC.L ...	0.55 × TDA + 6.88.
		Vertical Closed Transparent (VCT).	38 (M)	≥32	VCT.RC.M ..	0.15 × TDA + 1.95.
			0 (L)	<32	VCT.RC.L ...	0.49 × TDA + 2.61.
		Horizontal Closed Transparent (HCT).	38 (M)	≥32	HCT.RC.M ..	0.16 × TDA + 0.13.
			0 (L)	<32	HCT.RC.L ...	0.34 × TDA + 0.26.
		Vertical Closed Solid (VCS).	38 (M)	≥32	VCS.RC.M ..	0.1 × V + 0.26.
			0 (L)	<32	VCS.RC.L ...	0.21 × V + 0.54.
		Horizontal Closed Solid (HCS).	38 (M)	≥32	HCS.RC.M ..	0.1 × V + 0.26.
			0 (L)	<32	HCS.RC.L ...	0.21 × V + 0.54.
		Service Over Counter (SOC).	38 (M)	≥32	SOC.RC.M ..	0.44 × TDA + 0.11.
			0 (L)	<32	SOC.RC.L ...	0.93 × TDA + 0.22.
Self-Contained Commercial Refrigerators and Commercial Freezers Without Doors.	Self-Contained (SC).	Vertical Open (VOP).	38 (M)	≥32	VOP.SC.M ..	1.69 × TDA + 4.71.
			0 (L)	<32	VOP.SC.L ...	4.25 × TDA + 11.82.
		Semivertical Open (SVO).	38 (M)	≥32	SVO.SC.M ..	1.7 × TDA + 4.59.

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Equipment category	Condensing unit configuration	Equipment family	Rating temp. deg;F	Operating temp. deg;F	Equipment class designation *	Maximum daily energy consumption kWh/day
			0 (L)	<32	SVO.SC.L	4.26 × TDA + 11.51.
		Horizontal Open (HZO).	38 (M)	≥32	HZO.SC.M	0.72 × TDA + 5.55.
			0 (L)	<32	HZO.SC.L	1.9 × TDA + 7.08.
Self-Contained Commercial Refrigerators and Commercial Freezers With Doors.	Self-Contained (SC).	Vertical Closed Transparent (VCT).	38 (M)	≥32	VCT.SC.M	0.1 × V + 0.86.
			0 (L)	<32	VCT.SC.L	0.29 × V + 2.95.
		Vertical Closed Solid (VCS).	38 (M)	≥32	VCS.SC.M	0.05 × V + 1.36.
				<32	VCS.SC.L	0.22 × V + 1.38.
		Horizontal Closed Transparent (HCT).	38 (M)	≥32	HCT.SC.M	0.06 × V + 0.37.
			0 (L)	<32	HCT.SC.L	0.08 × V + 1.23.
		Horizontal Closed Solid (HCS).		≥32	HCS.SC.M	0.05 × V + 0.91.
			0 (L)	<32	HCS.SC.L	0.06 × V + 1.12.
		Service Over Counter (SOC).		≥32	SOC.SC.M	0.52 × TDA + 1.
			0 (L)	<32	SOC.SC.L	1.1 × TDA + 2.1.
Self-Contained Commercial Refrigerators with Transparent Doors for Pull-Down Temperature Applications.	Self-Contained (SC).	Pull-Down (PD)	38 (M)	≥32	PD.SC.M	0.11 × V + 0.81.
Commercial Ice-Cream Freezers.	Remote (RC)	Vertical Open (VOP).	−15 (I)	≤−5**	VOP.RC.I	2.79 × TDA + 8.7.
		Semivertical Open (SVO).			SVO.RC.I	2.79 × TDA + 8.7.
		Horizontal Open (HZO).			HZO.RC.I	0.7 × TDA + 8.74.
		Vertical Closed Transparent (VCT).			VCT.RC.I	0.58 × TDA + 3.05.
		Horizontal Closed Transparent (HCT).			HCT.RC.I	0.4 × TDA + 0.31.
		Vertical Closed Solid (VCS).			VCS.RC.I	0.25 × V + 0.63.
		Horizontal Closed Solid (HCS).			HCS.RC.I	0.25 × V + 0.63.
		Service Over Counter (SOC).			SOC.RC.I	1.09 × TDA + 0.26.
	Self-Contained (SC).	Vertical Open (VOP).			VOP.SC.I	5.4 × TDA + 15.02.
		Semivertical Open (SVO).			SVO.SC.I	5.41 × TDA + 14.63.
		Horizontal Open (HZO).			HZO.SC.I	2.42 × TDA + 9.
		Vertical Closed Transparent (VCT).			VCT.SC.I	0.62 × TDA + 3.29.
		Horizontal Closed Transparent (HCT).			HCT.SC.I	0.56 × TDA + 0.43.
		Vertical Closed Solid (VCS).			VCS.SC.I	0.34 × V + 0.88.
		Horizontal Closed Solid (HCS).			HCS.SC.I	0.34 × V + 0.88.
		Service Over Counter (SOC).			SOC.SC.I	1.53 × TDA + 0.36.

* The meaning of the letters in this column is indicated in the columns to the left.

** Ice-cream freezer is defined in 10 CFR 431.62 as a commercial freezer that is designed to operate at or below −5 °F *(−21 °C) and that the manufacturer designs, markets, or intends for the storing, displaying, or dispensing of ice cream.

(2) For commercial refrigeration equipment with two or more compartments (*i.e.*, hybrid refrigerators, hybrid freezers, hybrid refrigerator-freezers, and non-hybrid refrigerator-freezers), the maximum daily energy consumption for each model shall be the sum of the MDEC values for all of its compartments. For each compartment, measure the TDA or volume of that compartment, and determine the appropriate equipment class based on that compartment's equipment family, condensing unit configuration, and designed operating temperature. The MDEC limit for each compartment shall be the calculated value obtained by entering that compartment's TDA or volume into the standard equation in paragraph (e)(1) of this section for that compartment's equipment class. Measure the CDEC or TDEC for the entire case as described in §431.66(d)(2)(i) through (iii), except that where measurements and calculations reference ARI Standard 1200–2006 (incorporated by reference, see §431.63), AHRI Standard 1200 (I–P)–2010 (incorporated by reference, see §431.63) shall be used.

(3) For remote condensing and self-contained wedge cases, measure the CDEC or TDEC according to the AHRI Standard 1200 (I–P)–2010 test procedure (incorporated by reference, see §431.63). For wedge cases in equipment classes for which a volume metric is used, the MDEC shall be the amount derived from the appropriate standards equation in paragraph (e)(1) of this section. For wedge cases of equipment classes for which a TDA metric is used, the MDEC for each model shall be the amount derived by incorporating into the standards equation in paragraph (e)(1) of this section for the equipment class a value for the TDA that is the product of:

(i) The vertical height of the air curtain (or glass in a transparent door) and

(ii) The largest overall width of the case, when viewed from the front.

(f) *Exclusions*. The energy conservation standards in paragraphs (b) through (e) of this section do not apply to salad bars, buffet tables, and chef bases or griddle stands.

[70 FR 60414, Oct. 18, 2005, as amended at 74 FR 1140, Jan. 9, 2009; 78 FR 62993, Oct. 23, 2013; 79 FR 22308, Apr. 21, 2014; 79 FR 17816, Mar. 28, 2014]

APPENDIX A TO SUBPART C OF PART 431—UNIFORM TEST METHOD FOR THE MEASUREMENT OF ENERGY CONSUMPTION OF COMMERCIAL REFRIGERATORS, FREEZERS, AND REFRIGERATOR-FREEZERS

NOTE: After October 20, 2014 but before March 28, 2017, any representations made with respect to the energy use or efficiency of commercial refrigeration equipment must be made in accordance with the results of testing pursuant to this appendix.

Manufacturers conducting tests of commercial refrigeration equipment after May 21, 2014 and prior to October 20, 2014, must conduct such test in accordance with either this appendix or §431.64 as it appeared at 10 CFR part 430, subpart B, in the 10 CFR parts 200 to 499 edition revised as of January 1, 2014. Any representations made with respect to the energy use or efficiency of such commercial refrigeration equipment must be in accordance with whichever version is selected. Given that after October 20, 2014 representations with respect to the energy use or efficiency of commercial refrigeration equipment must be made in accordance with tests conducted pursuant to this appendix, manufacturers may wish to begin using this test procedure as soon as possible.

1. Test Procedure

1.1. Determination of Daily Energy Consumption. Determine the daily energy consumption of each covered commercial refrigerator, freezer, refrigerator-freezer or ice-cream freezer by conducting the test procedure set forth in the Air-Conditioning and Refrigeration Institute (ARI) Standard 1200–2006, ''Performance Rating of Commercial Refrigerated Display Merchandisers and Storage Cabinets,'' section 3, ''Definitions,'' section 4, ''Test Requirements,'' and section 7, ''Symbols and Subscripts'' (incorporated by reference, see §431.63). For each commercial refrigerator, freezer, or refrigerator-freezer with a self-contained condensing unit, also use ARI Standard 1200–2006, section 6, ''Rating Requirements for Self-contained Commercial Refrigerated Display Merchandisers and Storage Cabinets.'' For each commercial refrigerator, freezer, or refrigerator-freezer with a remote condensing unit, also use ARI Standard 1200–2006, section 5, ''Rating Requirements for Remote Commercial Refrigerated Display Merchandisers and Storage Cabinets.''

1.2. Methodology for Determining Applicability of Transparent Door Equipment Families. To determine if a door for a given model of commercial refrigeration equipment is transparent: (1) Calculate the outer door surface area including frames and mullions; (2) calculate the transparent surface area within the outer door surface area excluding frames and mullions; (3) calculate the ratio of (2) to (1) for each of the outer doors; and (4) the ratio for the transparent surface area of all outer doors must be greater than 0.25 to qualify as a transparent equipment family.

1.3. Additional Specifications for Testing of Components and Accessories. Subject to the provisions regarding specific components and accessories listed below, all standard components that would be used during normal operation of the basic model in the field shall be installed and in operation during testing as recommended by the manufacturer and representative of their typical operation in the field unless such installation and operation is inconsistent with any requirement of the test procedure. The specific components and accessories listed in the subsequent sections shall be operated as stated during the test.

1.3.1. Energy Management Systems. Applicable energy management systems may be activated during the test procedure provided they are permanently installed on the case, configured as sold and in such a manner so as to operate automatically without the intervention of the operator, and do not conflict with any of other requirements for a valid test as specified in this appendix.

1.3.2. Lighting. Energize all lighting, except customer display signs/lights as described in section 1.3.3 and UV lighting as described in section 1.3.6 of this appendix, to the maximum illumination level for the duration of testing. However, if a closed solid unit of commercial refrigeration equipment includes an automatic lighting control system that can turn off internal case lighting when the door is closed, and the manufacturer recommends the use of this system in writing in the product literature delivered with the unit, then the lighting control should be operated in the automatic setting, even if the model has a manual switch that disables the automatic lighting control.

1.3.3. Customer display signs/lights. Do not energize supplemental lighting that exists solely for the purposes of advertising or drawing attention to the case and is not integral to the operation of the case.

1.3.4. Condensate pan heaters and pumps. For self-contained equipment only, all electric resistance condensate heaters and condensate pumps must be installed and operational during the test. This includes the stabilization period (including pull-down), steady-state, and performance testing periods. Prior to the start of the stabilization period as defined by ASHRAE 72–2005 (incorporated by reference, see §431.63), the condensate pan must be dry. Following the start of the stabilization period, allow any condensate moisture generated to accumulate in the pan. Do not manually add or remove water from the condensate pan at any time during the test.

1.3.5. Anti-sweat door heaters. Anti-sweat door heaters must be in operation during the entirety of the test procedure. Models with a user-selectable setting must have the heaters energized and set to the maximum usage position. Models featuring an automatic, non-user-adjustable controller that turns on or off based on environmental conditions must be operating in the automatic state. If a unit is not shipped with a controller from the point of manufacture and is intended to be used with an automatic, non-user-adjustable controller, test the unit with a manufacturer-recommended controller that turns on or off based on environmental conditions.

1.3.6. Ultraviolet lights. Do not energize ultraviolet lights during the test.

1.3.7. Illuminated temperature displays and alarms. All illuminated temperature displays and alarms shall be energized and operated during the test as they would be during normal field operation.

1.3.8. Condenser filters. Remove any non-permanent filters that are provided to prevent particulates from blocking a model's condenser coil.

1.3.9. Refrigeration system security covers. Remove any devices used to secure the condensing unit against unwanted removal.

1.3.10. Night curtains and covers. Do not deploy night curtains or covers.

1.3.11. Grill options. Remove any optional, non-standard grills used to direct airflow.

1.3.12. Misting or humidification systems. Misting or humidification systems must be inactive during the test.

1.3.13. Air purifiers. Air purifiers must be inactive during the test.

1.3.14. General purpose outlets. During the test, do not connect any external load to any general purpose outlets contained within a unit.

1.3.15. Crankcase heaters. Crankcase heaters must be operational during the test. If a control system, such as a thermostat or electronic controller, is used to modulate the operation of the crankcase heater, it must be activated during the test.

1.3.16. Drawers. Drawers are to be treated as identical to doors when conducting the DOE test procedure. Commercial refrigeration equipment with drawers should be configured with the drawer pans that allow for the maximum packing of test simulators and filler packages without the filler packages and test simulators exceeding 90 percent of the refrigerated volume. Packing of test simulators and filler packages shall be in accordance with the requirements for commercial refrigerators without shelves, as specified in section 6.2.3 of ASHRAE 72–2005 (incorporated by reference, see §431.63).

2. Test Conditions

2.1. Integrated Average Temperatures. Conduct the testing required in section 1 and 2 of this appendix A, and determine the daily energy consumption at the applicable integrated average temperature as found in the following table.

Category	Test procedure	Integrated average temperature
(i) Refrigerator with Solid Door(s)	ARI Standard 1200–2006 [1]	38 °F (±2 °F).
(ii) Refrigerator with Transparent Door(s)	ARI Standard 1200–2006 [1]	38 °F (±2 °F).
(iii) Freezer with Solid Door(s)	ARI Standard 1200–2006 [1]	0 °F (±2 °F).
(iv) Freezer with Transparent Door(s)	ARI Standard 1200–2006 [1]	0 °F (±2 °F).
(v) Refrigerator-Freezer with Solid Door(s)	ARI Standard 1200–2006 [1]	38 °F (±2 °F) for refrigerator compartment. 0 °F (±2 °F) for freezer compartment.
(vi) Commercial Refrigerator with a Self-Contained Condensing Unit Designed for Pull-Down Temperature Applications and Transparent Doors.	ARI Standard 1200–2006 [1]	38 °F (±2 °F).
(vii) Ice-Cream Freezer	ARI Standard 1200–2006 [1]	−15.0 °F (±2 °F).
(viii) Commercial Refrigerator, Freezer, and Refrigerator-Freezer with a Self-Contained Condensing Unit and without Doors.	ARI Standard 1200–2006 [1]	(A) 0 °F (±2 °F) for low temperature applications. (B) 38 °F (±2 °F) for medium temperature applications.
(ix) Commercial Refrigerator, Freezer, and Refrigerator-Freezer with a Remote Condensing Unit.	ARI Standard 1200–2006 [1]	(A) 0 °F (±2 °F) for low temperature applications. (B) 38 °F (±2 °F) for medium temperature applications.

[1] Incorporated by reference, see §431.63.

2.2. Lowest Application Product Temperature. If a unit of commercial refrigeration equipment is not able to be operated at the integrated average temperature specified in the table in paragraph 2.1, test the unit at the lowest application product temperature (LAPT), as defined in §431.62. For units equipped with a thermostat, LAPT is the lowest thermostat setting. For remote condensing equipment without a thermostat or other means of controlling temperature at the case, the lowest application product temperature is the temperature achieved with the dew point temperature (as defined in AHRI Standard 1200 (I–P)-2010 (incorporated by reference see §431.63)) set to 5 degrees colder than that required to maintain the manufacturer's lowest specified operating temperature.

2.3. Testing at NSF Test Conditions. For commercial refrigeration equipment that is also tested in accordance with NSF test procedures (Type I and Type II), integrated average temperatures and ambient conditions used for NSF testing may be used in place of the DOE-prescribed integrated average temperatures and ambient conditions provided they result in a more stringent test. That is, the measured daily energy consumption of the same unit, when tested at the rating temperatures and/or ambient conditions specified in the DOE test procedure, must be lower than or equal to the measured daily energy consumption of the unit when tested with the rating temperatures or ambient conditions used for NSF testing. The integrated average temperature measured during the test may be lower than the range specified by the DOE applicable temperature specification provided in paragraph 2.1 of this appendix, but may not exceed the upper value of the specified range. Ambient temperatures and/or humidity values may be higher than those specified in the DOE test procedure.

3. Volume and Total Display Area

3.1. Determination of Volume. Determine the volume of a commercial refrigerator, freezer, refrigerator-freezer, or ice-cream freezer using the method set forth in the ANSI/AHAM HRF–1–2004, ''Energy, Performance and Capacity of Household Refrigerators, Refrigerator-Freezers and Freezers'' (incorporated by reference, see §431.63), section 3.21, ''Volume,'' sections 4.1 through 4.3, ''Method for Computing Total Refrigerated Volume and Total Shelf Area of Household Refrigerators and Household Wine Chillers,'' and sections 5.1 through 5.3, ''Method for Computing Total Refrigerated Volume and Total Shelf Area of Household Freezers.''

3.2. Determination of Total Display Area. Determine the total display area of a commercial refrigerator, freezer, refrigerator-freezer, or ice-cream freezer using the method set forth in ARI Standard 1200–2006 (incorporated by reference, see §431.63), but disregarding the specification that ''transparent material (≥65% light transmittance) in Appendix D. Specifically, total display area shall be the sum of the projected area(s) of visible product, expressed in ft^2 (*i.e.*, portions through which product can be viewed from an angle normal, or perpendicular, to the transparent area). Determine L as the interior length of the CRE model, provided no more than 10 percent of that length consists of non-transparent material. For those cases with greater than 10 percent of non-transparent area, L shall be determined as the projected linear dimension(s) of visible product plus 10 percent of non-transparent area.

See Figures A3.1, A3.2, A3.3, A3.4, and A3.5 as examples of how to calculate the dimensions associated with calculation of total display area. In the diagrams, D_h and L represent the dimensions of the projected visible product.

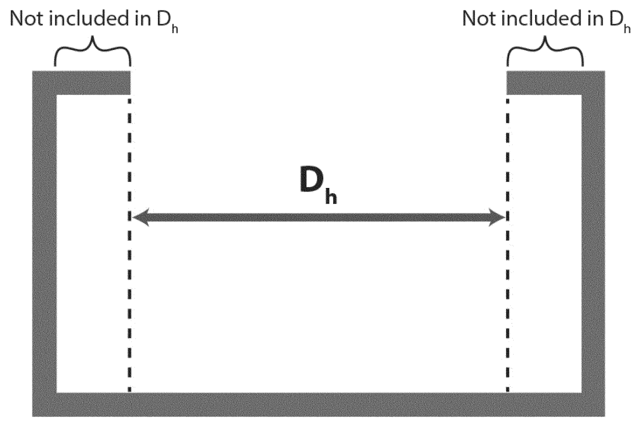

Figure A3.1 Horizontal open display case, where the distance "D_h" is the dimension of the projected visible product.

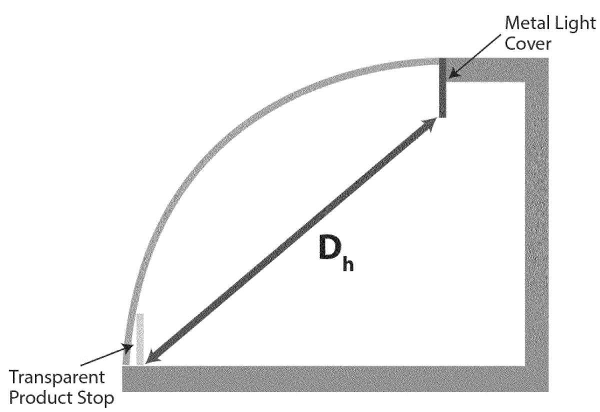

Figure A3.2 Service over counter display case, the distance "D_h" is the dimension of the projected visible product, that being the dimension transverse to the length of the case through which product can be viewed, excluding areas of the product zone that cannot be viewed as part of a direct projection through the glass front.

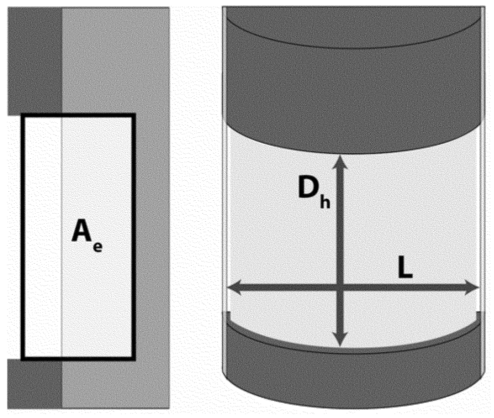

Figure A3.3 Radius case, where the distances "D_h" and "L," and the area "A_e," are representative of the planar projections of visible product when viewed at an angle normal to the transparent surface or opening.

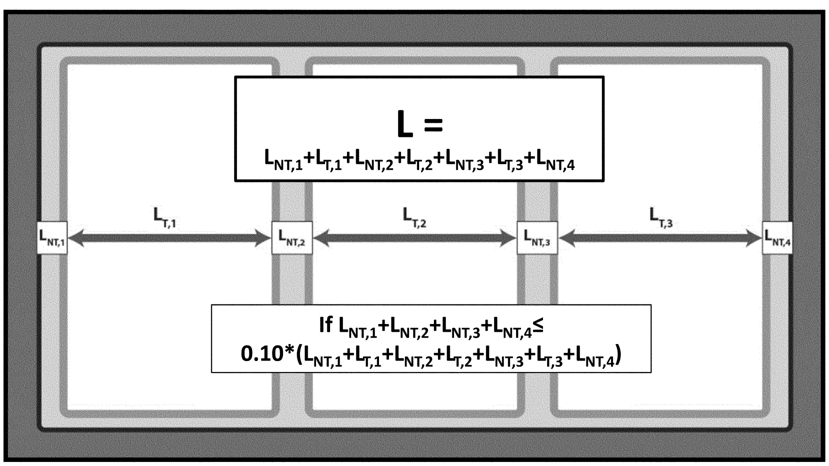

Figure A3.4 Three-door vertical closed transparent display case, where the distance "L" is the collective length of portions of the merchandiser through which product can be seen, including the linear dimension of transparent ($L_{T,i}$) and non-transparent ($L_{NT,i}$) areas, provided the total linear dimension of non-transparent areas are less than 5 inches.

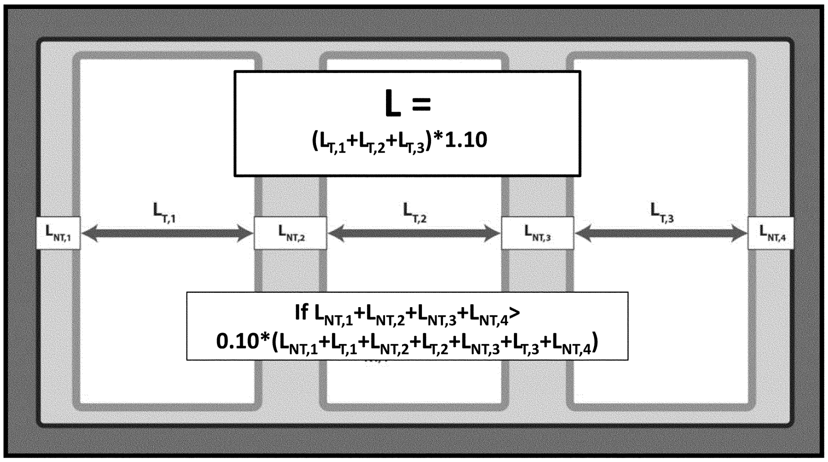

Figure A3.5 Three-door vertical closed transparent display case, where the distance "L" is the collective length of portions of the merchandiser through which product can be seen, including the linear dimension of transparent ($L_{T,i}$) and non-transparent ($L_{NT,i}$) areas, and the total linear dimension of non-transparent areas is greater than 5 inches.

[79 FR 22308, Apr. 21, 2014]

APPENDIX B TO SUBPART C OF PART 431—AMENDED UNIFORM TEST METHOD FOR THE MEASUREMENT OF ENERGY CONSUMPTION OF COMMERCIAL REFRIGERATORS, FREEZERS, AND REFRIGERATOR-FREEZERS

NOTE: Any representations made on or after March 28, 2017, with respect to the energy use or efficiency of commercial refrigeration equipment must be made in accordance with the results of testing pursuant to this appendix.

1. Test Procedure

1.1. Determination of Daily Energy Consumption. Determine the daily energy consumption of each covered commercial refrigerator, freezer, refrigerator-freezer or ice-cream freezer by conducting the test procedure set forth in the AHRI Standard 1200 (I–P)–2010, section 3, ''Definitions,'' section 4, ''Test Requirements,'' and section 7, ''Symbols and Subscripts'' (incorporated by reference, see §431.63). For each commercial refrigerator, freezer, or refrigerator-freezer with a self-contained condensing unit, also use AHRI Standard 1200 (I–P)–2010, section 6, ''Rating Requirements for Self-contained Commercial Refrigerated Display Merchandisers and Storage Cabinets.'' For each commercial refrigerator, freezer, or refrigerator-freezer with a remote condensing unit, also use AHRI Standard 1200 (I–P)-2010, section 5, ''Rating Requirements for Remote Commercial Refrigerated Display Merchandisers and Storage Cabinets.''

1.2. Methodology for Determining Applicability of Transparent Door Equipment Families

To determine if a door for a given model of commercial refrigeration equipment is transparent: (1) Calculate the outer door surface area including frames and mullions; (2) calculate the transparent surface area within the outer door surface area excluding frames and mullions; (3) calculate the ratio of (2) to (1) for each of the outer doors; and (4) the ratio for the transparent surface area of all outer doors must be greater than 0.25 to qualify as a transparent equipment family.

1.3. Additional Specifications for Testing of Components and Accessories. All standard components that would be used during normal operation of the basic model in the field shall be installed and used during testing as recommended by the manufacturer and representative of their typical operation in the field unless such installation and operation is inconsistent with any requirement of the test procedure. The specific components and accessories listed in the subsequent sections shall be operated as stated during the test.

1.3.1. Energy Management Systems. Applicable energy management systems may be activated during the test procedure provided they are permanently installed on the case, configured and sold in such a manner so as to operate automatically without the intervention of the operator, and do not conflict with any of other requirements for a valid test as specified in this appendix.

1.3.2. Lighting. All lighting except for customer display signs/lights as described in section 1.3.3 and UV lighting as described in section 1.3.6 of this appendix shall be energized to the maximum illumination level for the duration of testing for commercial refrigeration equipment with lighting except when the unit is equipped with lighting occupancy sensors and controls. If the unit includes an automatic lighting control system, it should be enabled during test. If the unit is equipped with lighting occupancy sensors and controls in should be tested in accordance with section 1.3.2.1 of this appendix.

1.3.2.1. Lighting Occupancy Sensors and Controls. For units with lighting occupancy sensors and/or scheduled lighting controls installed on the unit, determine the effect of the controls/sensors on daily energy consumption by either a physical test or a calculation method and using the variables that are defined as:

CEC_A is the alternate compressor energy consumption (kilowatt-hours);

LEC_{sc} is the lighting energy consumption of internal case lights with lighting occupancy sensors and controls deployed (kilowatt-hours);

P_{li} is the rated power of lights when they are fully on (watts);

$P_{li(off)}$ is the power of lights when they are off (watts);

$P_{li(dim)}$ is the power of lights when they are dimmed (watts);

$TDEC_o$ is the total daily energy consumption with lights fully on, as measured by AHRI Standard 1200 (I–P)–2010 (kilowatt-hours);

t_{dim} is the time period during which the lights are dimmed due to the use of lighting occupancy sensors or scheduled lighting controls (hours);

$t_{dim,controls}$ is the time case lighting is dimmed due to the use of lighting controls (hours);

$t_{dim,sensors}$ is the time case lighting is dimmed due to the use of lighting occupancy sensors (hours);

t_l is the time period when lights would be on without lighting occupancy sensors and/or scheduled lighting controls (24 hours);

t_{off} is the time period during which the lights are off due to the use of lighting occupancy sensors and/or scheduled lighting controls (hours);

$t_{off,controls}$ is the time case lighting is off due to the use of scheduled lighting controls (hours);

$t_{off,sensors}$ is the time case lighting is off due to the use of lighting occupancy sensors (hours); and

t_{sc} is the time period when lighting is fully on with lighting occupancy sensors and scheduled lighting controls enabled (hours).

1.3.2.1.i. For both a physical test and a calculation method, determine the estimated time off or dimmed, t_{off} or t_{dim}, as the sum of contributions from lighting occupancy sensors and scheduled lighting controls that dim or turn off lighting, respectively, as shown in the following equation:

$$t_{off} = t_{off,sensors} + t_{off,controls}$$

$$t_{dim} = t_{dim,sensors} + t_{dim,controls}$$

The sum of t_{sc}, t_{off}, and t_{dim} should equal 24 hours and the total time period during which the lights are off or dimmed shall not exceed 10.8 hours. For cases with scheduled lighting controls, the time the case lighting is off and/or dimmed due to scheduled lighting controls ($t_{off,controls}$ and/or $t_{dim,controls}$, as applicable) shall not exceed 8 hours. For cases with lighting occupancy sensors installed, the time the case lighting is off and/or dimmed due to lighting occupancy sensors ($t_{off,sensors}$ and/or $t_{dim,sensors}$, as applicable) shall not exceed 10.8 hours. For cases with lighting occupancy sensors and scheduled lighting controls installed, the time the case lighting is off and/or dimmed due to lighting occupancy sensors ($t_{off,sensors}$ and/or $t_{dim,sensors}$, as applicable) shall not exceed 2.8 hours and the time the case lighting is off and/or dimmed due to scheduled lighting controls ($t_{off,controls}$ and/or $t_{dim,controls}$, as applicable) shall not exceed 8 hours.

1.3.2.1.ii. If using a physical test to determine the daily energy consumption, turn off the lights for a time period equivalent to t_{off} and dim the lights for a time period equal to t_{dim}. If night curtains are also being tested on the case, the period of lights off and/or

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dimmed shall begin at the same time that the night curtain is being deployed and shall continue consecutively, in that order, for the appropriate number of hours.

1.3.2.1.iii. If using a calculation method to determine the daily energy consumption—

1.3.2.1.iii.A. Calculate the LEC_{sc} using the following equation:

$$LEC_{sc} = \frac{\left((P_{li} \times t_{sc}) + (P_{li(off)} \times t_{off}) + (P_{li(dim)} \times t_{dim})\right)}{(1000)}$$

1.3.2.1.iii.B. Calculate the CEC_A using the following equation:

$$CEC_A = 0.75 \times \frac{3.4121 \times \left(LEC_{sc} - P_{li} \times {}^{t_l}/_{1000}\right)}{EER}$$

Where EER represents the energy efficiency ratio from Table 1 in AHRI Standard 1200 (I–P)–2010 (incorporated by reference, see §431.63) for remote condensing equipment or the values shown in the following table for self-contained equipment:

EER FOR SELF-CONTAINED COMMERCIAL REFRIGERATED DISPLAY MERCHANDISERS AND STORAGE CABINETS

Operating temperature class	EER *Btu/W*
Medium	11
Low	7
Ice Cream	5

1.3.2.1.iii.C. For remote condensing units, calculate the revised compressor energy consumption (CEC_R) by adding the CEC_A to the compressor energy consumption (CEC) measured in AHRI Standard 1200 (I–P)–2010 (incorporated by reference, see §431.63). The CDEC for the entire case is the sum of the CEC_R and LEC_{sc} (as calculated above) and the fan energy consumption (FEC), anti-condensate energy consumption (AEC), defrost energy consumption (DEC), and condensate evaporator pan energy consumption (PEC) (as measured in AHRI Standard 1200 (I–P)–2010).

1.3.2.1.iii.D. For self-contained units, the TDEC for the entire case is the sum of total daily energy consumption as measured by the AHRI Standard 1200 (I–P)–2010 (incorporated by reference, see §431.63) test with the lights fully on ($TDEC_o$) and CEC_A, less the decrease in lighting energy use due to lighting occupancy sensors and scheduled lighting controls, as shown in following equation.

$$TDEC = TDEC_o + CEC_A - \left({}^{[P]_{li} \times t_l}/_{1000} - LEC_{sc}\right)$$

1.3.3. Customer display signs/lights. Do not energize supplemental lighting that exists solely for the purposes of advertising or drawing attention to the case and is not integral to the operation of the case.

1.3.4. Condensate pan heaters and pumps. For self-contained equipment only, all electric resistance condensate heaters and condensate pumps must be installed and in operation during the test. This includes the stabilization period (including pull-down), steady-state, and performance testing periods. Prior to the start of the stabilization period as defined by ASHRAE 72–2005 (incorporated by reference, see §431.63), the condensate pan must be dry. Following the start of the stabilization period, allow any condensate moisture generated to accumulate in the pan. Do not manually add or remove water to or from the condensate pan at any time during the test.

1.3.5. Anti-sweat door heaters. Anti-sweat door heaters must be operational during the entirety of the test procedure. Models with a user-selectable setting must have the heaters energized and set to the maximum usage position. Models featuring an automatic, non-user-adjustable controller that turns on or off based on environmental conditions must be operating in the automatic state. If a unit is not shipped with a controller from the point of manufacture and is intended to be used with an automatic, non-user-adjustable controller, test the unit with a manufacturer-recommended controller that turns on or off based on environmental conditions.

1.3.6. Ultraviolet lights. Do not energize ultraviolet lights during the test.

1.3.7. Illuminated temperature displays and alarms. All illuminated temperature displays and alarms shall be energized and operated during the test as they would be during normal field operation.

1.3.8. Condenser filters. Remove any non-permanent filters that are provided to prevent particulates from blocking a model's condenser coil.

1.3.9. Refrigeration system security covers. Remove any devices used to secure the condensing unit against unwanted removal.

1.3.10. Night curtains and covers. For display cases sold with night curtains installed, the night curtain shall be employed for 6 hours; beginning 3 hours after the start of the first defrost period. Upon the completion of the 6-hour period, the night curtain shall be raised until the completion of the 24-hour test period.

1.3.11. Grill options. Remove any optional non-standard grills used to direct airflow.

1.3.12. Misting or humidification systems. Misting or humidification systems must be inactive during the test.

1.3.13. Air purifiers. Air purifiers must be inactive during the test.

1.3.14. General purpose outlets. During the test, do not connect any external load to any general purpose outlets contained within a unit.

1.3.15. Crankcase heaters. Crankcase heaters must be operational during the test. If a control system, such as a thermostat or electronic controller, is used to modulate the operation of the crankcase heater, it must be utilized during the test.

1.3.16. Drawers. Drawers are to be treated as identical to doors when conducting the DOE test procedure. Commercial refrigeration equipment with drawers should be configured with the drawer pans that allow for the maximum packing of test simulators and filler packages without the filler packages and test simulators exceeding 90 percent of the refrigerated volume. Packing of test simulators and filler packages shall be in accordance with the requirements for commercial refrigerators without shelves, as specified in section 6.2.3 of ASHRAE 72–2005 (incorporated by reference, see §431.63).

2. Test Conditions

2.1. Integrated Average Temperatures. Conduct the testing required in section 1 of this appendix B, and determine the daily energy consumption at the applicable integrated average temperature in the following table.

Category	Test procedure	Integrated average temperature
(i) Refrigerator with Solid Door(s)	AHRI Standard 1200 (I–P)–2010 [1]	38 °F (±2 °F).
(ii) Refrigerator with Transparent Door(s)	AHRI Standard 1200 (I–P)–2010 [1]	38 °F (±2 °F).
(iii) Freezer with Solid Door(s)	AHRI Standard 1200 (I–P)–2010 [1]	0 °F (±2 °F).
(iv) Freezer with Transparent Door(s)	AHRI Standard 1200 (I–P)–2010 [1]	0 °F (±2 °F).
(v) Refrigerator-Freezer with Solid Door(s).	AHRI Standard 1200 (I–P)–2010 [1]	38 °F (±2 °F) for refrigerator compartment. 0 °F (±2 °F) for freezer compartment.
(vi) Commercial Refrigerator with a Self-Contained Condensing Unit Designed for Pull-Down Temperature Applications and Transparent Doors.	AHRI Standard 1200 (I–P)–2010 [1]	38 °F (±2 °F).
(vii) Ice-Cream Freezer	AHRI Standard 1200 (I–P)–2010 [1]	−15.0 °F (±2 °F).
(viii) Commercial Refrigerator, Freezer, and Refrigerator-Freezer with a Self-Contained Condensing Unit and without Doors.	AHRI Standard 1200 (I–P)–2010 [1]	(A) 0 °F (±2 °F) for low temperature applications. (B) 38.0 °F (±2 °F) for medium temperature applications.
(ix) Commercial Refrigerator, Freezer, and Refrigerator-Freezer with a Remote Condensing Unit.	AHRI Standard 1200 (I–P)–2010 [1]	(A) 0 °F (±2 °F) for low temperature applications. (B) 38.0 °F (±2 °F) for medium temperature applications.

[1] Incorporated by reference, see §431.63.

2.2. Lowest Application Product Temperature. If a unit of commercial refrigeration equipment is not able to be operated at the integrated average temperature specified in the table in paragraph 2.1 of this appendix, test the unit at the lowest application product temperature (LAPT), as defined in §431.62. For units equipped with a thermostat, LAPT is the lowest thermostat setting. For remote condensing equipment without a thermostat or other means of controlling temperature at the case, the lowest application product temperature is the temperature achieved with the dew point temperature (as defined in AHRI Standard 1200 (I–P)–2010 (incorporated by reference, see §431.63)) set to 5 degrees colder than that required to maintain the manufacturer's lowest specified application temperature.

2.3. Testing at NSF Test Conditions. For commercial refrigeration equipment that is also tested in accordance with NSF test procedures (Type I and Type II), integrated average temperatures and ambient conditions used for NSF testing may be used in place of the DOE-prescribed integrated average temperatures and ambient conditions provided they result in a more stringent test. That is, the measured daily energy consumption of the same unit, when tested at the rating temperatures and/or ambient conditions specified in the DOE test procedure, must be lower than or equal to the measured daily energy consumption of the unit when tested with the rating temperatures or ambient conditions used for NSF testing. The integrated average temperature measured during the test may be lower than the range specified by the DOE applicable temperature specification provided in paragraph 2.1 of this appendix, but may not exceed the upper value of the specified range. Ambient temperatures and/or humidity values may be higher than those specified in the DOE test procedure.

3. Volume and Total Display Area

3.1. Determination of Volume. Determine the volume of a commercial refrigerator, freezer, refrigerator-freezer, or ice-cream freezer using the method set forth in the HRF–1–2008 (incorporated by reference, see §431.63), section 3.30, ''Volume,'' and sections 4.1 through 4.3, ''Method for Computing Refrigerated Volume of Refrigerators, Refrigerator-Freezers, Wine Chillers and Freezers.''

3.2. Determination of Total Display Area. Determine the total display area of a commercial refrigerator, freezer, refrigerator-freezer, or ice-cream freezer using the method set forth in ARI Standard 1200–2006 (incorporated by reference, see §431.63), but disregarding the specification that ''transparent material (≥65% light transmittance) in Appendix D. Specifically, total display area shall be the sum of the projected area(s) of visible product, expressed in ft^2 (*i.e.*, portions through which product can be viewed from an angle normal, or perpendicular, to the transparent area). Determine L as the interior length of the CRE model, provided no more than 5 inches of that length consists of non-transparent material. For those cases with greater than 5 inches of non-transparent area, L shall be determined as the projected linear dimension(s) of visible product plus 5 inches of non-transparent area.

See Figures A3.1, A3.2, and A3.3 as examples of how to calculate the dimensions associated with calculation of total display area. In the diagrams, D_h and L represent the dimensions of the projected visible product.

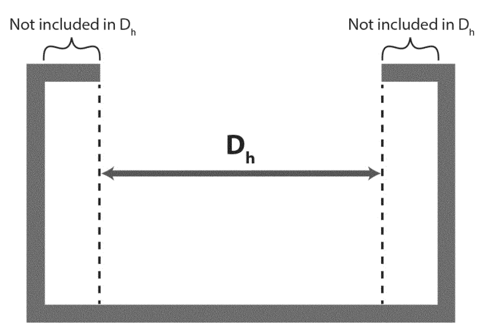

Figure A3.1 Horizontal open display case, where the distance "D_h" is the dimension of the projected visible product.

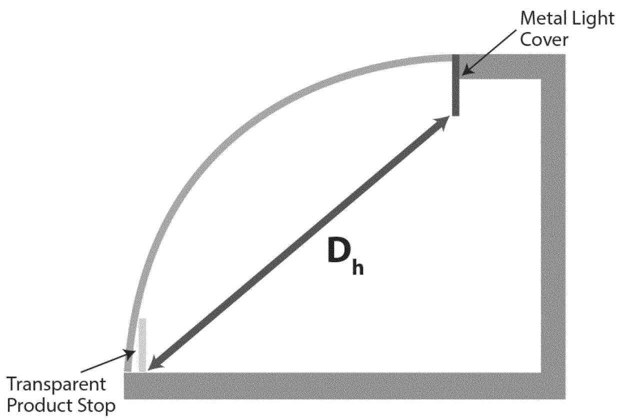

Figure A3.2 Service over counter display case, the distance "D_h" is the dimension of the projected visible product, that being the dimension transverse to the length of the case through which product can be viewed, excluding areas of the product zone that cannot be viewed as part of a direct projection through the glass front.

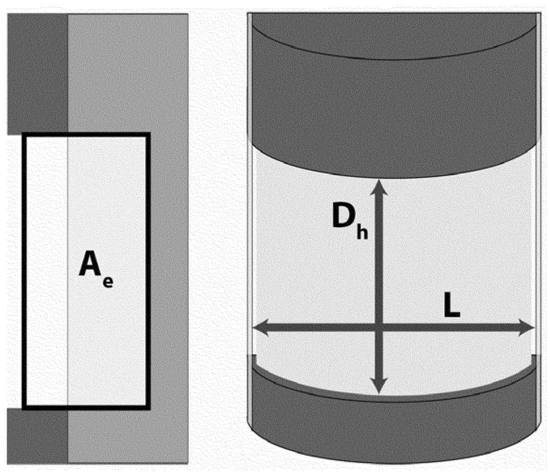

Figure A3.3 Radius case, where the distances "D_h" and "L," and the area "A_e," are representative of the planar projections of visible product when viewed at an angle normal to the transparent surface or opening.

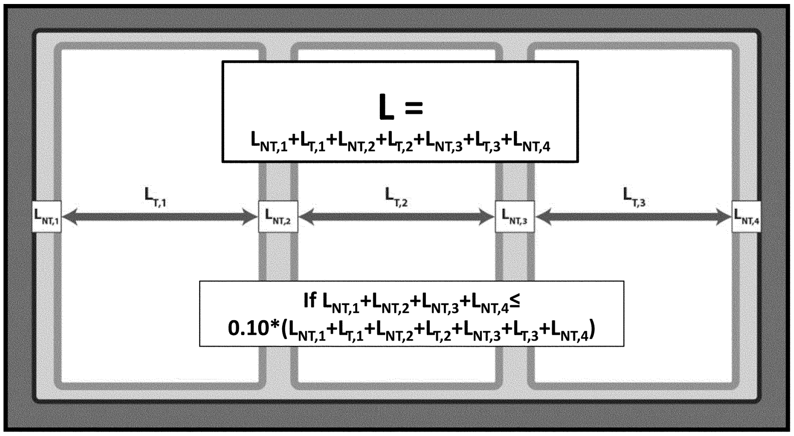

Figure A3.4 Three-door vertical closed transparent display case, where the distance "L" is the collective length of portions of the merchandiser through which product can be seen, including the linear dimension of transparent ($L_{T,i}$) and non-transparent ($L_{NT,i}$) areas, provided the total linear dimension of non-transparent areas are less than 5 inches.

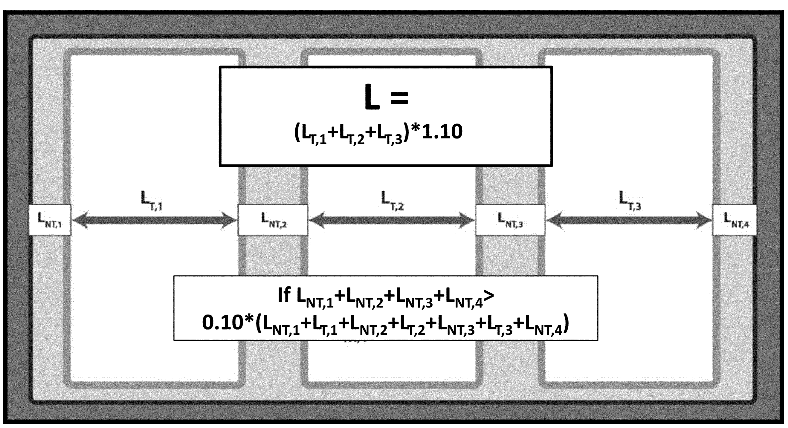

Figure A3.5 Three-door vertical closed transparent display case, where the distance "L" is

including the linear dimension of transparent ($L_{T,i}$) and non-transparent ($L_{NT,i}$) areas, and the total linear dimension of non-transparent areas is greater than 5 inches.

[79 FR 22308, Apr. 21, 2014]

Subpart D—Commercial Warm Air Furnaces

SOURCE: 69 FR 61939, Oct. 21, 2004, unless otherwise noted.

§431.71 Purpose and scope.

This subpart contains energy conservation requirements for commercial warm air furnaces, pursuant to Part C of Title III of the Energy Policy and Conservation Act, as amended, 42 U.S.C. 6311–6317.

[69 FR 61939, Oct. 21, 2004, as amended at 70 FR 60415, Oct. 18, 2005]

§431.72 Definitions concerning commercial warm air furnaces.

The following definitions apply for purposes of this subpart D, and of subparts J through M of this part. Any words or terms not defined in this Section or elsewhere in this part shall be defined as provided in Section 340 of the Act.

Basic model means all commercial warm air furnaces manufactured by one manufacturer within a single equipment class, that have the same nominal input rating and the same primary energy source (e.g. gas or oil) and that do not have any differing physical or functional characteristics that affect energy efficiency.

Commercial warm air furnace means a warm air furnace that is industrial equipment, and that has a capacity (rated maximum input) of 225,000 Btu per hour or more.

Thermal efficiency for a commercial warm air furnace equals 100 percent minus percent flue loss determined using test procedures prescribed under §431.76.

Warm air furnace means a self-contained oil-fired or gas-fired furnace designed to supply heated air through ducts to spaces that require it and includes combination warm air furnace/electric air conditioning units but does not include unit heaters and duct furnaces.

[69 FR 61939, Oct. 21, 2004, as amended at 76 FR 12503, Mar. 7, 2011; 78 FR 79598, Dec. 31, 2013]

TEST PROCEDURES

§431.75 Materials incorporated by reference.

(a) *General*. DOE incorporates by reference the following test procedures into subpart D of part 431. The materials listed have been approved for incorporation by reference by the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. Any subsequent amendment to the listed materials by the standard-setting organization will not affect the DOE regulations unless and until such regulations are amended by DOE. Materials are incorporated as they exist on the date of the approval, and a notice of any changes in the materials will be published in the FEDERAL REGISTER. All approved materials are available for inspection at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call (202) 741–6030 or go to: *http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html*. Also, these materials are available for inspection at U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Program, 6th Floor, 950 L'Enfant Plaza SW., Washington, DC 20024, (202) 586–2945, or go to: *http://www1.eere.energy.gov/buildings/appliance_standards/*. The referenced test procedure standards are listed below by relevant standard-setting organization, along with information on how to obtain copies from those sources.

(b) *ANSI*. American National Standards Institute. 25 W. 43rd Street, 4th Floor, New York, NY 10036. (212) 642–4900 or go to *http://www.ansi.org*.

(1) ANSI Z21.47–2012, (''ANSI Z21.47'') ''*Standard for Gas-fired Central Furnaces*,'' approved March 27, 2012, IBR approved for §431.76.

(2) [Reserved]

(c) *ASHRAE*. American Society of Heating, Refrigerating and Air-Conditioning Engineers Inc., 1791 Tullie Circle NE., Atlanta, Georgia 30329, (404) 636–8400, or go to: *http://www.ashrae.org*.

(1) ANSI/ASHRAE Standard 103–2007, (''ASHRAE 103''), ''Method of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and

Boilers,'' sections 7.2.2.4, 7.8, 9.2, and 11.3.7, approved June 27, 2007, IBR approved for §431.76.

(2) [Reserved]

(d) *HI*. Hydronics Institute Division of AHRI, 35 Russo Place, P.O. Box 218, Berkeley Heights, NJ 07922, (703) 600–0350, or go to: *http://www.ahrinet.org/hydronics + institute + section.aspx*.

(1) HI BTS–2000, sections 8.2.2, 11.1.4, 11.1.5, and 11.1.6.2, ''*Method to Determine Efficiency of Commercial Space Heating Boilers*,'' published January 2001, IBR approved for §431.76.

(2) [Reserved]

(e) *UL*. Underwriters Laboratories, Inc., 333 Pfingsten Road, Northbrook, IL 60062, (847) 272–8800, or go to: *http://www.ul.com*.

(1) UL 727 (UL 727–1994), ''*Standard for Safety Oil-Fired Central Furnaces*,'' published on August 1, 1994, IBR approved for §431.76.

(2) UL 727 (UL 727–2006), ''*Standard for Safety Oil-Fired Central Furnaces*,'' approved April 7, 2006, IBR approved for §431.76.

(3) [Reserved]

[77 FR 28987, May 16, 2012, as amended at 80 FR 42663, July 17, 2015]

§431.76 Uniform test method for the measurement of energy efficiency of commercial warm air furnaces.

(a) *Scope*. This section covers the test requirements used to measure the energy efficiency of commercial warm air furnaces with a rated maximum input of 225,000 Btu per hour or more. On and after July 11, 2016, any representations made with respect to the energy use or efficiency of commercial warm air furnaces must be made in accordance with the results of testing pursuant to this section. At that time, you must use the relevant procedures in ANSI Z21.47 or UL 727–2006 (incorporated by reference, see §431.75). On and after August 17, 2015 and prior to July 11, 2016, manufacturers must test commercial warm air furnaces in accordance with this amended section or the section as it appeared at 10 CFR part 430, subpart B in the 10 CFR parts 200 to 499 edition revised January 1, 2014. DOE notes that, because testing under this section is required as of July 11, 2016, manufacturers may wish to begin using this amended test procedure immediately. Any representations made with respect to the energy use or efficiency of such commercial warm air furnaces must be made in accordance with whichever version is selected.

(b) *Testing*. Where this section prescribes use of ANSI Z21.47 or UL 727–2006 (incorporated by reference, see §431.75), perform only the procedures pertinent to the measurement of the steady-state efficiency, as specified in paragraph (c) of this section.

(c) *Test set-up*—(1) *Test set-up for gas-fired commercial warm air furnaces*. The test set-up, including flue requirement, instrumentation, test conditions, and measurements for determining thermal efficiency is as specified in sections 1.1 (Scope), 2.1 (General), 2.2 (Basic Test Arrangements), 2.3 (Test Ducts and Plenums), 2.4 (Test Gases), 2.5 (Test Pressures and Burner Adjustments), 2.6 (Static Pressure and Air Flow Adjustments), 2.39 (Thermal Efficiency), and 4.2.1 (Basic Test Arrangements for Direct Vent Central Furnaces) of ANSI Z21.47 (incorporated by reference, see §431.75). The thermal efficiency test must be conducted only at the normal inlet test pressure, as specified in section 2.5.1 of ANSI Z21.47, and at the maximum hourly Btu input rating specified by the manufacturer for the product being tested.

(2) *Test setup for oil-fired commercial warm air furnaces*. The test setup, including flue requirement, instrumentation, test conditions, and measurement for measuring thermal efficiency is as specified in sections 1 (Scope), 2 (Units of Measurement), 3 (Glossary), 37 (General), 38 and 39 (Test Installation), 40 (Instrumentation, except 40.4 and 40.6.2 through 40.6.7, which are not required for the thermal efficiency test), 41 (Initial Test Conditions), 42 (Combustion Test—Burner and Furnace), 43.2 (Operation Tests), 44 (Limit Control Cutout Test), 45 (Continuity of Operation Test), and 46 (Air Flow, Downflow or Horizontal Furnace Test), of UL 727–2006 (incorporated by reference, see §431.75). You must conduct a fuel oil analysis for heating value, hydrogen content, carbon content, pounds per gallon, and American Petroleum Institute (API) gravity as specified in section 8.2.2 of HI BTS–2000 (incorporated by reference, see §431.75). The steady-

state combustion conditions, specified in Section 42.1 of UL 727–2006, are attained when variations of not more than 5 °F in the measured flue gas temperature occur for three consecutive readings taken 15 minutes apart.

(d) *Additional test measurements*—(1) *Measurement of flue CO_2 (carbon dioxide) for oil-fired commercial warm air furnaces.* In addition to the flue temperature measurement specified in section 40.6.8 of UL 727–2006 (incorporated by reference, see § 431.75), you must locate one or two sampling tubes within six inches downstream from the flue temperature probe (as indicated on Figure 40.3 of UL 727–2006). If you use an open end tube, it must project into the flue one-third of the chimney connector diameter. If you use other methods of sampling CO_2, you must place the sampling tube so as to obtain an average sample. There must be no air leak between the temperature probe and the sampling tube location. You must collect the flue gas sample at the same time the flue gas temperature is recorded. The CO_2 concentration of the flue gas must be as specified by the manufacturer for the product being tested, with a tolerance of ±0.1 percent. You must determine the flue CO_2 using an instrument with a reading error no greater than ±0.1 percent.

(2) *Procedure for the measurement of condensate for a gas-fired condensing commercial warm air furnace.* The test procedure for the measurement of the condensate from the flue gas under steady-state operation must be conducted as specified in sections 7.2.2.4, 7.8, and 9.2 of ASHRAE 103 (incorporated by reference, see § 431.75) under the maximum rated input conditions. You must conduct this condensate measurement for an additional 30 minutes of steady-state operation after completion of the steady-state thermal efficiency test specified in paragraph (c) of this section.

(e) *Calculation of thermal efficiency* —(1) *Gas-fired commercial warm air furnaces.* You must use the calculation procedure specified in section 2.39, Thermal Efficiency, of ANSI Z21.47 (incorporated by reference, see § 431.75).

(2) *Oil-fired commercial warm air furnaces.* You must calculate the percent flue loss (in percent of heat input rate) by following the procedure specified in sections 11.1.4, 11.1.5, and 11.1.6.2 of the HI BTS–2000 (incorporated by reference, see § 431.75). The thermal efficiency must be calculated as: Thermal Efficiency (percent) = 100 percent − flue loss (in percent).

(f) *Procedure for the calculation of the additional heat gain and heat loss, and adjustment to the thermal efficiency, for a condensing commercial warm air furnace.* (1) You must calculate the latent heat gain from the condensation of the water vapor in the flue gas, and calculate heat loss due to the flue condensate down the drain, as specified in sections 11.3.7.1 and 11.3.7.2 of ASHRAE 103 (incorporated by reference, see § 431.75), with the exception that in the equation for the heat loss due to hot condensate flowing down the drain in section 11.3.7.2, the assumed indoor temperature of 70 °F and the temperature term T_{OA} must be replaced by the measured room temperature as specified in section 2.2.8 of ANSI Z21.47 (incorporated by reference, see § 431.75).

(2) *Adjustment to the thermal efficiency for condensing furnaces.* You must adjust the thermal efficiency as calculated in paragraph (e)(1) of this section by adding the latent gain, expressed in percent, from the condensation of the water vapor in the flue gas, and subtracting the heat loss (due to the flue condensate down the drain), also expressed in percent, both as calculated in paragraph (f)(1) of this section, to obtain the thermal efficiency of a condensing furnace.

[80 FR 42663, July 17, 2015]

ENERGY CONSERVATION STANDARDS

§ 431.77 Energy conservation standards and their effective dates.

(a) *Gas-fired commercial warm air furnaces.* Each gas-fired commercial warm air furnace must meet the following energy efficiency standard levels:

(1) For gas-fired commercial warm air furnaces manufactured starting on January 1, 1994, until January 1, 2023, the TE at the maximum rated capacity (rated maximum input) must be not less than 80 percent; and

(2) For gas-fired commercial warm air furnaces manufactured starting on

January 1, 2023, the TE at the maximum rated capacity (rated maximum input) must be not less than 81 percent.

(b) *Oil-fired commercial warm air furnaces*. Each oil-fired commercial warm air furnace must meet the following energy efficiency standard levels:

(1) For oil-fired commercial warm air furnaces manufactured starting on January 1, 1994, until January 1, 2023, the TE at the maximum rated capacity (rated maximum input) must be not less than 81 percent; and

(2) For oil-fired commercial warm air furnaces manufactured starting on January 1, 2023, the TE at the maximum rated capacity (rated maximum input) must be not less than 82 percent.

[81 FR 2528, Jan. 15, 2016]

Subpart E—Commercial Packaged Boilers

SOURCE: 69 FR 61960, Oct. 21, 2004, unless otherwise noted.

§ 431.81 Purpose and scope.

This subpart contains energy conservation requirements for certain commercial packaged boilers, pursuant to Part C of Title III of the Energy Policy and Conservation Act. (42 U.S.C. 6311–6317)

[69 FR 61960, Oct. 21, 2004, as amended at 70 FR 60415, Oct. 18, 2005]

§ 431.82 Definitions concerning commercial packaged boilers.

The following definitions apply for purposes of this subpart E, and of subparts A and J through M of this part. Any words or terms not defined in this section or elsewhere in this part shall be defined as provided in 42 U.S.C. 6311.

Basic model means all commercial packaged boilers manufactured by one manufacturer within a single equipment class having the same primary energy source (e.g., gas or oil) and that have essentially identical electrical, physical and functional characteristics that affect energy efficiency.

Btu/h or *Btu/hr* means British thermal units per hour.

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 losses due to dry flue gas, incomplete combustion, and moisture formed by combustion of hydrogen, as determined with the test procedures prescribed under § 431.86 of this chapter.

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

(1) Has rated input 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.

Condensing boiler means a commercial packaged boiler that condenses part of the water vapor in the flue gases, and that includes a means of collecting and draining this condensate from its heat exchanger section.

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.

Flue condensate means liquid formed by the condensation of moisture in the flue gases.

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

Manufacturer of a commercial packaged boiler means any person who manufactures, produces, assembles or imports such a boiler, including any person who:

(1) Manufactures, produces, assembles or imports a commercial packaged boiler in its entirety;

(2) Manufactures, produces, assembles or imports a commercial packaged boiler in part, and specifies or approves the boiler's components, including burners or other components produced by others, as for example by specifying such components in a catalogue by make and model number or parts number; or

(3) Is any vendor or installer who sells a commercial packaged boiler that consists of a combination of components that is not specified or approved by a person described in paragraph (1) or (2) of this definition.

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.

Rated input means the maximum rate at which the commercial packaged boiler has been rated to use energy as indicated by the nameplate and in the manual shipped with the commercial packaged boiler.

Thermal efficiency for a commercial packaged boiler is determined using test procedures prescribed under § 431.86 and is the ratio of the heat absorbed by the water or the water and steam to the higher heating value in the fuel burned.

[69 FR 61960, Oct. 21, 2004, as amended at 74 FR 36354, July 22, 2009; 76 FR 12503, Mar. 7, 2011; 78 FR 79598, Dec. 31, 2013; 81 FR 89304, Dec. 9, 2016]

TEST PROCEDURES

§ 431.85 Materials incorporated by reference.

(a) *General*. We incorporate by reference the following standards into subpart E of part 431. The material listed has been approved for incorporation by reference by the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. Any subsequent amendment to a standard by the standard-setting organization will not affect the DOE regulations unless and until amended by DOE. Material is incorporated as it exists on the date of the approval and a notice of any change in the material will be published in the FEDERAL REGISTER. All approved material is available for inspection at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202–741–6030 or go to *http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html*. Also, this material is available for inspection at U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Program, 6th Floor, 950 L'Enfant Plaza, SW., Washington, DC 20024, 202–586–2945, or go to: *http://www1.eere.energy.gov/buildings/appliance_standards/*. Standards can be obtained from the sources listed below.

(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, (''ANSI/AHRI Standard 1500–2015''), ''2015 Standard for Performance Rating of Commercial Space Heating Boilers,'' ANSI approved November 28, 2014, IBR approved for appendix A to subpart E as follows:

(i) Section 3—Definitions (excluding introductory text to section 3, introductory text to 3.2, 3.2.4, 3.2.7, 3.6, 3.12, 3.13, 3.20, 3.23, 3.24, 3.26, 3.27, and 3.31);

(ii) Section 5—Rating Requirements, 5.3 Standard Rating Conditions: (excluding introductory text to section 5.3, 5.3.5, 5.3.8, and 5.3.9);

(iii) Appendix C—Methods of Testing for Rating Commercial Space Heating Boilers—Normative, excluding C2.1, C2.7.2.2.2, C3.1.3, C3.5–C3.7, C4.1.1.1.2, C4.1.1.2.3, C4.1.2.1.5, C4.1.2.2.2, C4.1.2.2.3, C4.2, C5, C7.1, C7.2.12, C7.2.20;

(iv) Appendix D. Properties of Saturated Steam—Normative.

(v) Appendix E. Correction Factors for Heating Values of Fuel Gases—Normative.

(2) [Reserved].

[74 FR 36354, July 22, 2009, as amended at 81 FR 89305, Dec. 9, 2016]

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§ 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 commercial packaged boilers by conducting the appropriate test procedure(s) indicated in Table 1 of this section.

TABLE 1—TEST REQUIREMENTS FOR COMMERCIAL PACKAGED BOILER EQUIPMENT CLASSES

Equipment category	Subcategory	Certified rated input Btu/h	Standards efficiency metric (§ 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.

*Equipment 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).

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

[81 FR 89305, Dec. 9, 2016]

ENERGY EFFICIENCY STANDARDS

§ 431.87 Energy and water conservation standards and their effective dates.

(a) Each commercial packaged boiler listed in Table 1 to § 431.87 and manufactured on or after March 2, 2012 and prior to January 10, 2023, must meet the applicable energy conservation standard levels as follows:

TABLE 1 TO § 431.87—COMMERCIAL PACKAGED BOILER ENERGY CONSERVATIONS STANDARDS

Equipment	Subcategory	Size category (input)	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.

TABLE 1 TO § 431.87—COMMERCIAL PACKAGED BOILER ENERGY CONSERVATIONS STANDARDS—Continued

Equipment	Subcategory	Size category (input)	Efficiency level—effective date: March 2, 2012 *
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.

* Where E_T means "thermal efficiency" and E_C means "combustion efficiency" as defined in 10 CFR 431.82.

(b) Each commercial packaged boiler listed in Table 2 to § 431.87 and manufactured on or after January 10, 2023, must meet the applicable energy conservation standard levels as follows:

TABLE 2 TO § 431.87—COMMERCIAL PACKAGED BOILER ENERGY CONSERVATIONS STANDARDS

Equipment	Size category (rated input)	Energy conservation standard
Small Gas-Fired Hot Water Commercial Packaged Boilers.	≥300,000 Btu/h and ≤2,500,000 Btu/h	84.0% E_T.
Large Gas-Fired Hot Water Commercial Packaged Boilers.	>2,500,000 Btu/h and ≤10,000,000 Btu/h	85.0% E_C.
Very Large Gas-Fired Hot Water Commercial Packaged Boilers.	>10,000,000 Btu/h	82.0% E_C.
Small Oil-Fired Hot Water Commercial Packaged Boilers.	≥300,000 Btu/h and ≤2,500,000 Btu/h	87.0% E_T.
Large Oil-Fired Hot Water Commercial Packaged Boilers.	>2,500,000 Btu/h and ≤10,000,000 Btu/h	88.0% E_C.
Very Large Oil-Fired Hot Water Commercial Packaged Boilers.	>10,000,000 Btu/h	84.0% E_C.
Small Gas-Fired Steam Commercial Packaged Boilers.	≥300,000 Btu/h and ≤2,500,000 Btu/h	81.0% E_T.
Large Gas-Fired Steam Commercial Packaged Boilers.	>2,500,000 Btu/h and ≤10,000,000 Btu/h	82.0% E_T.
Very Large Gas-Fired Steam Commercial Packaged Boilers **.	>10,000,000 Btu/h	79.0% E_T.
Small Oil-Fired Steam Commercial Packaged Boilers.	≥300,000 Btu/h and ≤2,500,000 Btu/h	84.0% E_T.
Large Oil-Fired Steam Commercial Packaged Boilers.	>2,500,000 Btu/h and ≤10,000,000 Btu/h	85.0% E_T.
Very Large Oil-Fired Steam Commercial Packaged Boilers.	>10,000,000 Btu/h	81.0% E_T.

* Where E_T means "thermal efficiency" and E_C means "combustion efficiency" as defined in 10 CFR 431.82.
** Prior to March 2, 2022, for natural draft very large gas-fired steam commercial packaged boilers, a minimum thermal efficiency level of 77 percent is permitted and meets Federal commercial packaged boiler energy conservation standards.

[85 FR 1681, Jan. 10, 2020]

APPENDIX A TO SUBPART E OF PART 431—UNIFORM TEST METHOD FOR THE MEASUREMENT OF THERMAL EFFICIENCY AND COMBUSTION EFFICIENCY OF COMMERCIAL PACKAGED BOILERS

NOTE: Prior to December 4, 2017, 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 this Appendix or the test procedures as they appeared in 10 CFR 431.86 revised as of January 1, 2016. On and after December 4, 2017, 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

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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 the introductory text to section 3, the introductory text to section 3.2, ''Boiler''; 3.2.4, ''Heating Boiler''; 3.2.7, ''Packaged Boiler''; 3.6, ''Combustion Efficiency''; 3.12, ''Efficiency, Combustion''; 3.13, ''Efficiency, Thermal''; 3.20, ''Gross Output''; 3.23, ''Input Rating''; 3.24, ''Net Rating''; 3.26, ''Published Rating''; 3.26.1, ''Standard Rating''; 3.27, ''Rating Conditions''; 3.27.1, ''Standard Rating Conditions''; and 3.31, ''Thermal Efficiency.'' 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.

1.3. Unless otherwise noted, in all incorporated sections of ANSI/AHRI Standard 1500–2015, the term ''input rating'' means ''rated input'' 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.* Record all test data in accordance with Table 2.1 and Table 2.2. Do not use Section C5 and Table C4 of Appendix C of ANSI/AHRI Standard 1500–2015.

TABLE 2.1—DATA TO BE RECORDED BEFORE TESTING

Item recorded	Additional instruction
Date of Test	None.
Manufacturer	None.
Commercial Packaged Boiler Model Number.	None.
Burner Model Number & Manufacturer.	None.
Nozzle description and oil pressure	None.
Oil Analysis—H, C, API Gravity, lb/gal and Btu/lb.	None.
Gas Manifold Pressure	Record at start and end of test.
Gas line pressure at meter	Measurement may be made manually.
Gas temperature	Measurement may be made manually.
Barometric Pressure (Steam and Natural Gas Only).	Measurement may be made manually.
Gas Heating Value, Btu/ft^3*	Record at start and end of test.

*Multiplied by correction factors, as applicable, in accordance with Appendix E of ANSI/AHRI Standard 1500–2015.

Table 2.2. Data to be Recorded During Testing

Item Recorded		Digital Acquisition Required?	Required Data Recording: Every 1 Minute	Required Data Recording: Every 15 Minutes	For Use in Calculations (Section 2.4) As Applicable: Average During Test Period	For Use in Calculations (Section 2.4) As Applicable: Total During Test Period
Time, minutes/seconds		Yes	X			
Flue Gas Temperature, °F		Yes	X		X	
Pressure in Firebox, in H_2O (if required per Section C3.4 of ANSI/AHRI Standard 1500-2015)		No		X	X	
Flue Gas Smoke Spot Reading (oil)		No		X	X	
Room Air Temperature		Yes	X		X	
Fuel Weight or Volume, lb (oil) or ft^3 (gas)		Yes		X		X
Test Air Temperature, °F		Yes	X		X	
Draft in Vent, in H_2O (oil and non-atmospheric gas)		No		X	X	
Flue Gas CO_2 or O_2, %		No		X	X	
Flue Gas CO, ppm		No		At Least Start and End	X	
Relative Humidity, %		No		X	X	
STEAM	Separator water weight, lb	No		At Least Start and End		X
STEAM	Steam Pressure, in Hg	No		X	X	
STEAM	Steam Temperature, °F (if used)	Yes	X		X	
STEAM	Condensate collected, or water fed, lb	No		X		X
WATER	Outlet Water Temperature, °F	Yes	X		X	
WATER	Water fed, lb	No		X		X
WATER	Inlet Water Temperature at Points A and B of Figure 9 of ANSI/AHRI Standard 1500-2015 as applicable, °F	Yes	X		X	

2.1.3. *Instrument Calibration.* Instruments must be calibrated at least once per year and a calibration record, containing at least the date of calibration and the method of calibration, must be kept as part of the data underlying each basic model certification, pursuant to § 429.71 of this chapter.

2.1.4. *Test Setup and Apparatus*. Set up the commercial packaged boiler for thermal efficiency testing according to the provisions of Section C2 (except section C2.1) of Appendix C of ANSI/AHRI Standard 1500–2015 (incorporated by reference, see § 431.85).

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 the following sections 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 sections 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 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 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 C 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 sections 2.3.4 and 2.3.5 of this appendix.

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 sections 2.3.4 and 2.3.5 of this appendix.

2.1.4.3 In addition to the provisions of Section C2.2.1.2 of ANSI/AHRI Standard 1500–2015, vent gases may alternatively be discharged vertically into a straight stack section without elbows. R–7 minimum insulation must extend 6 stack diameters above the flue collar, the thermocouple grid must be located at a vertical distance of 3 stack diameters above the flue collar, and the sampling tubes for flue gases must be installed within 1 stack diameter beyond the thermocouple grid. If dilution air is introduced into the flue gases before the plane of the thermocouple and flue gas sampling points, utilize an alternate plane of thermocouple grid and flue gas sampling point located downstream from the heat exchanger and upstream from the point of dilution air introduction.

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; incorporated by reference, see § 431.85) 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 (incorporated by reference, see § 431.85), the following requirements apply for steam tests.

2.1.6.1. 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 2.3 of this appendix.

Table 2.3. Minimum Piping Insulation Thickness Requirements

Fluid Temperature Range °F	Insulation Conductivity		Nominal Pipe Size 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
> 350°F	0.32-0.34	250	4.5	5.0	5.0	5.0	5.0
251 °F-350 °F	0.29-0.32	200	3.0	4.0	4.5	4.5	4.5
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

2.1.6.2. 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.

2.1.6.3. 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.

2.1.7. *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), 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 2.3 of this appendix.

2.1.7.2. Install a temperature measuring device at Point B of Figure C9 of ANSI/AHRI Standard 1500–2015 (incorporated by reference, see §431.85). Water entering the commercial packaged boiler must first enter the run of a tee and exit from the top outlet of the tee. The remaining connection of the tee must be plugged. Measure the inlet water temperature at Point B in the run of a second tee located 12 ± 2 pipe diameters downstream from the first tee and no more than the greater of 12 inches or 6 pipe diameters from the inlet of the commercial packaged boiler. The temperature measuring device shall extend into the water flow at the point of exit from the side outlet of the second tee. All inlet piping between the temperature measuring device and the inlet of the commercial packaged boilers must be wrapped with R–7 insulation.

2.1.7.3. Do not use Section C2.7.2.2.2 or its subsections of ANSI/AHRI Standard 1500–2015 for water meter calibration.

2.1.8. *Flue Gas Sampling.* In section C2.5.2 of Appendix C of ANSI/AHRI Standard 1500–2015, replace the last sentence with the following: When taking flue gas samples from a rectangular plane, collect samples at ¼, ½, and ¾ the distance from one side of the rectangular plane in the longer dimension and along the centerline midway between the edges of the plane in the shorter dimension and use the average of the three samples. The tolerance in each dimension for each measurement location is ± 1 inch.

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 (incorporated by reference, see §431.85) for thermal efficiency testing but do not use the following sections:

(1) 5.3 Introductory text
(2) 5.3.5 (and subsections; see sections 2.2.3. and 2.2.4. of this appendix)
(3) 5.3.8 (see section 2.2.5. of this appendix)
(4) 5.3.9 (see section 2.2.6. of this appendix)
(5) C3.1.3 (and subsections)
(6) C3.5 (including Table C2; see section 2.2.7. of this appendix)
(7) C3.6 (see section 2.2.5. of this appendix)
(8) C3.7 (see section 2.2.6. of this appendix)

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 (or to be 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. *Water Temperatures.* Maintain the outlet temperature measured at Point C in Figure C9 of Appendix C of ANSI/AHRI Standard 1500–2015 at 180 °F ± 2 °F and maintain the inlet temperature measured at Point B at 80 °F ± 5 °F during the "Warm-up

Period'' and ''Test Period'' as indicated by 1-minute interval data pursuant to Table 2.2 of this appendix. Each reading must meet these temperature requirements. Use the inlet temperature and flow rate measured at Point B in Figure C9 of Appendix C of ANSI/AHRI Standard 1500–2015 for calculation of thermal efficiency.

2.2.4 *Exceptions to Water Temperature Requirements.* For commercial packaged boilers that require a higher flow rate than that resulting from the water temperature requirements of sections 2.2.3 of this appendix to prevent boiling, use a recirculating loop and maintain the inlet temperature at Point B of Figure C9 of Appendix C of ANSI/AHRI Standard 1500–2015 at 140 °F ± 5 °F during the ''Warm-up Period'' and ''Test Period'' as indicated by 1-minute interval data pursuant to Table 2.2 of this appendix. Each reading must meet these temperature requirements. Use the inlet temperature and flow rate 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.* For tests of non-condensing boilers, maintain ambient room temperature between 65 °F and 100 °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 1-minute interval data pursuant to Table 2.2 of this appendix. For tests of condensing boilers, maintain ambient room temperature between 65 °F and 85 °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 1-minute interval data pursuant to Table 2.2 of this appendix. The ambient room temperature may not differ by more than ± 5 °F from the average ambient room temperature during the entire ''Test Period'' at any reading. Measure the room ambient temperature within 6 feet of the front of the unit at mid height. The test air temperature, measured at the air inlet of the commercial packaged boiler, must be within ± 5 °F of the room ambient temperature when recorded at the 1-minute interval defined by Table 2.2 of this appendix.

2.2.6. *Ambient Humidity.* For condensing boilers, maintain ambient room relative humidity below 80-percent 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) pursuant to Table 2.2 of this appendix. Measure the ambient humidity in the same location as ambient air temperature in section 2.2.5 of this appendix.

2.2.7. *Flue Gas Temperature.* The flue gas temperature during the test must not vary from the flue gas temperature measured at the start of the Test Period (as defined in Section C4 of ANSI/AHRI Standard 1500–2015) when recorded at the interval defined in Table 2.2 of this appendix by more than the limits prescribed in Table 2.4 of this appendix.

TABLE 2.4—FLUE GAS TEMPERATURE VARIATION LIMITS DURING TEST PERIOD

Fuel type	Non-condensing	Condensing
Gas	± 2 percent	Greater of ± 3 percent and ± 5 °F
Light Oil	± 2 percent.	
Heavy Oil	Greater of ± 3 percent and ± 5 °F.	

2.3. *Test Method.*

2.3.1. *General.* Conduct the thermal efficiency test as prescribed in Section C4 ''Test Procedure'' of Appendix C of ANSI/AHRI Standard 1500–2015 (incorporated by reference, see § 431.85) excluding sections:

(1) C4.1.1.1.2 (see section 2.3.1.1 of this appendix)
(2) C4.1.1.2.3 (see 2.3.4 of this appendix)
(3) C4.1.2.1.5 (see section 2.3.2. of this appendix)
(4) C4.1.2.2.2
(5) C4.1.2.2.3 (see 2.3.5 of this appendix)
(6) C4.2
(7) C4.2.1
(8) C4.2.2

2.3.1.1. 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. *Water Test Steady-State*. Ensure that a steady-state is reached by confirming that three consecutive readings have been recorded at 15-minute intervals pursuant to Table 2.2 of this appendix that indicate that the measured fuel input rate is within ± 2-percent of the rated input. Water temperatures must meet the conditions specified in sections 2.2.3 and 2.2.4 of this appendix as applicable.

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

2.3.4. *Steam Test Duration*. Replace Section C4.1.1.2.3 of ANSI/AHRI Standard 1500–2015 with the following: The test period is one hour in duration if the steam condensate is measured or two hours if feedwater is measured. The test period must end with a 15-minute reading (steam condensate or feedwater and separator weight reading) pursuant to Table 2.2 of this appendix. When feedwater is measured, the water line at the end of the test must be within 0.25 inches of the starting level.

2.3.5. *Water Test Duration*. Replace Section C4.1.2.2.3 of ANSI/AHRI Standard 1500–2015 with the following: The test period is one hour for condensing commercial packaged boilers and 30 minutes for non-condensing commercial packaged boilers, and ends with a 15-minute interval reading pursuant to Table 2.2 of this appendix.

2.4. *Calculations*.

2.4.1. *General*. To determine the thermal efficiency of commercial packaged boilers, use the variables in section C6 of Appendix C of ANSI/AHRI Standard 1500–2015 and calculation procedure for the thermal efficiency test specified in section C7.2 of Appendix C of ANSI/AHRI Standard 1500–2015, excluding sections C7.2.12 and C7.2.20.

2.4.2. *Use of Steam Properties Table*. If the average measured temperature of the steam is higher than the value in Table D1 in Appendix D of ANSI/AHRI Standard 1500–2015 that corresponds to the average measured steam pressure, then use Table 2.5 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 D1 in Appendix D of ANSI/AHRI Standard 1500–2015 or in Table 2.5 of this appendix.

Table 2.5. 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 $Effy_{ss}$ in steam mode according to Section 3. *Combustion Efficiency Test* of this appendix and convert to thermal efficiency using the following equation:

$$Effy_T = Effy_{ss} - 2.0$$

where $Effy_T$ is the thermal efficiency and $EFFY_{ss}$ is the combustion efficiency as defined in C6 of ANSI/AHRI Standard 1500–2015. The combustion efficiency $Effy_{ss}$ 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.

3. *Combustion Efficiency Test*.

3.1. *Test Setup*.

3.1.1. *Instrumentation*. Use instrumentation meeting the minimum requirements found in

sfrattini on LAPCK6H6L3 with DISTILLER
VerDate Sep<11>2014 13:03 Aug 22, 2023 Jkt 259032 PO 00000 Frm 00939 Fmt 8010 Sfmt 8002 C:\MCWORK\259032.XXX PC31
ER09DE16.026</GPH>

Table C1 of ANSI/AHRI Standard 1500–2015 (incorporated by reference, see § 431.85).

3.1.2. *Data collection and sampling*. Record all test data in accordance with Table 3.1 and Table 3.2 of this appendix. Do not use Section C5 and Table C4 of Appendix C in ANSI/AHRI Standard 1500–2015.

TABLE 3.1—DATA TO BE RECORDED BEFORE TESTING

Item recorded	Additional instruction
Date of Test	None.
Manufacturer	None.
Commercial Packaged Boiler Model Number.	None.
Burner Model Number & Manufacturer.	None.
Nozzle description and oil pressure.	None.
Oil Analysis—H, C, API Gravity, lb/gal and Btu/lb.	None.
Gas Manifold Pressure	Record at start and end of test.
Gas line pressure at meter	Measurement may be made manually.
Gas temperature	Measurement may be made manually.
Barometric Pressure (Steam and Natural Gas Only).	Measurement may be made manually.
Gas Heating Value, Btu/ft^3 *	Record at start and end of test.

* Multiplied by correction factors, as applicable, in accordance with Appendix E of ANSI/AHRI Standard 1500–2015.

Table 3.2. Data to be Recorded During Testing

			Required Data Recording		For Use in Calculations (Section 3.4), As Applicable	
	Item Recorded	Digital Acquisition Required?	Every 1 Minute	Every 15 Minutes	Average During Test Period	Total During Test Period
	Time, minutes/seconds	Yes	X			
	Flue Gas Temperature, °F	Yes	X		X	
	Pressure in Firebox, in H_2O (if required per Section C3.4 of ANSI/AHRI Standard 1500-2015)	No		X	X	
	Flue Gas Smoke Spot Reading (oil)	No		X	X	
	Room Air Temperature	Yes	X		X	
	Fuel Weight or Volume, lb (oil) or ft^3 (gas)	Yes		X		X
	Test Air Temperature, °F	Yes	X		X	
	Draft in Vent, in H_2O (oil and non-atmospheric gas)	No		X	X	
	Flue Gas CO_2 or O_2, %	No		X	X	
	Flue Gas CO, ppm	No		At Least Start and End	X	
	Relative Humidity, %	No		X	X	
STEAM	Separator water weight, lb	No		At Least Start and End		X
STEAM	Steam Pressure, in Hg	No		X	X	
STEAM	Steam Temperature, °F (if used)	Yes	X		X	
STEAM	Condensate collected, or water fed, lb	No		X		X
WATER	Outlet Water Temperature, °F	Yes	X		X	
WATER	Water fed, lb	No		X		X
WATER	Inlet Water Temperature at Points A and B of Figure 9 of ANSI/AHRI Standard 1500-2015 as applicable, °F	Yes	X		X	

3.1.3. *Instrument Calibration*. Instruments must be calibrated at least once per year and a calibration record, containing at least the date of calibration and the method of calibration, must be kept as part of the data underlying each basic model certification, pursuant to § 429.71 of this chapter.

3.1.4. *Test Setup and Apparatus*. Set up the commercial packaged boiler for combustion efficiency testing according to the provisions of Section C2 (except section C2.1) 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 sections 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 sections 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 sections 3.1.4.1.3.1. 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 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 hour 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 hour pursuant to section 3.3.1.1. of this appendix.

3.1.4.3. In addition to the provisions of Section C2.2.1.2 of ANSI/AHRI Standard 1500–2015, vent gases may alternatively be discharged vertically into a straight stack section without elbows. R–7 minimum insulation must extend 6 stack diameters above the flue collar, the thermocouple grid must be located at a vertical distance of 3 stack diameters above the flue collar, and the sampling tubes for flue gases must be installed within 1 stack diameter beyond the thermocouple grid. If dilution air is introduced into the flue gases before the plane of the thermocouple and flue gas sampling points, utilize an alternate plane of thermocouple grid and flue gas sampling point located downstream from the heat exchanger and upstream from the point of dilution air introduction.

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 (incorporated by reference, see §431.85) 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.

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.

3.1.6.2. 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) the following requirements apply for water tests:

3.1.7.1. 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 2.3 of this appendix.

3.1.7.2. Install a temperature measuring device at Point B of Figure C9 of ANSI/AHRI Standard 1500–2015. Water entering the commercial packaged boiler must first enter the run of a tee and exit from the top outlet of the tee. The remaining connection of the tee must be plugged. Measure the inlet water temperature at Point B in the run of a second tee located 12 ± 2 pipe diameters downstream from the first tee and no more than the greater of 12 inches or 6 pipe diameters from the inlet of the commercial packaged boiler. The temperature measuring device shall extend into the water flow at the point of exit from the side outlet of the second tee. All inlet piping between the temperature measuring device and the inlet of the commercial packaged boilers must be wrapped with R–7 insulation. Field tests must also measure the inlet water temperature at Point B in Figure C9, however they are not required to use the temperature measurement piping described in this section 3.1.7. of this appendix.

3.1.7.3. Do not use Section C2.7.2.2.2 or its subsections of ANSI/AHRI Standard 1500–2015 for water meter calibration.

3.1.8. *Flue Gas Sampling*. In section C2.5.2 of Appendix C of ANSI/AHRI Standard 1500–2015, replace the last sentence with the following: When taking flue gas samples from a rectangular plane, collect samples at ¼, ½, and ¾ the distance from one side of the rectangular plane in the longer dimension and along the centerline midway between the edges of the plane in the shorter dimension and use the average of the three samples. The tolerance in each dimension for each measurement location is ± 1 inch.

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 (incorporated by reference; see §431.85) for combustion efficiency testing but do not use the following sections:

(1) 5.3 Introductory text
(2) 5.3.5 (and subsections; see sections 3.2.3, 3.2.3.1, and 3.2.3.2 of this appendix)
(3) 5.3.7 (excluded for field tests only)
(4) 5.3.8 (see section 3.2.4 of this appendix)
(5) 5.3.9 (see section 3.2.5 of this appendix)
(6) C3.1.3 (and subsections)
(7) C3.5 (including Table C2; see section 3.2.6 of this appendix)
(8) C3.6 (see section 3.2.4 of this appendix)
(9) C3.7 (see section 3.2.5 of this appendix)

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 (or to be 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. *Water Temperatures*. Maintain the outlet temperature measured at Point C in Figure C9 at 180 °F ± 2 °F and maintain the inlet temperature measured at Point B at 80 °F ± 5 °F during the ''Warm-up Period'' and ''Test Period'' as indicated by 1-minute interval data pursuant to Table 3.2 of this appendix. Each reading must meet these temperature requirements. 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 A and 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 1-minute interval data pursuant to Table 3.2 of this appendix.

3.2.3.2 For commercial packaged boilers that require a higher flow rate than that resulting from the water temperature requirements of sections 3.2.3 of this appendix to prevent boiling, use a recirculating loop and maintain the inlet temperature at Point B of Figure C9 of ANSI/AHRI Standard 1500–2015 at 140 °F ± 5 °F during the ''Warm-up Period'' and ''Test Period'' as indicated by 1-minute interval data pursuant to Table 3.2 of this appendix. Each reading must meet these temperature requirements.

3.2.4. *Air Temperature*. For tests of non-condensing boilers (except during field tests), maintain ambient room temperature between 65 °F and 100 °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 1-minute interval data pursuant to Table 3.2 of this appendix. For tests of condensing boilers (except during field tests), maintain ambient room temperature between 65 °F and 85 °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 1-minute interval data pursuant to Table 3.2 of this appendix. The ambient room temperature may not differ by more than ± 5 °F from the average ambient room temperature during the entire ''Test

Period'' at any 1-minute interval reading. Measure the room ambient temperature within 6 feet of the front of the unit at mid height. The test air temperature, measured at the air inlet of the commercial packaged boiler, must be within ± 5 °F of the room ambient temperature when recorded at the 1-minute interval defined by Table 3.2 of this appendix. For field tests, record the ambient room temperature at 1-minute intervals in accordance with Table 3.2 of this appendix.

3.2.5. *Ambient Humidity*. For condensing boilers (except during field tests), maintain ambient room relative humidity below 80-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) pursuant to Table 3.2 of this appendix. Measure the ambient humidity in the same location as ambient air temperature. For field tests of condensing boilers, record the ambient room relative humidity in accordance with Table 3.2 of this appendix.

3.2.6. *Flue Gas Temperature*. The flue gas temperature during the test must not vary from the flue gas temperature measured at the start of the Test Period (as defined in Section C4 of ANSI/AHRI Standard 1500–2015) when recorded at the interval defined in Table 3.2 by more than the limits prescribed in Table 3.3 of this appendix. For field tests, flue gas temperature does not need to be within the limits in Table 3.3 of this appendix but must be recorded at the interval specified in Table 3.2 of this appendix.

TABLE 3.3—FLUE GAS TEMPERATURE VARIATION LIMITS DURING TEST PERIOD

Fuel type	Non-condensing	Condensing
Gas	± 2 percent	Greater of ± 3 percent and ± 5 °F.
Light Oil	± 2 percent.	
Heavy Oil	Greater of ± 3 percent and ± 5 °F.	

3.3. *Test Method*.

3.3.1. *General*. Conduct the combustion efficiency test using the test method prescribed in Section C4 ''Test Procedure'' of Appendix C of ANSI/AHRI Standard 1500–2015 excluding sections:

(1) C4.1.1.1.2 (see section 3.3.1.2 of this appendix)
(2) C4.1.1.2.3
(3) C4.1.2.1.5 (see section 3.3.2 of this appendix)
(4) C4.1.2.2.2
(5) C4.1.2.2.3
(6) C4.2
(7) C4.2.1
(8) C4.2.2

3.3.1.1. The duration of the ''Test Period'' for combustion efficiency 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. For condensing commercial packaged boilers, condensate must be collected for the 30 minute Test Period.

3.3.1.2. 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.

3.3.2. *Water Test Steady-State*. 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 is within ± 2-percent of the rated input. Water temperatures must meet the conditions specified in sections 3.2.3, 3.2.3.1, and 3.2.3.2 of this appendix as applicable.

3.3.3. *Procedure for the Measurement of Condensate for a Condensing Commercial Packaged Boiler*. Collect flue condensate 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.''

3.4. *Calculations*.

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3.4.1. *General.* To determine the combustion efficiency of commercial packaged boilers, use the variables in Section C6 and 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 (incorporated by reference, see §431.85).

3.4.2. *Rounding.* Round the final combustion efficiency value to nearest one tenth of a percent.

[81 FR 89306, Dec. 9, 2016]

Subpart F—Commercial Air Conditioners and Heat Pumps

SOURCE: 69 FR 61969, Oct. 21, 2004, unless otherwise noted.

§431.91 Purpose and scope.

This subpart specifies test procedures and energy conservation standards for certain commercial air conditioners and heat pumps, pursuant to Part C of Title III of the Energy Policy and Conservation Act, as amended, 42 U.S.C. 6311–6317.

[69 FR 61969, Oct. 21, 2004, as amended at 70 FR 60415, Oct. 18, 2005]

§431.92 Definitions concerning commercial air conditioners and heat pumps.

The following definitions apply for purposes of this subpart F, and of subparts J through M of this part. Any words or terms not defined in this section or elsewhere in this part shall be defined as provided in 42 U.S.C. 6311.

Basic model includes:

(1) *Computer room air conditioners* means all units manufactured by one manufacturer within a single equipment class, having the same primary energy source (*e.g.*, electric or gas), and which have the same or comparably performing compressor(s), heat exchangers, and air moving system(s) that have a common ''nominal'' cooling capacity.

(2) *Direct expansion-dedicated outdoor air system* means all units manufactured by one manufacturer, having the same primary energy source (*e.g.*, electric or gas), within a single equipment class; with the same or comparably performing compressor(s), heat exchangers, ventilation energy recovery system(s) (if present), and air moving system(s) that have a common ''nominal'' moisture removal capacity.

(3) *Packaged terminal air conditioner (PTAC) or packaged terminal heat pump (PTHP)* means all units manufactured by one manufacturer within a single equipment class, having the same primary energy source (*e.g.*, electric or gas), and which have the same or comparable compressors, same or comparable heat exchangers, and same or comparable air moving systems that have a cooling capacity within 300 Btu/h of one another.

(4) *Single package vertical units* means all units manufactured by one manufacturer within a single equipment class, having the same primary energy source (*e.g.*, electric or gas), and which have the same or comparably performing compressor(s), heat exchangers, and air moving system(s) that have a rated cooling capacity within 1500 Btu/h of one another.

(5) *Small, large, and very large air-cooled or water-cooled commercial package air conditioning and heating equipment* means all units manufactured by one manufacturer within a single equipment class, having the same or comparably performing compressor(s), heat exchangers, and air moving system(s) that have a common ''nominal'' cooling capacity.

(6) *Small, large, and very large water source heat pump* means all units manufactured by one manufacturer within a single equipment class, having the same primary energy source (*e.g.*, electric or gas), and which have the same or comparable compressors, same or comparable heat exchangers, and same or comparable ''nominal'' capacity.

(7) *Variable refrigerant flow systems* means all units manufactured by one manufacturer within a single equipment class, having the same primary energy source (*e.g.*, electric or gas), and which have the same or comparably performing compressor(s) that have a common ''nominal'' cooling capacity and the same heat rejection medium (*e.g.*, air or water) (includes VRF water source heat pumps).

Coefficient of Performance, or *COP* means the ratio of the produced cooling effect of an air conditioner or heat pump (or its produced heating effect, depending on the mode of operation) to its net work input, when both the cooling (or heating) effect and the net work input are expressed in identical units of measurement.

Commercial package air-conditioning and heating equipment means air-cooled, water-cooled, evaporatively-cooled, or water source (not including ground water source) electrically operated, unitary central air conditioners and central air-conditioning heat pumps for commercial application.

Computer Room Air Conditioner means a basic model of commercial package air-conditioning and heating equipment (packaged or split) that is: Used in computer rooms, data processing rooms, or other information technology cooling applications; rated for sensible coefficient of performance (SCOP) and tested in accordance with 10 CFR 431.96, and is not a covered consumer product under 42 U.S.C. 6291(1)–(2) and 6292. A computer room air conditioner may be provided with, or have as available options, an integrated humidifier, temperature, and/or humidity control of the supplied air, and reheating function.

Direct expansion-dedicated outdoor air system, or *DX–DOAS*, means a unitary dedicated outdoor air system that is capable of dehumidifying air to a 55 °F dew point—when operating under Standard Rating Condition A as specified in Table 4 or Table 5 of AHRI 920–2020 (incorporated by reference, see § 431.95) with a barometric pressure of 29.92 in Hg—for any part of the range of airflow rates advertised in manufacturer materials, and has a moisture removal capacity of less than 324 lb/h.

Double-duct air conditioner or heat pump means air-cooled commercial package air conditioning and heating equipment that—

(1) Is either a horizontal single package or split-system unit; or a vertical unit that consists of two components that may be shipped or installed either connected or split;

(2) Is intended for indoor installation with ducting of outdoor air from the building exterior to and from the unit, as evidenced by the unit and/or all of its components being non-weatherized, including the absence of any marking (or listing) indicating compliance with UL 1995, ''Heating and Cooling Equipment,'' or any other equivalent requirements for outdoor use;

(3)(i) If it is a horizontal unit, a complete unit has a maximum height of 35 inches; (ii) If it is a vertical unit, a complete unit has a maximum depth of 35 inches; and

(4) Has a rated cooling capacity greater than or equal to 65,000 Btu/h and up to 300,000 Btu/h.

Energy Efficiency Ratio, or *EER* means the ratio of the produced cooling effect of an air conditioner or heat pump to its net work input, expressed in Btu/watt-hour.

Heat Recovery (in the context of variable refrigerant flow multi-split air conditioners or variable refrigerant flow multi-split heat pumps) means that the air conditioner or heat pump is also capable of providing simultaneous heating and cooling operation, where recovered energy from the indoor units operating in one mode can be transferred to one or more other indoor units operating in the other mode. A variable refrigerant flow multi-split heat recovery heat pump is a variable refrigerant flow multi-split heat pump with the addition of heat recovery capability.

Heating seasonal performance factor, or *HSPF* means the total heating output of a central air-conditioning heat pump during its normal annual usage period for heating, expressed in Btu's and divided by the total electric power input, expressed in watt-hours, during the same period.

Integrated energy efficiency ratio, or IEER, means a weighted average calculation of mechanical cooling EERs determined for four load levels and corresponding rating conditions, expressed in Btu/watt-hour. IEER is measured per appendix A to this subpart for air-cooled small (≥65,000 Btu/h), large, and very large commercial package air conditioning and heating equipment and measured per appendix D1 to this subpart for variable refrigerant flow multi-split air conditioners and heat pumps (other than air-cooled with rated cooling capacity less than 65,000 Btu/h).

Integrated seasonal coefficient of performance 2 or *ISCOP2*, means a seasonal weighted-average heating efficiency for heat pump dedicated outdoor air systems, expressed in W/W, as measured according to appendix B of this subpart.

Integrated seasonal moisture removal efficiency 2, or *ISMRE2*, means a seasonal weighted average dehumidification efficiency for dedicated outdoor air systems, expressed in lbs. of moisture/kWh, as measured according to appendix B of this subpart.

Large commercial package air-conditioning and heating equipment means commercial package air-conditioning and heating equipment that is rated—

(1) At or above 135,000 Btu per hour; and

(2) Below 240,000 Btu per hour (cooling capacity).

Non-standard size means a packaged terminal air conditioner or packaged terminal heat pump with existing wall sleeve dimensions having an external wall opening of less than 16 inches high or less than 42 inches wide, and a cross-sectional area less than 670 square inches.

Packaged terminal air conditioner means a wall sleeve and a separate unencased combination of heating and cooling assemblies specified by the builder and intended for mounting through the wall, and that is industrial equipment. It includes a prime source of refrigeration, separable outdoor louvers, forced ventilation, and heating availability by builder's choice of hot water, steam, or electricity.

Packaged terminal heat pump means a packaged terminal air conditioner that utilizes reverse cycle refrigeration as its prime heat source, that has a supplementary heat source available, with the choice of hot water, steam, or electric resistant heat, and that is industrial equipment.

Seasonal energy efficiency ratio or *SEER* means the total cooling output of a central air conditioner or central air-conditioning heat pump, expressed in Btu's, during its normal annual usage period for cooling and divided by the total electric power input, expressed in watt-hours, during the same period.

Sensible Coefficient of Performance, or *SCOP* means the net sensible cooling capacity in watts divided by the total power input in watts (excluding reheaters and humidifiers).

Single package unit means any central air conditioner or central air-conditioning heat pump in which all the major assemblies are enclosed in one cabinet.

Single package vertical air conditioner means air-cooled commercial package air conditioning and heating equipment that—

(1) Is factory-assembled as a single package that—

(i) Has major components that are arranged vertically;

(ii) Is an encased combination of cooling and optional heating components; and

(iii) Is intended for exterior mounting on, adjacent interior to, or through an outside wall;

(2) Is powered by a single-or 3-phase current;

(3) May contain 1 or more separate indoor grilles, outdoor louvers, various ventilation options, indoor free air discharges, ductwork, well plenum, or sleeves; and

(4) Has heating components that may include electrical resistance, steam, hot water, or gas, but may not include reverse cycle refrigeration as a heating means.

Single package vertical heat pump means a single package vertical air conditioner that—

(1) Uses reverse cycle refrigeration as its primary heat source; and

(2) May include secondary supplemental heating by means of electrical resistance, steam, hot water, or gas.

Small commercial package air-conditioning and heating equipment means commercial package air-conditioning and heating equipment that is rated below 135,000 Btu per hour (cooling capacity).

Split system means any central air conditioner or central air conditioning heat pump in which one or more of the major assemblies are separate from the others.

Standard size means a packaged terminal air conditioner or packaged terminal heat pump with wall sleeve dimensions having an external wall opening of greater than or equal to 16 inches high or greater than or equal to 42 inches wide, and a cross-sectional area greater than or equal to 670 square inches.

Unitary dedicated outdoor air system, or *unitary DOAS*, means a category of small, large, or very large commercial package air-conditioning and heating equipment that is capable of providing ventilation and conditioning of 100-percent outdoor air and is marketed in materials (including but not limited to, specification sheets, insert sheets, and online materials) as having such capability.

Variable Refrigerant Flow Multi-Split Air Conditioner means a unit of commercial package air-conditioning and heating equipment that is configured as a split system air conditioner incorporating a single refrigerant circuit, with one or more outdoor units, at least one variable-speed compressor or an alternate compressor combination for varying the capacity of the system by three or more steps, and multiple indoor fan coil units, each of which is individually metered and individually controlled by an integral control device and common communications network and which can operate independently in response to multiple indoor thermostats. Variable refrigerant flow implies three or more steps of capacity control on common, inter-connecting piping.

Variable Refrigerant Flow Multi-Split Heat Pump means a unit of commercial package air-conditioning and heating equipment that is configured as a split system heat pump that uses reverse cycle refrigeration as its primary heating source and which may include secondary supplemental heating by means of electrical resistance, steam, hot water, or gas. The equipment incorporates a single refrigerant circuit, with one or more outdoor units, at least one variable-speed compressor or an alternate compressor combination for varying the capacity of the system by three or more steps, and multiple indoor fan coil units, each of which is individually metered and individually controlled by a control device and common communications network and which can operate independently in response to multiple indoor thermostats. Variable refrigerant flow implies three or more steps of capacity control on common, inter-connecting piping.

Ventilation energy recovery system, or *VERS*, means a system that preconditions outdoor ventilation air entering the equipment through direct or indirect thermal and/or moisture exchange with the exhaust air, which is defined as the building air being exhausted to the outside from the equipment.

Very large commercial package air-conditioning and heating equipment means commercial package air-conditioning and heating equipment that is rated—

(1) At or above 240,000 Btu per hour; and

(2) Below 760,000 Btu per hour (cooling capacity).

Water-source heat pump means a single-phase or three-phase reverse-cycle heat pump that uses a circulating water loop as the heat source for heating and as the heat sink for cooling. The main components are a compressor, refrigerant-to-water heat exchanger, refrigerant-to-air heat exchanger, refrigerant expansion devices, refrigerant reversing valve, and indoor fan. Such equipment includes, but is not limited to, water-to-air water-loop heat pumps.

[69 FR 61969, Oct. 21, 2004, as amended at 70 FR 60415, Oct. 18, 2005; 73 FR 58828, Oct. 7, 2008; 74 FR 12073, Mar. 23, 2009; 76 FR 12503, Mar. 7, 2011; 77 FR 28988, May 16, 2012; 78 FR 79598, Dec. 31, 2013; 80 FR 42664, July 17, 2015; 80 FR 79669, Dec. 23, 2015; 81 FR 2529, Jan. 15, 2016; 87 FR 45197, July 27, 2022; 87 FR 63896, Oct. 20, 2022]

EFFECTIVE DATE NOTES: 1. At 87 FR 75167, Dec. 7, 2022, § 431.92 was amended by revising the definitions for "Integrated energy efficiency ratio, or IEER," "Single package vertical air conditioner," and "Single package vertical heat pump"; and adding definitions for "Single-phase single package vertical air conditioner with cooling capacity less than 65,000 Btu/h" and "Single-phase single package vertical heat pump with cooling capacity less than 65,000 Btu/h" in alphabetical order, effective Jan. 6, 2023. For the convenience of the user, the added and revised text is set forth as follows:

§ 431.92 Definitions concerning commercial air conditioners and heat pumps.

* * * * *

Integrated energy efficiency ratio, or IEER, means a weighted average calculation of mechanical cooling EERs determined for four load levels and corresponding rating conditions, expressed in Btu/watt-hour. IEER is measured per appendix A to this subpart for air-cooled small (≥65,000 Btu/h), large, and very large commercial package air conditioning and heating equipment, measured per appendix D1 to this subpart for variable refrigerant flow multi-split air conditioners and heat pumps (other than air-cooled with rated cooling capacity less than 65,000 Btu/h), and measured per appendix G1 to this subpart for single package vertical air conditioners and single package vertical heat pumps.

* * * * *

Single package vertical air conditioner means:

(1) Air-cooled commercial package air conditioning and heating equipment that—

(i) Is factory-assembled as a single package that—

(A) Has major components that are arranged vertically;

(B) Is an encased combination of cooling and optional heating components; and

(C) Is intended for exterior mounting on, adjacent interior to, or through an outside wall;

(ii) Is powered by a single-or 3-phase current;

(iii) May contain 1 or more separate indoor grilles, outdoor louvers, various ventilation options, indoor free air discharges, ductwork, well plenum, or sleeves; and

(iv) Has heating components that may include electrical resistance, steam, hot water, or gas, but may not include reverse-cycle refrigeration as a heating means; and

(2) Includes single-phase single package vertical air conditioner with cooling capacity less than 65,000 Btu/h, as defined in this section.

Single package vertical heat pump means:

(1) A single package vertical air conditioner that—

(i) Uses reverse-cycle refrigeration as its primary heat source; and

(ii) May include secondary supplemental heating by means of electrical resistance, steam, hot water, or gas; and

(2) Includes single-phase single package vertical heat pump with cooling capacity less than 65,000 Btu/h, as defined in this section.

Single-phase single package vertical air conditioner with cooling capacity less than 65,000 Btu/h means air-cooled commercial package air conditioning and heating equipment that meets the criteria in paragraphs (1)(i) through (iv) of the definition for a single package vertical air conditioner in this section; that is single-phase; has a cooling capacity less than 65,000 Btu/h, and that:

(1) Is weatherized, determined by a model being denoted for ''Outdoor Use'' or marked as ''Suitable for Outdoor Use'' on the equipment nameplate; or

(2) Is non-weatherized and is a model that has optional ventilation air provisions available. When such ventilation air provisions are present on the unit, the unit must be capable of drawing in and conditioning outdoor air for delivery to the conditioned space at a rate of at least 400 cubic feet per minute, as determined in accordance with § 429.134(x)(3) of this chapter, while the equipment is operating with the same drive kit and motor settings used to determine the certified efficiency rating of the equipment (as required for submittal to DOE by § 429.43(b)(4)(xi) of this chapter).

Single-phase single package vertical heat pump with cooling capacity less than 65,000 Btu/h means air-cooled commercial package air conditioning and heating equipment that meets the criteria in paragraphs (1)(i) and (ii) of the definition for a single package vertical heat pump in this section; that is single-phase; has a cooling capacity less than 65,000 Btu/h, and that:

(1) Is weatherized, determined by a model being denoted for ''Outdoor Use'' or marked as ''Suitable for Outdoor Use'' on the equipment nameplate; or

(2) Is non-weatherized and is a model that has optional ventilation air provisions available. When such ventilation air provisions are present on the unit, the unit must be capable of drawing in and conditioning outdoor air for delivery to the conditioned space at a rate of at least 400 cubic feet per minute, as determined in accordance with § 429.134(x)(3) of this chapter, while the equipment is operating with the same drive kit and motor settings used to determine the certified efficiency rating of the equipment (as required for submittal to DOE by § 429.43(b)(4)(xii) of this chapter).

* * * * *

2. At 87 FR 77325, Dec. 16, 2022, § 431.92 was amended in the definition of *Basic model*, by revising paragraphs (5) and (7), and adding paragraph (8), effective Jan. 17, 2023. For the convenience of the user, the added and revised text is set forth as follows:

§ 431.92 Definitions concerning commercial air conditioners and heat pumps.

* * * * *

Basic model includes:

* * * * *

(5) *Small, large, and very large air-cooled or water-cooled commercial package air conditioning and heating equipment (excluding air-cooled, three-phase, small commercial package air conditioning and heating equipment with a cooling capacity of less than 65,000 Btu/h cooling capacity)* means all units manufactured

by one manufacturer within a single equipment class, having the same or comparably performing compressor(s), heat exchangers, and air moving system(s) that have a common ''nominal'' cooling capacity.

* * * * *

(7) *Variable refrigerant flow systems (excluding air-cooled, three-phase, variable refrigerant flow air conditioners and heat pumps with a cooling capacity of less than 65,000 Btu/h)* means all units manufactured by one manufacturer within a single equipment class, having the same primary energy source (e.g., electric or gas), and which have the same or comparably performing compressor(s) that have a common ''nominal'' cooling capacity and the same heat rejection medium (e.g., air or water) (includes VRF water source heat pumps).

(8) *Air-cooled, three-phase, small commercial package air conditioning and heating equipment with a cooling capacity of less than 65,000 Btu/h* and *air-cooled, three-phase, variable refrigerant flow multi-split air conditioners and heat pumps with a cooling capacity of less than 65,000 Btu/h* means all units manufactured by one manufacturer, having the same primary energy source, and, which have essentially identical electrical, physical, and functional (or hydraulic) characteristics that affect energy consumption, energy efficiency, water consumption, or water efficiency; where essentially identical electrical, physical, and functional (or hydraulic) characteristics means:

(i) For split systems manufactured by outdoor unit manufacturers (OUMs): all individual combinations having the same model of outdoor unit, which means comparably performing compressor(s) [a variation of no more than five percent in displacement rate (volume per time) as rated by the compressor manufacturer, and no more than five percent in capacity and power input for the same operating conditions as rated by the compressor manufacturer], outdoor coil(s) [no more than five percent variation in face area and total fin surface area; same fin material; same tube material], and outdoor fan(s) [no more than ten percent variation in airflow and no more than twenty percent variation in power input];

(ii) For split systems having indoor units manufactured by independent coil manufacturers (ICMs): all individual combinations having comparably performing indoor coil(s) [plus or minus one square foot face area, plus or minus one fin per inch fin density, and the same fin material, tube material, number of tube rows, tube pattern, and tube size]; and

(iii) For single-package systems: all individual models having comparably performing compressor(s) [no more than five percent variation in displacement rate (volume per time) rated by the compressor manufacturer, and no more than five percent variations in capacity and power input rated by the compressor manufacturer corresponding to the same compressor rating conditions], outdoor coil(s) and indoor coil(s) [no more than five percent variation in face area and total fin surface area; same fin material; same tube material], outdoor fan(s) [no more than ten percent variation in outdoor airflow], and indoor blower(s) [no more than ten percent variation in indoor airflow, with no more than twenty percent variation in fan motor power input];

(iv) Except that,

(A) For single-package systems and single-split systems, manufacturers may instead choose to make each individual model/combination its own basic model provided the testing and represented value requirements in 10 CFR 429.67 of this chapter are met; and

(B) For multi-split, multi-circuit, and multi-head mini-split combinations, a basic model may not include both individual small-duct, high velocity (SDHV) combinations and non-SDHV combinations even when they include the same model of outdoor unit. The manufacturer may choose to identify specific individual combinations as additional basic models.

* * * * *

TEST PROCEDURES

§ 431.95 Materials incorporated by reference.

(a) Certain material is incorporated by reference into this subpart with the approval of the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. To enforce any edition other than that specified in this section, DOE must publish a document in the FEDERAL REGISTER and the material must be available to the public. All approved incorporation by reference (IBR) material is available for inspection at DOE, and at the National Archives and Records Administration (NARA). Contact DOE at: the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Program, Sixth Floor, 950 L'Enfant Plaza SW, Washington, DC 20024, (202) 586–9127, *Buildings@ee.doe.gov*, *https://www.energy.gov/eere/buildings/building-technologies-office*. For information on the availability of this material at NARA, email: *fr.inspection@nara.gov*, or go to: *www.archives.gov/federal-register/cfr/ibr-locations.html*. The material may be obtained from the sources in the following paragraphs of this section.

(b) *AHRI*. Air-Conditioning, Heating, and Refrigeration Institute, 2311 Wilson Blvd., Suite 400, Arlington, VA 22201; (703) 524–8800; *www.ahrinet.org*.

(1) ANSI/AHRI Standard 210/240–2008 (AHRI 210/240–2008), ''2008 Standard for Performance Rating of Unitary Air-Conditioning & Air-Source Heat Pump Equipment,'' ANSI-approved October 27, 2011, and updated by addendum 1 in June 2011 and addendum 2 in March 2012; IBR approved for § 431.96.

(2) AHRI Standard 310/380–2014 (''AHRI 310/380–2014''), ''Standard for Packaged Terminal Air-Conditioners and Heat Pumps,'' February 2014; IBR approved for § 431.96.

(3) ANSI/AHRI Standard 340/360–2007 (AHRI 340/360–2007), ''2007 Standard for Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment,'' ANSI-approved October 27, 2011, and updated by addendum 1 in December 2010 and addendum 2 in June 2011; IBR approved for § 431.96; appendix A to this subpart.

(4) ANSI/AHRI Standard 390–2003 (AHRI 390–2003), ''2003 Standard for Performance Rating of Single Package Vertical Air-Conditioners and Heat Pumps,'' dated 2003; IBR approved for § 431.96.

(5) AHRI Standard 920 (I–P) with Addendum 1 (''AHRI 920–2020''), ''2020 Standard for Performance Rating of Direct Expansion-Dedicated Outdoor Air System Units,'' copyright 2021; IBR approved for § 431.92; appendix B to this subpart.

(6) AHRI Standard 1060 (I–P) (''AHRI 1060–2018''), ''2018 Standard for Performance Rating of Air-to-Air Exchangers for Energy Recovery Ventilation Equipment,'' copyright 2018; IBR approved for appendix B to this subpart.

(7) ANSI/AHRI Standard 1230–2010, (''ANSI/AHRI 1230–2010''), ''2010 Standard for *Performance Rating of Variable Refrigerant Flow (VRF) Multi-Split Air-Conditioning and Heat Pump Equipment*,'' approved August 2, 2010 and updated by addendum 1 in March 2011; IBR approved for § 431.96 and appendix D to this subpart.

(8) AHRI Standard 1230 (I–P), (''AHRI 1230–2021'), ''*2021 Standard for Performance Rating of Variable Refrigerant Flow (VRF) Multi-Split Air-Conditioning and Heat Pump Equipment*'', copyright in 2021; IBR approved for appendix D1 to this subpart.

(c) *ASHRAE*. American Society of Heating, Refrigerating and Air-Conditioning Engineers, 180 Technology Parkway, Peachtree Corners, Georgia 30092; (404) 636–8400; *www.ashrae.org*.

(1) ANSI/ASHRAE Standard 16–1983 (RA 2014), (''ANSI/ASHRAE 16''), ''Method of Testing for Rating Room Air Conditioners and Packaged Terminal Air Conditioners,'' ASHRAE reaffirmed July 3, 2014, IBR approved for § 431.96.

(2) ANSI/ASHRAE Standard 37–2009, (''ANSI/ASHRAE 37–2009''), ''Methods of Testing for Rating Electrically Driven Unitary Air-Conditioning and Heat Pump Equipment,'' ASHRAE approved June 24, 2009; IBR approved for § 431.96 and appendices A, B, and D1 to this subpart.

(3) Errata Sheet for ANSI/ASHRAE Standard 37–2009, *Methods of Testing for Rating Electrically Driven Unitary Air-Conditioning and Heat Pump Equipment*, March 27, 2019; IBR approved for appendix D1 to this subpart.

(4) ANSI/ASHRAE Standard 41.1– 2013 (''ANSI/ASHRAE 41.1–2013''), ''Standard Method for Temperature Measurement,'' ANSI-approved January 30, 2013; IBR approved for appendix B to this subpart.

(5) ANSI/ASHRAE Standard 41.6– 2014 (''ANSI/ASHRAE 41.6–2014''), ''Standard Method for Humidity Measurement,'' ANSI-approved July 3, 2014; IBR approved for appendix B to this subpart.

(6) ANSI/ASHRAE Standard 58–1986 (RA 2014), (''ANSI/ASHRAE 58''), ''Method of Testing for Rating Room Air-Conditioner and Packaged Terminal Air-Conditioner Heating Capacity,'' ASHRAE reaffirmed July 3, 2014, IBR approved for § 431.96.

(7) ASHRAE Standard 127–2007, ''*Method of Testing for Rating Computer and Data Processing Room Unitary Air Conditioners*,'' approved on June 28, 2007, (ASHRAE 127–2007), IBR approved for § 431.96.

(8) ANSI/ASHRAE Standard 198– 2013 (''ANSI/ASHRAE 198–2013''), ''Method

of Test for Rating DX-Dedicated Outdoor Air Systems for Moisture Removal Capacity and Moisture Removal Efficiency,'' ANSI-approved January 30, 2013; IBR approved for appendix B to this subpart.

(d) *ISO*. International Organization for Standardization, 1, ch. De la Voie-Creuse, Case Postale 56, CH–1211 Geneva 20, Switzerland, + 41 22 749 01 11 or go to: *http://www.iso.ch/*.

(1) ISO Standard 13256–1, ''*Water-source heat pumps—Testing and rating for performance—Part 1: Water-to-air and brine-to-air heat pumps*,'' approved 1998, IBR approved for § 431.96.

(2) [Reserved]

[77 FR 28989, May 16, 2012, as amended at 80 FR 37148, June 30, 2015; 80 FR 79669, Dec. 23, 2015; 87 FR 45198, July 27, 2022; 87 FR 63896, Oct. 20, 2022]

EFFECTIVE DATE NOTES: 1. At 87 FR 75168, Dec. 7, 2022, § 431.95 was amended by revising paragraphs (b)(4) and (c)(2), effective Jan. 6, 2023. For the convenience of the user, the revised text is set forth as follows:

§ 431.95 Materials incorporated by reference.

* * * * *

(b) * * *

(4) AHRI Standard 390(I–P)–2021 (''AHRI 390–2021''), *2021 Standard for Performance Rating of Single Package Vertical Air-Conditioners and Heat Pumps*, copyright 2021; (AHRI 390–2021), IBR approved for appendices G and G1 to this subpart.

* * * * *

(c) * * *

(2) ANSI/ASHRAE Standard 37–2009 (''ANSI/ASHRAE 37–2009''), *Methods of Testing for Rating Electrically Driven Unitary Air-Conditioning and Heat Pump Equipment*, ASHRAE approved June 24, 2009, IBR approved for § 431.96 and appendices A, B, D1, G, and G1 to this subpart.

* * * * *

2. At 87 FR 77325, Dec. 16, 2022, § 431.95 was amended by:

a. Revising paragraph (b)(1);

b. Redesignating paragraphs (b)(2) through (8) as (b)(3) through (9);

c. Adding new paragraph (b)(2);

d. Revising newly redesignated paragraph (b)(8); and

e. Revising paragraph (c)(2).

The amendments are effective Jan. 6, 2023. For the convenience of the user, the added and revised text is set forth as follows:

§ 431.95 Materials incorporated by reference.

* * * * *

(b) * * *

(1) ANSI/AHRI Standard 210/240–2008 (AHRI 210/240–2008), *2008 Standard for Performance Rating of Unitary Air-Conditioning & Air-Source Heat Pump Equipment*, approved by ANSI on October 27, 2011, and updated by addendum 1 in June 2011 and addendum 2 in March 2012; IBR approved for § 431.96 and appendix F to this subpart.

(2) AHRI Standard 210/240–2023 (AHRI 210/240–2023), *2023 Standard for Performance Rating of Unitary Air-conditioning & Air-source Heat Pump Equipment*, copyright May 2020; IBR approved for appendix F1 to this subpart.

* * * * *

(8) ANSI/AHRI Standard 1230–2010 (AHRI 1230–2010), *2010 Standard for Performance Rating of Variable Refrigerant Flow (VRF) Multi-Split Air-Conditioning and Heat Pump Equipment*, approved August 2, 2010, and updated by addendum 1 in March 2011; IBR approved for § 431.96 and appendices D and F to this subpart.

(c) * * *

(2) ANSI/ASHRAE Standard 37–2009 (''ANSI/ASHRAE 37–2009''), *Methods of Testing for Rating Electrically Driven Unitary Air-Conditioning and Heat Pump Equipment*, ASHRAE approved June 24, 2009; IBR approved for § 431.96 and appendices A, B, D1, F1, G, and G1 to this subpart.

* * * * *

§ 431.96 Uniform test method for the measurement of energy efficiency of commercial air conditioners and heat pumps.

(a) *Scope*. This section contains test procedures for measuring, pursuant to EPCA, the energy efficiency of any small, large, or very large commercial package air-conditioning and heating equipment, packaged terminal air conditioners and packaged terminal heat pumps, computer room air conditioners, variable refrigerant flow systems, single package vertical air conditioners and single package vertical heat pumps, and direct expansion-dedicated outdoor air systems.

(b) *Testing and calculations*. (1) Determine the energy efficiency of each type of covered equipment by conducting the test procedure(s) listed in table 1 to this paragraph (b) along with any additional testing provisions set forth in paragraphs (c) through (g) of this section and appendices A through D1 of this subpart, that apply to the energy efficiency descriptor for that equipment, category, and cooling capacity. The omitted sections of the test procedures listed in table 1 to this paragraph (b) must not be used. For equipment with multiple appendices listed in table 1 to this paragraph (b), consult the notes at the beginning of those appendices to determine the applicable appendix to use for testing.

(2) After June 24, 2016, any representations made with respect to the energy use or efficiency of packaged terminal air conditioners and heat pumps (PTACs and PTHPs) must be made in accordance with the results of testing pursuant to this section. Manufacturers conducting tests of PTACs and PTHPs after July 30, 2015 and prior to June 24, 2016, must conduct such test in accordance with either table 1 to this section or § 431.96 as it appeared at 10 CFR part 431, subpart F, in the 10 CFR parts 200 to 499 edition revised as of January 1, 2014. Any representations made with respect to the energy use or efficiency of such packaged terminal air conditioners and heat pumps must be in accordance with whichever version is selected.

TABLE 1 TO PARAGRAPH (b)—TEST PROCEDURES FOR COMMERCIAL AIR CONDITIONERS AND HEAT PUMPS

Equipment type	Category	Cooling capacity or moisture removal capacity [2]	Energy efficiency descriptor	Use tests, conditions, and procedures [1] in	Additional test procedure provisions as indicated in the listed paragraphs of this section
Small Commercial Package Air-Conditioning and Heating Equipment.	Air-Cooled, 3-Phase, AC and HP.	<65,000 Btu/h	SEER and HSPF.	AHRI 210/240–2008 (omit section 6.5).	Paragraphs (c) and (e).
	Air-Cooled AC and HP.	≥65,000 Btu/h and <135,000 Btu/h.	EER, IEER, and COP.	Appendix A to this subpart.	None.
	Water-Cooled and Evaporatively-Cooled AC.	<65,000 Btu/h	EER	AHRI 210/240–2008 (omit section 6.5).	Paragraphs (c) and (e).
		≥65,000 Btu/h and <135,000 Btu/h.	EER	AHRI 340/360–2007 (omit section 6.3).	Paragraphs (c) and (e).
	Water-Source HP.	<135,000 Btu/h	EER and COP	ISO Standard 13256–1.	Paragraph (e).
Large Commercial Package Air-Conditioning and Heating Equipment.	Air-Cooled AC and HP.	≥135,000 Btu/h and <240,000 Btu/h.	EER, IEER and COP.	Appendix A to this subpart.	None.
	Water-Cooled and Evaporatively-Cooled AC.	≥135,000 Btu/h and <240,000 Btu/h.	EER	AHRI 340/360–2007 (omit section 6.3).	Paragraphs (c) and (e).
Very Large Commercial Package Air-Conditioning and Heating Equipment.	Air-Cooled AC and HP.	≥240,000 Btu/h and <760,000 Btu/h.	EER, IEER and COP.	Appendix A to this subpart.	None.

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TABLE 1 TO PARAGRAPH (b)—TEST PROCEDURES FOR COMMERCIAL AIR CONDITIONERS AND HEAT PUMPS—Continued

Equipment type	Category	Cooling capacity or moisture removal capacity [2]	Energy efficiency descriptor	Use tests, conditions, and procedures [1] in	Additional test procedure provisions as indicated in the listed paragraphs of this section
	Water-Cooled and Evaporatively-Cooled AC.	≥240,000 Btu/h and <760,000 Btu/h.	EER	AHRI 340/360–2007 (omit section 6.3).	Paragraphs (c) and (e).
Packaged Terminal Air Conditioners and Heat Pumps.	AC and HP	<760,000 Btu/h	EER and COP	Paragraph (g) of this section.	Paragraphs (c), (e), and (g).
Computer Room Air Conditioners.	AC	<65,000 Btu/h	SCOP	ASHRAE 127–2007 (omit section 5.11).	Paragraphs (c) and (e).
		≥65,000 Btu/h and <760,000 Btu/h.	SCOP	ASHRAE 127–2007 (omit section 5.11).	Paragraphs (c) and (e).
Variable Refrigerant Flow Multi-split Systems.	AC	<65,000 Btu/h (3-phase).	SEER	ANSI/AHRI 1230–2010 (omit sections 5.1.2 and 6.6).	Paragraphs (c), (d), (e), and (f).
Variable Refrigerant Flow Multi-split Systems, Air-cooled.	HP	<65,000 Btu/h (3-phase).	SEER and HSPF.	ANSI/AHRI 1230–2010 (omit sections 5.1.2 and 6.6).	Paragraphs (c), (d), (e), and (f).
Variable Refrigerant Flow Multi-split Systems, Air-cooled.	AC and HP	≥65,000 Btu/h and <760,000 Btu/h.	EER and COP	Appendix D to this subpart [3].	None.
		≥65,000 Btu/h and <760,000 Btu/h.	IEER and COP	Appendix D1 to this subpart [3].	None.
Variable Refrigerant Flow Multi-split Systems, Water-source.	HP	<760,000 Btu/h	EER and COP	Appendix D to this subpart [3].	None.
		<760,000 Btu/h	IEER and COP	Appendix D1 to this subpart [3].	None.
Single Package Vertical Air Conditioners and Single Package Vertical Heat Pumps.	AC and HP	<760,000 Btu/h	EER and COP	AHRI 390–2003 (omit section 6.4).	Paragraphs (c) and (e).
Direct Expansion-Dedicated Outdoor Air Systems.	All	<324 lbs. of moisture removal/hr.	ISMRE2 and ISCOP2.	Appendix B to this subpart.	None.

[1] Incorporated by reference; see § 431.95.
[2] Moisture removal capacity applies only to direct expansion-dedicated outdoor air systems.
[3] For equipment with multiple appendices listed in this table 1, consult the notes at the beginning of those appendices to determine the applicable appendix to use for testing.

(c) *Optional break-in period for tests conducted using AHRI 210/240–2008, AHRI 390–2003, AHRI 1230–2010, and ASHRAE 127–2007.* Manufacturers may optionally specify a ''break-in'' period, not to exceed 20 hours, to operate the equipment under test prior to conducting the test method specified by AHRI 210/240–2008, AHRI 390–2003, AHRI 1230–2010, or ASHRAE 127–2007 (incorporated by reference; see § 431.95). A manufacturer who elects to use an optional compressor break-in period in its certification testing should record this information (including the duration) in the test data underlying the certified ratings that is required to be maintained under 10 CFR 429.71.

(d) *Refrigerant line length corrections for tests conducted using AHRI 1230–2010.* For test setups where it is physically impossible for the laboratory to use the required line length listed in Table 3 of the AHRI 1230–2010 (incorporated by reference, see § 431.95), then the actual refrigerant line length used by the laboratory may exceed the required length and the following correction factors are applied:

TABLE 2 TO PARAGRAPH (d)

Piping length beyond minimum, X (ft)	Piping length beyond minimum, Y (m)	Cooling capacity correction %
0>X ≤20	0>Y ≤6.1	1
20>X ≤40	6.1>Y ≤12.2	2
40>X ≤60	12.2>Y ≤18.3	3
60>X ≤80	18.3>Y ≤24.4	4
80>X ≤100	24.4>Y ≤30.5	5
100 >X ≤120	30.5>Y ≤36.6	6

(e) *Additional provisions for equipment set-up.* The only additional specifications that may be used in setting up the basic model for test are those set forth in the installation and operation manual shipped with the unit. Each unit should be set up for test in accordance with the manufacturer installation and operation manuals. Paragraphs (e)(1) through (3) of this section provide specifications for addressing key information typically found in the installation and operation manuals.

(1) If a manufacturer specifies a range of superheat, sub-cooling, and/or refrigerant pressure in its installation and operation manual for a given basic model, any value(s) within that range may be used to determine refrigerant charge or mass of refrigerant, unless the manufacturer clearly specifies a rating value in its installation and operation manual, in which case the specified rating value shall be used.

(2) The air flow rate used for testing must be that set forth in the installation and operation manuals being shipped to the commercial customer with the basic model and clearly identified as that used to generate the DOE performance ratings. If a rated air flow value for testing is not clearly identified, a value of 400 standard cubic feet per minute (scfm) per ton shall be used.

(3) For VRF systems, the test set-up and the fixed compressor speeds (*i.e.*, the maximum, minimum, and any intermediate speeds used for testing) should be recorded and maintained as part of the test data underlying the certified ratings that is required to be maintained under 10 CFR 429.71.

(f) *Manufacturer involvement in assessment or enforcement testing for variable refrigerant flow systems.* A manufacturer's representative will be allowed to witness assessment and/or enforcement testing for VRF systems. The manufacturer's representative will be allowed to inspect and discuss set-up only with a DOE representative and adjust only the modulating components during testing in the presence of a DOE representative that are necessary to achieve steady-state operation. Only previously documented specifications for set-up as specified under paragraphs (d) and (e) of this section will be used.

(g) *Test Procedures for Packaged Terminal Air Conditioners and Packaged Terminal Heat Pumps*—(1) *Cooling mode testing.* The test method for testing packaged terminal air conditioners and packaged terminal heat pumps in cooling mode shall consist of application of the methods and conditions in AHRI 310/380–2014 sections 3, 4.1, 4.2, 4.3, and 4.4 (incorporated by reference; see § 431.95), and in ANSI/ASHRAE 16 (incorporated by reference; see § 431.95) or ANSI/ASHRAE 37 (incorporated by reference; see § 431.95), except that instruments used for measuring electricity input shall be accurate to within ±0.5 percent of the quantity measured. Where definitions provided in AHRI 310/380–2014, ANSI/ASHRAE 16, and/or ANSI/ASHRAE 37 conflict with the definitions provided in 10 CFR 431.92, the 10 CFR 431.92 definitions shall be used. Where AHRI 310/380–2014 makes reference to ANSI/ASHRAE 16, it is interpreted as reference to ANSI/ASHRAE 16–1983 (RA 2014).

(2) *Heating mode testing.* The test method for testing packaged terminal heat pumps in heating mode shall consist of application of the methods and conditions in AHRI 310/380–2014 sections 3, 4.1, 4.2 (except the section 4.2.1.2(b) reference to ANSI/ASHRAE 37), 4.3, and 4.4 (incorporated by reference; see § 431.95), and in ANSI/ASHRAE 58 (incorporated by reference; see § 431.95). Where definitions provided in AHRI 310/380–2014 or ANSI/ASHRAE 58 conflict with the definitions provided in 10 CFR 431.92, the 10 CFR 431.92 definitions shall be used. Where AHRI 310/380–2014 makes reference to ANSI/ASHRAE 58, it is interpreted as reference to ANSI/ASHRAE 58–1986 (RA 2014).

(3) *Wall sleeves.* For packaged terminal air conditioners and packaged terminal heat pumps, the unit must be installed in a wall sleeve with a 14 inch depth if available. If a 14 inch deep wall sleeve is not available, use the available wall sleeve option closest to 14 inches in depth. The area(s) between the wall sleeve and the insulated partition between the indoor and outdoor rooms must be sealed to eliminate all air leakage through this area.

(4) *Optional pre-filling of the condensate drain pan.* For packaged terminal air conditioners and packaged terminal heat pumps, test facilities may add water to the condensate drain pan of the equipment under test (until the water drains out due to overflow devices or until the pan is full) prior to conducting the test method specified by AHRI 310/380–2014 (incorporated by reference, see § 431.95). No specific level of water mineral content or water temperature is required for the water added to the condensate drain pan.

(5) *Filter selection.* For packaged terminal air conditioners and packaged terminal heat pumps, the indoor filter used during testing shall be the standard or default filter option shipped with the model. If a particular model is shipped without a filter, the unit must be tested with a MERV–1 filter sized appropriately for the filter slot.

[77 FR 28989, May 16, 2012; 80 FR 11857, Mar. 5, 2015, as amended at 80 FR 37148, June 30, 2015; 80 FR 79669, Dec. 23, 2015; 87 FR 45198, July 27, 2022; 87 FR 63897, Oct. 20, 2022]

EFFECTIVE DATE NOTES: 1. At 87 FR 75168, Dec. 7, 2022, § 431.96 was amended by revising paragraph (b)(1), table 1 to paragraph (b), and paragraph (c), effective Jan. 6, 2023. For the convenience of the user, the revised text is set forth as follows:

§ 431.96 Uniform test method for the measurement of energy efficiency of commercial air conditioners and heat pumps.

* * * * *

(b) * * *

(1) Determine the energy efficiency and capacity of each category of covered equipment by conducting the test procedure(s) listed in table 1 to this paragraph (b) along with any additional testing provisions set forth in paragraphs (c) through (g) of this section and appendices A through G1 to this subpart, that apply to the energy efficiency descriptor for that equipment, category, and cooling capacity. The omitted sections of the test procedures listed in table 1 must not be used. For equipment with multiple appendices listed in table 1, consult the notes at the beginning of those appendices to determine the applicable appendix to use for testing.

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TABLE 1 TO PARAGRAPH (b)—TEST PROCEDURES FOR COMMERCIAL AIR CONDITIONERS AND HEAT PUMPS

Equipment type	Category	Cooling capacity or moisture removal capacity [2]	Energy efficiency descriptor	Use tests, conditions, and procedures [1] in	Additional test procedure provisions as indicated in the listed paragraphs of this section
Small Commercial Package Air-Conditioning and Heating Equipment.	Air-Cooled, 3-Phase, AC and HP.	<65,000 Btu/h	SEER and HSPF	AHRI 210/240–2008 (omit section 6.5).	None.

TABLE 1 TO PARAGRAPH (b)—TEST PROCEDURES FOR COMMERCIAL AIR CONDITIONERS AND HEAT PUMPS—Continued

Equipment type	Category	Cooling capacity or moisture removal capacity [2]	Energy efficiency descriptor	Use tests, conditions, and procedures [1] in	Additional test procedure provisions as indicated in the listed paragraphs of this section
	Air-Cooled AC and HP.	≥65,000 Btu/h and <135,000 Btu/h.	EER, IEER, and COP.	Appendix A to this subpart.	None.
	Water-Cooled and Evaporatively-Cooled AC.	<65,000 Btu/h	EER	AHRI 210/240–2008 (omit section 6.5).	Paragraphs (c) and (e).
		≥65,000 Btu/h and <135,000 Btu/h.	EER	AHRI 340/360–2007 (omit section 6.3).	Paragraphs (c) and (e).
	Water-Source HP	<135,000 Btu/h	EER and COP	ISO Standard 13256–1.	Paragraph (e).
Large Commercial Package Air-Conditioning and Heating Equipment.	Air-Cooled AC and HP.	≥135,000 Btu/h and <240,000 Btu/h.	EER, IEER and COP.	Appendix A to this subpart.	None.
	Water-Cooled and Evaporatively-Cooled AC.	≥135,000 Btu/h and <240,000 Btu/h.	EER	AHRI 340/360–2007 (omit section 6.3).	Paragraphs (c) and (e).
Very Large Commercial Package Air-Conditioning and Heating Equipment.	Air-Cooled AC and HP.	≥240,000 Btu/h and <760,000 Btu/h.	EER, IEER and COP.	Appendix A to this subpart.	None.
	Water-Cooled and Evaporatively-Cooled AC.	≥240,000 Btu/h and <760,000 Btu/h.	EER	AHRI 340/360–2007 (omit section 6.3).	Paragraphs (c) and (e).
Packaged Terminal Air Conditioners and Heat Pumps.	AC and HP	<760,000 Btu/h	EER and COP	Paragraph (g) of this section.	Paragraphs (c), (e), and (g).
Computer Room Air Conditioners.	AC	<65,000 Btu/h	SCOP	ASHRAE 127–2007 (omit section 5.11).	Paragraphs (c) and (e).
		≥65,000 Btu/h and <760,000 Btu/h.	SCOP	ASHRAE 127–2007 (omit section 5.11).	Paragraphs (c) and (e).
Variable Refrigerant Flow Multi-split Systems.	AC	<65,000 Btu/h (3-phase).	SEER	HRI 1230–2010 (omit sections 5.1.2 and 6.6).	Paragraphs (c), (d), (e), and (f).
Variable Refrigerant Flow Multi-split Systems, Air-cooled.	HP	<65,000 Btu/h (3-phase).	SEER and HSPF	AHRI 1230–2010 (omit sections 5.1.2 and 6.6).	Paragraphs (c), (d), (e), and (f)
Variable Refrigerant Flow Multi-split Systems, Air-cooled.	AC and HP	≥65,000 Btu/h and <760,000 Btu/h.	EER and COP	Appendix D to this subpart [3].	None.
		≥65,000 Btu/h and <760,000 Btu/h.	IEER and COP	Appendix D1 to this subpart [3].	None.
Variable Refrigerant Flow Multi-split Systems, Water-source.	HP	<760,000 Btu/h	EER and COP	Appendix D to this subpart [3].	None.
		<760,000 Btu/h	IEER and COP	Appendix D1 to this subpart [2].	None.
Single Package Vertical Air Conditioners and Single Package Vertical Heat Pumps.	AC and HP	<760,000 Btu/h	EER and COP	Appendix G to this subpart [3].	None.
			EER, IEER, and COP.	Appendix G1 to this subpart [3].	None.

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TABLE 1 TO PARAGRAPH (b)—TEST PROCEDURES FOR COMMERCIAL AIR CONDITIONERS AND HEAT PUMPS—Continued

Equipment type	Category	Cooling capacity or moisture removal capacity [2]	Energy efficiency descriptor	Use tests, conditions, and procedures [1] in	Additional test procedure provisions as indicated in the listed paragraphs of this section
Direct Expansion-Dedicated Outdoor Air Systems.	All	<324 lbs. of moisture removal/hr.	ISMRE2 and ISCOP2.	Appendix B to this subpart.	None.

[1] Incorporated by reference; see §431.95.
[2] Moisture removal capacity applies only to direct expansion-dedicated outdoor air systems.
[3] For equipment with multiple appendices listed in this table 1, consult the notes at the beginning of those appendices to determine the applicable appendix to use for testing.

(c) *Optional break-in period for tests conducted using AHRI 210/240–2008, AHRI 1230–2010, and ASHRAE 127–2007.* Manufacturers may optionally specify a ''break-in'' period, not to exceed 20 hours, to operate the equipment under test prior to conducting the test method specified by AHRI 210/240–2008 or ASHRAE 127–2007 (incorporated by reference; see §431.95). A manufacturer who elects to use an optional compressor break-in period in its certification testing should record this information (including the duration) in the test data underlying the certified ratings that is required to be maintained under 10 CFR 429.71.

* * * * *

2. At 87 FR 77325, Dec. 16, 2022, §431.96 was amended by revising table 1 to paragraph (b), effective Jan. 17, 2023. For the convenience of the user, the added and revised text is set forth as follows:

§431.96 Uniform test method for the measurement of energy efficiency of commercial air conditioners and heat pumps.

* * * * *

(b) * * *

TABLE 1 TO PARAGRAPH (b)—TEST PROCEDURES FOR COMMERCIAL AIR CONDITIONERS AND HEAT PUMPS

Equipment type	Category	Cooling capacity or moisture removal capacity [2]	Energy efficiency descriptor	Use tests, conditions, and procedures [1] in	Additional test procedure provisions as indicated in the listed paragraphs of this section
Small Commercial Package Air-Conditioning and Heating Equipment.	Air-Cooled, 3-Phase, AC and HP.	<65,000 Btu/h	SEER and HSPF	Appendix F to this subpart [3].	None.
			SEER2 and HSPF2.	Appendix F1 to this subpart [3].	None.
	Air-Cooled AC and HP.	≥65,000 Btu/h and <135,000 Btu/h.	EER, IEER, and COP.	Appendix A of this subpart.	None.
	Water-Cooled and Evaporatively-Cooled AC.	<65,000 Btu/h	EER	AHRI 210/240–2008 (omit section 6.5).	Paragraphs (c) and (e).
		≥65,000 Btu/h and <135,000 Btu/h.	EER	AHRI 340/360–2007 (omit section 6.3).	Paragraphs (c) and (e).
	Water-Source HP	<135,000 Btu/h	EER and COP	ISO Standard 13256–1.	Paragraph (e).
Large Commercial Package Air-Conditioning and Heating Equipment.	Air-Cooled AC and HP.	≥135,000 Btu/h and <240,000 Btu/h.	EER, IEER and COP.	Appendix A to this subpart.	None.
	Water-Cooled and Evaporatively-Cooled AC.	≥135,000 Btu/h and <240,000 Btu/h.	EER	AHRI 340/360–2007 (omit section 6.3).	Paragraphs (c) and (e).

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TABLE 1 TO PARAGRAPH (b)—TEST PROCEDURES FOR COMMERCIAL AIR CONDITIONERS AND HEAT PUMPS—Continued

Equipment type	Category	Cooling capacity or moisture removal capacity [2]	Energy efficiency descriptor	Use tests, conditions, and procedures [1] in	Additional test procedure provisions as indicated in the listed paragraphs of this section
Very Large Commercial Package Air-Conditioning and Heating Equipment.	Air-Cooled AC and HP.	≥240,000 Btu/h and <760,000 Btu/h.	EER, IEER and COP.	Appendix A to this subpart.	None.
	Water-Cooled and Evaporatively-Cooled AC.	≥240,000 Btu/h and <760,000 Btu/h.	EER	AHRI 340/360–2007 (omit section 6.3).	Paragraphs (c) and (e).
Packaged Terminal Air Conditioners and Heat Pumps.	AC and HP	<760,000 Btu/h	EER and COP	Paragraph (g) of this section.	Paragraphs (c), (e), and (g).
Computer Room Air Conditioners.	AC	<65,000 Btu/h	SCOP	ASHRAE 127–2007 (omit section 5.11).	Paragraphs (c) and (e).
		≥65,000 Btu/h and <760,000 Btu/h.	SCOP	ASHRAE 127–2007 (omit section 5.11).	Paragraphs (c) and (e).
Variable Refrigerant Flow Multi-split Systems.	AC	<65,000 Btu/h (3-phase).	SEER	Appendix F to this subpart [3].	None.
			SEER2	Appendix F1 to this subpart [3].	None.
Variable Refrigerant Flow Multi-split Systems, Air-cooled.	HP	<65,000 Btu/h (3-phase).	SEER and HSPF	Appendix F to this subpart [3].	None.
			SEER2 and HSPF2.	Appendix F1 to this subpart [3].	None.
Variable Refrigerant Flow Multi-split Systems, Air-cooled.	AC and HP	≥65,000 Btu/h and <760,000 Btu/h.	EER and COP	Appendix D of this subpart [3].	None.
		≥65,000 Btu/h and <760,000 Btu/h.	IEER and COP	Appendix D1 of this subpart [3].	None.
Variable Refrigerant Flow Multi-split Systems, Water-source.	HP	<760,000 Btu/h	EER and COP	Appendix D of this subpart [3].	None.
		<760,000 Btu/h	IEER and COP	Appendix D1 of this subpart [3].	None.
Single Package Vertical Air Conditioners and Single Package Vertical Heat Pumps.	AC and HP	<760,000 Btu/h	EER and COP	Appendix G to this subpart [3].	None.
			EER, IEER, and COP.	Appendix G1 to this subpart [3].	None.
Direct Expansion-Dedicated Outdoor Air Systems.	All	<324 lbs. of moisture removal/hr.	ISMRE2 and ISCOP2.	Appendix B of this subpart.	None.

[1] Incorporated by reference; see §431.95.
[2] Moisture removal capacity applies only to direct expansion-dedicated outdoor air systems
[3] For equipment with multiple appendices listed in table 1, consult the notes at the beginning of those appendices to determine the applicable appendix to use for testing.

* * * * *

ENERGY EFFICIENCY STANDARDS

§ 431.97 Energy efficiency standards and their compliance dates.

(a) All basic models of commercial package air-conditioning and heating equipment must be tested for performance using the applicable DOE test procedure in § 431.96, be compliant with the applicable standards set forth in paragraphs (b) through (f) of this section, and be certified to the Department under 10 CFR part 429.

(b) Each commercial air conditioner or heat pump (not including single package vertical air conditioners and single package vertical heat pumps, packaged terminal air conditioners and packaged terminal heat pumps, computer room air conditioners, and variable refrigerant flow systems) manufactured starting on the compliance date listed in the corresponding table must meet the applicable minimum energy efficiency standard level(s) set forth in Tables 1 through 6 of this section.

TABLE 1 TO § 431.97—MINIMUM COOLING EFFICIENCY STANDARDS FOR AIR CONDITIONING AND HEATING EQUIPMENT

[Not including single package vertical air conditioners and single package vertical heat pumps, packaged terminal air conditioners and packaged terminal heat pumps, computer room air conditioners, variable refrigerant flow multi-split air conditioners and heat pumps, and double-duct air-cooled commercial package air conditioning and heating equipment]

Equipment type	Cooling capacity	Subcategory	Heating type	Efficiency level	Compliance date: Equipment manufactured starting on . . .
Small Commercial Package Air Conditioning and Heating Equipment (Air-Cooled, 3-Phase, Split-System).	<65,000 Btu/h	AC	All	SEER = 13	June 16, 2008.
		HP	All	SEER = 13	June 16, 2008.[1]
Small Commercial Package Air Conditioning and Heating Equipment (Air-Cooled, 3-Phase, Single-Package).	<65,000 Btu/h	AC	All	SEER = 13	June 16, 2008.[1]
		HP	All	SEER = 13	June 16, 2008.[1]
Small Commercial Package Air Conditioning and Heating Equipment (Air-Cooled).	≥65,000 Btu/h and <135,000 Btu/h.	AC	No Heating or Electric Resistance Heating.	EER = 11.2	January 1, 2010.[2]
			All Other Types of Heating.	EER = 11.0	January 1, 2010.[2]
		HP	No Heating or Electric Resistance Heating.	EER = 11.0	January 1, 2010.[2]
			All Other Types of Heating.	EER = 10.8	January 1, 2010.[2]
Large Commercial Package Air Conditioning and Heating Equipment (Air-Cooled).	≥135,000 Btu/h and <240,000 Btu/h.	AC	No Heating or Electric Resistance Heating.	EER = 11.0	January 1, 2010.[2]
			All Other Types of Heating.	EER = 10.8	January 1, 2010.[2]
		HP	No Heating or Electric Resistance Heating.	EER = 10.6	January 1, 2010.[2]
			All Other Types of Heating.	EER = 10.4	January 1, 2010.[2]
Very Large Commercial Package Air Conditioning and Heating Equipment (Air-Cooled).	≥240,000 Btu/h and <760,000 Btu/h.	AC	No Heating or Electric Resistance Heating.	EER = 10.0	January 1, 2010.[2]
			All Other Types of Heating.	EER = 9.8	January 1, 2010.[2]
		HP	No Heating or Electric Resistance Heating.	EER = 9.5	January 1, 2010.[2]
			All Other Types of Heating.	EER = 9.3	January 1, 2010.[2]
Small Commercial Package Air Conditioning and Heating Equipment (Water-Cooled).	<65,000 Btu/h	AC	All	EER = 12.1	October 29, 2003.
....	≥65,000 Btu/h and <135,000 Btu/h.	AC	No Heating or Electric Resistance Heating.	EER = 12.1	June 1, 2013.

TABLE 1 TO §431.97—MINIMUM COOLING EFFICIENCY STANDARDS FOR AIR CONDITIONING AND HEATING EQUIPMENT—Continued

[Not including single package vertical air conditioners and single package vertical heat pumps, packaged terminal air conditioners and packaged terminal heat pumps, computer room air conditioners, variable refrigerant flow multi-split air conditioners and heat pumps, and double-duct air-cooled commercial package air conditioning and heating equipment]

Equipment type	Cooling capacity	Sub-category	Heating type	Efficiency level	Compliance date: Equipment manufactured starting on . . .
			All Other Types of Heating.	EER = 11.9	June 1, 2013.
Large Commercial Package Air-Conditioning and Heating Equipment (Water-Cooled).	≥135,000 Btu/h and <240,000 Btu/h.	AC	No Heating or Electric Resistance Heating.	EER = 12.5	June 1, 2014.
			All Other Types of Heating.	EER = 12.3	June 1, 2014.
Very Large Commercial Package Air-Conditioning and Heating Equipment (Water-Cooled).	≥240,000 Btu/h and <760,000 Btu/h.	AC	No Heating or Electric Resistance Heating.	EER = 12.4	June 1, 2014.
			All Other Types of Heating.	EER = 12.2	June 1, 2014.
Small Commercial Package Air-Conditioning and Heating Equipment (Evaporatively-Cooled).	<65,000 Btu/h	AC	All	EER = 12.1	October 29, 2003.
	≥65,000 Btu/h and <135,000 Btu/h.	AC	No Heating or Electric Resistance Heating.	EER = 12.1	June 1, 2013.
			All Other Types of Heating.	EER = 11.9	June 1, 2013.
Large Commercial Package Air-Conditioning and Heating Equipment (Evaporatively-Cooled).	≥135,000 Btu/h and <240,000 Btu/h.	AC	No Heating or Electric Resistance Heating.	EER = 12.0	June 1, 2014.
			All Other Types of Heating.	EER = 11.8	June 1, 2014.
Very Large Commercial Package Air Conditioning and Heating Equipment (Evaporatively-Cooled).	≥240,000 Btu/h and <760,000 Btu/h.	AC	No Heating or Electric Resistance Heating.	EER = 11.9	June 1, 2014.
			All Other Types of Heating.	EER = 11.7	June 1, 2014.
Small Commercial Package Air-Conditioning and Heating Equipment (Water-Source: Water-to-Air, Water-Loop).	<17,000 Btu/h	HP	All	EER = 11.2	October 29, 2003.[3]
	≥17,000 Btu/h and <65,000 Btu/h.	HP	All	EER = 12.0	October 29, 2003.[3]
	≥65,000 Btu/h and <135,000 Btu/h.	HP	All	EER = 12.0	October 29, 2003.[3]

[1] And manufactured before January 1, 2017. See Table 3 of this section for updated efficiency standards.
[2] And manufactured before January 1, 2018. See Table 3 of this section for updated efficiency standards.
[3] And manufactured before October 9, 2015. See Table 3 of this section for updated efficiency standards.

TABLE 2 TO §431.97—MINIMUM HEATING EFFICIENCY STANDARDS FOR AIR CONDITIONING AND HEATING EQUIPMENT [HEAT PUMPS]

[Not including single package vertical air conditioners and single package vertical heat pumps, packaged terminal air conditioners and packaged terminal heat pumps, computer room air conditioners, variable refrigerant flow multi-split air conditioners and heat pumps, and double-duct air-cooled commercial package air conditioning and heating equipment]

Equipment type	Cooling capacity	Efficiency level	Compliance date: Equipment manufactured starting on . . .
Small Commercial Package Air Conditioning and Heating Equipment (Air-Cooled, 3-Phase, Split-System).	<65,000 Btu/h	HSPF = 7.7	June 16, 2008.[1]
Small Commercial Package Air-Conditioning and Heating Equipment (Air-Cooled, 3-Phase, Single-Package).	<65,000 Btu/h	HSPF = 7.7	June 16, 2008.[1]
Small Commercial Package Air Conditioning and Heating Equipment (Air-Cooled).	≥65,000 Btu/h and <135,000 Btu/h.	COP = 3.3	January 1, 2010.[2]
Large Commercial Packaged Air Conditioning and Heating Equipment (Air-Cooled).	≥135,000 Btu/h and <240,000 Btu/h.	COP = 3.2	January 1, 2010.[2]
Very Large Commercial Packaged Air Conditioning and Heating Equipment (Air-Cooled).	≥240,000 Btu/h and <760,000 Btu/h.	COP = 3.2	January 1, 2010.[2]

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TABLE 2 TO § 431.97—MINIMUM HEATING EFFICIENCY STANDARDS FOR AIR CONDITIONING AND HEATING EQUIPMENT [HEAT PUMPS]—Continued

[Not including single package vertical air conditioners and single package vertical heat pumps, packaged terminal air conditioners and packaged terminal heat pumps, computer room air conditioners, variable refrigerant flow multi-split air conditioners and heat pumps, and double-duct air-cooled commercial package air conditioning and heating equipment]

Equipment type	Cooling capacity	Efficiency level	Compliance date: Equipment manufactured starting on . . .
Small Commercial Packaged Air Conditioning and Heating Equipment (Water-Source: Water-to-Air, Water-Loop).	<135,000 Btu/h	COP = 4.2	October 29, 2003.[3]

[1] And manufactured before January 1, 2017. See Table 4 of this section for updated heating efficiency standards.
[2] And manufactured before January 1, 2018. See Table 4 of this section for updated heating efficiency standards.
[3] And manufactured before October 9, 2015. See Table 4 of this section for updated heating efficiency standards.

TABLE 3 TO § 431.97—UPDATES TO THE MINIMUM COOLING EFFICIENCY STANDARDS FOR AIR CONDITIONING AND HEATING EQUIPMENT

[Not including single package vertical air conditioners and single package vertical heat pumps, packaged terminal air conditioners and packaged terminal heat pumps, computer room air conditioners, variable refrigerant flow multi-split air conditioners and heat pumps, and double-duct air-cooled commercial package air conditioning and heating equipment]

Equipment type	Cooling capacity	Sub-category	Heating type	Efficiency level	Compliance date: Equipment manufactured starting on . . .
Small Commercial Packaged Air Conditioning and Heating Equipment (Air-Cooled).	≥65,000 Btu/h and <135,000 Btu/h.	AC	Electric Resistance Heating or No Heating.	IEER = 12.9 IEER = 14.8	January 1, 2018.[1] January 1, 2023.
			All Other Types of Heating.	IEER = 12.7 IEER = 14.6	January 1, 2018.[1] January 1, 2023.
		HP	Electric Resistance Heating or No Heating.	IEER = 12.2 IEER = 14.1	January 1, 2018.[1] January 1, 2023.
			All Other Types of Heating.	IEER = 12.0 IEER = 13.9	January 1, 2018.[1] January 1, 2023.
Large Commercial Packaged Air Conditioning and Heating Equipment (Air-Cooled).	≥135,000 Btu/h and <240,000 Btu/h.	AC	Electric Resistance Heating or No Heating.	IEER = 12.4 IEER = 14.2	January 1, 2018.[1] January 1, 2023.
		....	All Other Types of Heating.	IEER = 12.2 IEER = 14.0	January 1, 2018.[1] January 1, 2023.
		HP	Electric Resistance Heating or No Heating.	IEER = 11.6 IEER = 13.5	January 1, 2018.[1] January 1, 2023.
			All Other Types of Heating.	IEER = 11.4 IEER = 13.3	January 1, 2018.[1] January 1, 2023.
Very Large Commercial Packaged Air Conditioning and Heating Equipment (Air-Cooled).	≥240,000 Btu/h and <760,000 Btu/h.	AC	Electric Resistance Heating or No Heating.	IEER = 11.6 IEER = 13.2	January 1, 2018.[1] January 1, 2023.
			All Other Types of Heating.	IEER = 11.4 IEER = 13.0	January 1, 2018.[1] January 1, 2023.
		HP	Electric Resistance Heating or No Heating.	IEER = 10.6 IEER = 12.5	January 1, 2018.[1] January 1, 2023.
			All Other Types of Heating.	IEER = 10.4 IEER = 12.3	January 1, 2018.[1] January 1, 2023.
Small Commercial Package Air-Conditioning and Heating Equipment (Air-Cooled, 3-Phase, Split-System).	<65,000 Btu/h	AC	All	SEER = 13.0	June 16, 2008.
		HP	All	SEER = 14.0	January 1, 2017.
Small Commercial Package Air-Conditioning and Heating Equipment (Air-Cooled, 3-Phase, Single-Package).	<65,000Btu/h	AC	All	SEER = 14.0	January 1, 2017.
		HP	All	SEER = 14.0	January 1, 2017.
Small Commercial Packaged Air-Conditioning and Heating Equipment (Water Source: Water-to-Air, Water-Loop).	<17,000 Btu/h	HP	All	EER = 12.2	October 9, 2015.
	≥17,000 Btu/h and <65,000 Btu/h.	HP	All	EER = 13.0	October 9, 2015.

TABLE 3 TO §431.97—UPDATES TO THE MINIMUM COOLING EFFICIENCY STANDARDS FOR AIR CONDITIONING AND HEATING EQUIPMENT—Continued

[Not including single package vertical air conditioners and single package vertical heat pumps, packaged terminal air conditioners and packaged terminal heat pumps, computer room air conditioners, variable refrigerant flow multi-split air conditioners and heat pumps, and double-duct air-cooled commercial package air conditioning and heating equipment]

Equipment type	Cooling capacity	Sub-category	Heating type	Efficiency level	Compliance date: Equipment manufactured starting on . . .
	≥65,000 Btu/h and <135,000Btu/h.	HP ..	All	EER = 13.0	October 9, 2015.

[1] And manufactured before January 1, 2023.

TABLE 4 TO §431.97—UPDATES TO THE MINIMUM HEATING EFFICIENCY STANDARDS FOR AIR-COOLED AIR CONDITIONING AND HEATING EQUIPMENT [HEAT PUMPS]

[Not including single package vertical air conditioners and single package vertical heat pumps, packaged terminal air conditioners and packaged terminal heat pumps, computer room air conditioners, variable refrigerant flow multi-split air conditioners and heat pumps, and double-duct air-cooled commercial package air conditioning and heating equipment]

Equipment type	Cooling capacity	Efficiency level.[1]	Compliance date: Equipment manufactured starting on . . .
Small Commercial Package Air Conditioning and Heating Equipment (Air-Cooled, 3-Phase, Split-System).	<65,000 Btu/h	HSPF = 8.2	January 1, 2017.
Small Commercial Package Air Conditioning and Heating Equipment (Air-Cooled, 3-Phase, Single Package).	<65,000 Btu/h	HSPF = 8.0	January 1, 2017.
Small Commercial Package Air Conditioning and Heating Equipment (Water-Source: Water-to-Air, Water-Loop).	<135,000 Btu/h	COP = 4.3	October 9, 2015.
Small Commercial Packaged Air Conditioning and Heating Equipment (Air-Cooled).	≥65,000 Btu/h and <135,000 Btu/h	COP = 3.3 .... COP = 3.4	January 1, 2018.[2] January 1, 2023.
Large Commercial Packaged Air Conditioning and Heating Equipment (Air-Cooled).	≥135,000 Btu/h and <240,000 Btu/h	COP = 3.2 .... COP = 3.3	January 1, 2018.[2] January 1, 2023.
Very Large Commercial Packaged Air Conditioning and Heating Equipment (Air-Cooled).	≥240,000 Btu/h and <760,000 Btu/h	COP = 3.2	January 1, 2018.

[1] For units tested using the relevant AHRI Standards, all COP values must be rated at 47 °F outdoor dry-bulb temperature for air-cooled equipment.
[2] And manufactured before January 1, 2023.

TABLE 5 TO §431.97—MINIMUM COOLING EFFICIENCY STANDARDS FOR DOUBLE-DUCT AIR-CONDITIONING AND HEATING EQUIPMENT

Equipment type	Cooling capacity	Sub-category	Heating type	Efficiency level	Compliance date: Equipment manufactured starting on . . .
Small Double-Duct Commercial Packaged Air Conditioning and Heating Equipment (Air-Cooled).	≥65,000 Btu/h and <135,000 Btu/h.	AC ..	Electric Resistance Heating or No Heating.	EER = 11.2	January 1, 2010.
			All Other Types of Heating	EER = 11.0	January 1, 2010.
		HP ..	Electric Resistance Heating or No Heating.	EER = 11.0	January 1, 2010.
			All Other Types of Heating.	EER = 10.8	January 1, 2010.
Large Commercial Double-Duct Packaged Air Conditioning and Heating Equipment (Air-Cooled).	≥135,000 Btu/h and <240,000 Btu/h.	AC ..	Electric Resistance Heating or No Heating.	EER = 11.0	January 1, 2010.
			All Other Types of Heating.	EER = 10.8	January 1, 2010.
		HP ..	Electric Resistance Heating or No Heating.	EER = 10.6	January 1, 2010.
			All Other Types of Heating.	EER = 10.4	January 1, 2010.
Very Large Double-Duct Commercial Packaged Air Conditioning and Heating Equipment (Air-Cooled).	≥240,000 Btu/h and <300,000 Btu/h.	AC ..	Electric Resistance Heating or No Heating.	EER = 10.0	January 1, 2010.

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TABLE 5 TO § 431.97—MINIMUM COOLING EFFICIENCY STANDARDS FOR DOUBLE-DUCT AIR-CONDITIONING AND HEATING EQUIPMENT—Continued

Equipment type	Cooling capacity	Sub-category	Heating type	Efficiency level	Compliance date: Equipment manufactured starting on . . .
			All Other Types of Heating.	EER = 9.8 ...	January 1, 2010.
		HP ..	Electric Resistance Heating or No Heating.	EER = 9.5 ...	January 1, 2010.
			All Other Types of Heating.	EER = 9.3 ...	January 1, 2010.

TABLE 6 TO § 431.97—MINIMUM HEATING EFFICIENCY STANDARDS FOR DOUBLE-DUCT AIR-COOLED AIR CONDITIONING AND HEATING EQUIPMENT

[Heat pumps]

Equipment type	Cooling capacity	Heating type	Efficiency level [1]	Compliance date: Equipment manufactured starting on . . .
Small Commercial Packaged Air Conditioning and Heating Equipment (Air-Cooled, Double-Duct).	≥65,000 Btu/h and <135,000 Btu/h.	Electric Resistance Heating or No Heating.	COP = 3.3 ..	January 1, 2010.
		All Other Types of Heating	COP = 3.3 ..	January 1, 2010.
Large Commercial Packaged Air-Conditioning and Heating Equipment (Air-Cooled, Double-Duct).	≥135,000 Btu/h and <240,000 Btu/h.	Electric Resistance Heating or No Heating.	COP = 3.2 ..	January 1, 2010.
		All Other Types of Heating	COP = 3.2 ..	January 1, 2010.
Very Large Commercial Packaged Air Conditioning and Heating Equipment (Air-Cooled, Double-Duct).	≥240,000 Btu/h and <300,000 Btu/h.	Electric Resistance Heating or No Heating.	COP = 3.2 ..	January 1, 2010.
		All Other Types of Heating	COP = 3.2 ..	January 1, 2010.

[1] For units tested using the relevant AHRI Standards, all COP values must be rated at 47 °F outdoor dry-bulb temperature for air-cooled equipment.

(c) Each non-standard size packaged terminal air conditioner (PTAC) and packaged terminal heat pump (PTHP) manufactured on or after October 7, 2010 must meet the applicable minimum energy efficiency standard level(s) set forth in Table 7 of this section. Each standard size PTAC manufactured on or after October 8, 2012, and before January 1, 2017 must meet the applicable minimum energy efficiency standard level(s) set forth in Table 7 of this section. Each standard size PTHP manufactured on or after October 8, 2012 must meet the applicable minimum energy efficiency standard level(s) set forth in Table 7 of this section. Each standard size PTAC manufactured on or after January 1, 2017 must meet the applicable minimum energy efficiency standard level(s) set forth in Table 8 of this section.

TABLE 7 TO § 431.97—MINIMUM EFFICIENCY STANDARDS FOR PTAC AND PTHP

Equipment type	Category	Cooling capacity	Efficiency level	Compliance date: products manufactured on and after . . .
PTAC	Standard Size	<7,000 Btu/h	EER = 11.7	October 8, 2012.[2]
		≥7,000 Btu/h and ≤15,000 Btu/h	EER = 13.8 − (0.3 × Cap [1])	October 8, 2012.[2]
		>15,000 Btu/h	EER = 9.3	October 8, 2012.[2]
	Non-Standard Size.	<7,000 Btu/h	EER = 9.4	October 7, 2010.
		≥7,000 Btu/h and ≤15,000 Btu/h	EER = 10.9 − (0.213 × Cap [1])	October 7, 2010.
		>15,000 Btu/h	EER = 7.7	October 7, 2010.
PTHP	Standard Size	<7,000 Btu/h	EER = 11.9 .... COP = 3.3	October 8, 2012.

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TABLE 7 TO § 431.97—MINIMUM EFFICIENCY STANDARDS FOR PTAC AND PTHP—Continued

Equipment type	Category	Cooling capacity	Efficiency level	Compliance date: products manufactured on and after . . .
		≥7,000 Btu/h and ≤15,000 Btu/h	EER = 14.0 − (0.3 × Cap [1]) COP = 3.7 − (0.052 × Cap [1])	October 8, 2012.
		>15,000 Btu/h	EER = 9.5 COP = 2.9	October 8, 2012.
	Non-Standard Size.	<7,000 Btu/h	EER = 9.3 COP = 2.7	October 7, 2010.
		≥7,000 Btu/h and ≤15,000 Btu/h	EER = 10.8 − (0.213 × Cap [1]) COP = 2.9 − (0.026 × Cap [1])	October 7, 2010.
		>15,000 Btu/h	EER = 7.6 COP = 2.5	October 7, 2010.

[1] "Cap" means cooling capacity in thousand Btu/h at 95 °F outdoor dry-bulb temperature.
[2] And manufactured before January 1, 2017. See Table 8 of this section for updated efficiency standards that apply to this category of equipment manufactured on and after January 1, 2017.

TABLE 8 TO § 431.97—UPDATED MINIMUM EFFICIENCY STANDARDS FOR PTAC

Equipment type	Category	Cooling capacity	Efficiency level	Compliance date: products manufactured on and after . . .
PTAC	Standard Size	<7,000 Btu/h	EER = 11.9	January 1, 2017.
		≥7,000 Btu/h and ≤15,000 Btu/h	EER = 14.0 − (0.3 × Cap [1])	January 1, 2017.
		>15,000 Btu/h	EER = 9.5	January 1, 2017.

[1] "Cap" means cooling capacity in thousand Btu/h at 95 °F outdoor dry-bulb temperature.

(d)(1) Each single package vertical air conditioner and single package vertical heat pump manufactured on or after January 1, 2010, but before October 9, 2015 (for models ≥65,000 Btu/h and <135,000 Btu/h) or October 9, 2016 (for models ≥135,000 Btu/h and <240,000 Btu/h), must meet the applicable minimum energy conservation standard level(s) set forth in this section.

TABLE 9 TO § 431.97—MINIMUM EFFICIENCY STANDARDS FOR SINGLE PACKAGE VERTICAL AIR CONDITIONERS AND SINGLE PACKAGE VERTICAL HEAT PUMPS

Equipment type	Cooling capacity	Sub-category	Efficiency level	Compliance date: products manufactured on and after . . .
Single package vertical air conditioners and single package vertical heat pumps, single-phase and three-phase.	<65,000 Btu/h	AC	EER = 9.0	January 1, 2010
		HP	EER = 9.0 COP = 3.0	January 1, 2010
Single package vertical air conditioners and single package vertical heat pumps.	≥65,000 Btu/h and <135,000 Btu/h.	AC	EER = 8.9	January 1, 2010
		HP	EER = 8.9 COP = 3.0	January 1, 2010
Single package vertical air conditioners and single package vertical heat pumps.	≥135,000 Btu/h and <240,000 Btu/h.	AC	EER = 8.6	January 1, 2010
		HP	EER = 8.6 COP = 2.9	January 1, 2010

(2) Each single package vertical air conditioner and single package vertical heat pump manufactured on and after October 9, 2015 (for models ≥65,000 Btu/h and <135,000 Btu/h) or October 9, 2016 (for models ≥135,000 Btu/h and <240,000 Btu/h), but before September 23, 2019 must meet the applicable minimum energy conservation standard level(s) set forth in this section.

TABLE 10 TO § 431.97—MINIMUM EFFICIENCY STANDARDS FOR SINGLE PACKAGE VERTICAL AIR CONDITIONERS AND SINGLE PACKAGE VERTICAL HEAT PUMPS

Equipment type	Cooling capacity	Sub-category	Efficiency level	Compliance date: Products manufactured on and after . . .
Single package vertical air conditioners and single package vertical heat pumps, single-phase and three-phase.	<65,000 Btu/h	AC HP	EER = 9.0 EER = 9.0 COP = 3.0	January 1, 2010 January 1, 2010
Single package vertical air conditioners and single package vertical heat pumps.	≥65,000 Btu/h and <135,000 Btu/h.	AC HP	EER = 10.0 EER = 10.0 COP = 3.0	October 9, 2015 October 9, 2015
Single package vertical air conditioners and single package vertical heat pumps.	≥135,000 Btu/h and <240,000 Btu/h.	AC HP	EER = 10.0 EER = 10.0 COP = 3.0	October 9, 2016 October 9, 2016

(3) Each single package vertical air conditioner and single package vertical heat pump manufactured on and after September 23, 2019 must meet the applicable minimum energy conservation standard level(s) set forth in this section.

TABLE 11 TO § 431.97—UPDATED MINIMUM EFFICIENCY STANDARDS FOR SINGLE PACKAGE VERTICAL AIR CONDITIONERS AND SINGLE PACKAGE VERTICAL HEAT PUMPS

Equipment type	Cooling capacity	Sub-category	Efficiency level	Compliance date: products manufactured on and after . . .
Single package vertical air conditioners and single package vertical heat pumps, single-phase and three-phase.	<65,000 Btu/h	AC HP	EER = 11.0 EER = 11.0 COP = 3.3	September 23, 2019. September 23, 2019.
Single package vertical air conditioners and single package vertical heat pumps.	≥65,000 Btu/h and <135,000 Btu/h.	AC HP	EER = 10.0 EER = 10.0 COP = 3.0	October 9, 2015. October 9, 2015.
Single package vertical air conditioners and single package vertical heat pumps.	≥135,000 Btu/h and <240,000 Btu/h.	AC HP	EER = 10.0 EER = 10.0 COP = 3.0	October 9, 2016. October 9, 2016.

(e) Each computer room air conditioner with a net sensible cooling capacity less than 65,000 Btu/h manufactured on or after October 29, 2012, and each computer room air conditioner with a net sensible cooling capacity greater than or equal to 65,000 Btu/h manufactured on or after October 29, 2013, must meet the applicable minimum energy efficiency standard level(s) set forth in this section.

TABLE 12 TO § 431.97—MINIMUM EFFICIENCY STANDARDS FOR COMPUTER ROOM AIR CONDITIONERS

Equipment type	Net sensible cooling capacity	Minimum SCOP efficiency		Compliance date: Products manufactured on and after . . .
		Downflow unit	Upflow unit	
Computer Room Air Conditioners, Air-Cooled.	<65,000 Btu/h	2.20	2.09	October 29, 2012.
	≥65,000 Btu/h and <240,000 Btu/h.	2.10	1.99	October 29, 2013.
	≥240,000 Btu/h and <760,000 Btu/h.	1.90	1.79	October 29, 2013.
Computer Room Air Conditioners, Water-Cooled.	<65,000 Btu/h	2.60	2.49	October 29, 2012.
	≥65,000 Btu/h and <240,000 Btu/h.	2.50	2.39	October 29, 2013.
	≥240,000 Btu/h and <760,000 Btu/h.	2.40	2.29	October 29, 2013.

TABLE 12 TO §431.97—MINIMUM EFFICIENCY STANDARDS FOR COMPUTER ROOM AIR CONDITIONERS—Continued

Equipment type	Net sensible cooling capacity	Minimum SCOP efficiency		Compliance date: Products manufactured on and after . . .
		Downflow unit	Upflow unit	
Computer Room Air Conditioners, Water-Cooled with a Fluid Economizer.	<65,000 Btu/h	2.55	2.44	October 29, 2012.
	≥65,000 Btu/h and <240,000 Btu/h.	2.45	2.34	October 29, 2013.
	≥240,000 Btu/h and <760,000 Btu/h.	2.35	2.24	October 29, 2013.
Computer Room Air Conditioners, Glycol-Cooled.	<65,000 Btu/h	2.50	2.39	October 29, 2012.
	≥65,000 Btu/h and <240,000 Btu/h.	2.15	2.04	October 29, 2013.
	≥240,000 Btu/h and <760,000 Btu/h.	2.10	1.99	October 29, 2013.
Computer Room Air Conditioner, Glycol-Cooled with a Fluid Economizer.	<65,000 Btu/h	2.45	2.34	October 29, 2012.
	≥65,000 Btu/h and <240,000 Btu/h.	2.10	1.99	October 29, 2013.
	≥240,000 Btu/h and <760,000 Btu/h.	2.05	1.94	October 29, 2013.

(f) Each variable refrigerant flow air conditioner or heat pump manufactured on or after the compliance date listed in this table must meet the applicable minimum energy efficiency standard level(s) set forth in this section.

TABLE 13 TO §431.97—MINIMUM EFFICIENCY STANDARDS FOR VARIABLE REFRIGERANT FLOW MULTI-SPLIT AIR CONDITIONERS AND HEAT PUMPS

Equipment type	Cooling capacity	Heating type[1]	Efficiency level	Compliance date: Products manufactured on and after . . .
VRF Multi-Split Air Conditioners (Air-Cooled).	<65,000 Btu/h	All	13.0 SEER	June 16, 2008.
	≥65,000 Btu/h and <135,000 Btu/h.	No Heating or Electric Resistance Heating.	11.2 EER	January 1, 2010.
		All Other Types of Heating.	11.0 EER	January 1, 2010.
	≥135,000 Btu/h and <240,000 Btu/h.	No Heating or Electric Resistance Heating.	11.0 EER	January 1, 2010.
		All Other Types of Heating.	10.8 EER	January 1, 2010.
	≥240,000 Btu/h and <760,000 Btu/h.	No Heating or Electric Resistance Heating.	10.0 EER	January 1, 2010.
		All Other Types of Heating.	9.8 EER	January 1, 2010.
VRF Multi-Split Heat Pumps (Air-Cooled)	<65,000 Btu/h	All	13.0 SEER 7.7 HSPF	June 16, 2008.
	≥65,000 Btu/h and <135,000 Btu/h.	No Heating or Electric Resistance Heating.	11.0 EER 3.3 COP	January 1, 2010.
		All Other Types of Heating.	10.8 EER 3.3 COP	January 1, 2010.
	≥135,000 Btu/h and <240,000 Btu/h.	No Heating or Electric Resistance Heating.	10.6 EER 3.2 COP	January 1, 2010.
		All Other Types of Heating.	10.4 EER 3.2 COP	January 1, 2010.
	≥240,000 Btu/h and <760,000 Btu/h.	No Heating or Electric Resistance Heating.	9.5 EER 3.2 COP	January 1, 2010.
		All Other Types of Heating.	9.3 EER 3.2 COP	January 1, 2010.
VRF Multi-Split Heat Pumps (Water-Source)* * *	<17,000 Btu/h	Without heat recovery.	12.0 EER 4.2 COP	October 29, 2012. October 29, 2003.
		With heat recovery	11.8 EER 4.2 COP	October 29, 2012. October 29, 2003.

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TABLE 13 TO § 431.97—MINIMUM EFFICIENCY STANDARDS FOR VARIABLE REFRIGERANT FLOW MULTI-SPLIT AIR CONDITIONERS AND HEAT PUMPS—Continued

Equipment type	Cooling capacity	Heating type[1]	Efficiency level	Compliance date: Products manufactured on and after . . .
	≥17,000 Btu/h and <65,000 Btu/h.	All	12.0 EER 4.2 COP	October 29, 2003.
	≥65,000 Btu/h and <135,000 Btu/h.	All	12.0 EER 4.2 COP	October 29, 2003.
	≥135,000 Btu/h and <760,000 Btu/h.	Without heat recovery.	10.0 EER 3.9 COP	October 29, 2013.
		With heat recovery	9.8 EER 3.9 COP	October 29, 2013

[1] VRF Multi-Split Heat Pumps (Air-Cooled) with heat recovery fall under the category of "All Other Types of Heating" unless they also have electric resistance heating, in which case it falls under the category for "No Heating or Electric Resistance Heating."

[77 FR 28991, May 16, 2012, as amended at 77 FR 76830, Dec. 31, 2012; 80 FR 42664, July 17, 2015; 80 FR 43212, July 21, 2015; 80 FR 56895, Sept. 21, 2015; 80 FR 57500, Sept. 23, 2015; 81 FR 2529, Jan. 15, 2016; 81 FR 53907, Aug. 15, 2016]

EFFECTIVE DATE NOTE: At 87 FR 65668, Nov. 1, 2022, § 431.97 was amended by adding paragraph (g) and table 14, effective Jan. 3, 2023. For the convenience of the user, the added text is set forth as follows:

§ 431.97 Energy efficiency standards and their compliance dates.

* * * * *

(g) Each direct expansion-dedicated outdoor air system manufactured on or after the compliance date listed in table 14 to this section must meet the applicable minimum energy efficiency standard level(s) set forth in this section.

TABLE 14 TO § 431.97—MINIMUM EFFICIENCY STANDARDS FOR DIRECT EXPANSION-DEDICATED OUTDOOR AIR SYSTEMS

Equipment type	Subcategory	Efficiency level	Compliance date: equipment manufactured starting on . . .
Direct expansion-dedicated outdoor air systems.	(AC)—Air-cooled without ventilation energy recovery systems.	ISMRE2 = 3.8	May 1, 2024.
	(AC w/VERS)—Air-cooled with ventilation energy recovery systems.	ISMRE2 = 5.0	May 1, 2024.
	(ASHP)—Air-source heat pumps without ventilation energy recovery systems.	ISMRE2 = 3.8 ISCOP2 = 2.05	May 1, 2024.
	(ASHP w/VERS)—Air-source heat pumps with ventilation energy recovery systems.	ISMRE2 = 5.0 ISCOP2 = 3.20	May 1, 2024.
	(WC)—Water-cooled without ventilation energy recovery systems.	ISMRE2 = 4.7	May 1, 2024.
	(WC w/VERS)—Water-cooled with ventilation energy recovery systems.	ISMRE2 = 5.1	May 1, 2024.
	(WSHP)—Water-source heat pumps without ventilation energy recovery systems.	ISMRE2 = 3.8 ISCOP2 = 2.13	May 1, 2024.
	(WSHP w/VERS)—Water-source heat pumps with ventilation energy recovery systems.	ISMRE2 = 4.6 ISCOP2 = 4.04	May 1, 2024.

APPENDIX A TO SUBPART F OF PART 431—UNIFORM TEST METHOD FOR THE MEASUREMENT OF ENERGY CONSUMPTION OF AIR-COOLED SMALL (≥65,000 BTU/H), LARGE, AND VERY LARGE COMMERCIAL PACKAGE AIR CONDITIONING AND HEATING EQUIPMENT

Note: Prior to December 19, 2016, representations with respect to the energy use or efficiency of air-cooled small, large, and very large commercial package air conditioning and heating equipment, including compliance certifications, must be based on testing conducted in accordance with either Table 1 to §431.96 as it now appears or Table 1 to §431.96 as it appeared in subpart F of this part, in the 10 CFR parts 200 through 499 edition revised as of January 1, 2015. After December 19, 2016, representations with respect to energy use or efficiency of air-cooled small, large, and very large commercial package air conditioning and heating equipment, including compliance certifications, must be based on testing conducted in accordance with Table 1 to §431.96 as it now appears.

(1) *Cooling mode test method.* The test method for cooling mode consists of the methods and conditions in AHRI 340/360–2007 sections 3, 4, and 6 (omitting section 6.3) (incorporated by reference; see §431.95), and in ANSI/ASHRAE 37–2009 (incorporated by reference; see §431.95). In case of a conflict between AHRI 340/360–2007 or ANSI/ASHRAE 37–2009 and the CFR, the CFR provisions control.

(2) *Heating mode test method.* The test method for heating mode consists of the methods and conditions in AHRI 340/360–2007 sections 3, 4, and 6 (omitting section 6.3) (incorporated by reference; see §431.95), and in ANSI/ASHRAE 37–2009 (incorporated by reference; see §431.95). In case of a conflict between AHRI 340/360–2007 or ANSI/ASHRAE 37–2009 and the CFR, the CFR provisions control.

(3) *Minimum external static pressure.* Use the certified cooling capacity for the basic model to choose the minimum external static pressure found in table 5 of section 6 of AHRI 340/360–2007 (incorporated by reference; see §431.95) for testing.

(4) *Optional break-in period.* Manufacturers may optionally specify a ''break-in'' period, not to exceed 20 hours, to operate the equipment under test prior to conducting the test method in appendix A of this part. A manufacturer who elects to use an optional compressor break-in period in its certification testing must record this information (including the duration) as part of the information in the supplemental testing instructions under 10 CFR 429.43.

(5) *Additional provisions for equipment set-up.* The only additional specifications that may be used in setting up a unit for test are those set forth in the installation and operation manual shipped with the unit. Each unit should be set up for test in accordance with the manufacturer installation and operation manuals. Paragraphs (5)(i) through (ii) of this section provide specifications for addressing key information typically found in the installation and operation manuals.

(i) If a manufacturer specifies a range of superheat, sub-cooling, and/or refrigerant pressure in its installation and operation manual for a given basic model, any value(s) within that range may be used to determine refrigerant charge or mass of refrigerant, unless the manufacturer clearly specifies a rating value in its installation and operation manual, in which case the specified rating value shall be used.

(ii) The airflow rate used for testing must be that set forth in the installation and operation manuals being shipped to the customer with the basic model and clearly identified as that used to generate the DOE performance ratings. If a certified airflow value for testing is not clearly identified, a value of 400 standard cubic feet per minute (scfm) per ton shall be used.

(6) *Indoor airflow testing and adjustment.* (i) When testing full-capacity cooling operation at the required external static pressure condition, the full-load indoor airflow rate must be within ± 3 percent of the certified-rated airflow at full-capacity cooling operation. If the indoor airflow rate at the required minimum external pressure is outside the ± 3-percent tolerance, the unit and/or test setup must be adjusted such that both the airflow and ESP are within the required tolerances. This process may include, but is not limited to, adjusting any adjustable motor sheaves, adjusting variable drive settings, or adjusting the code tester fan.

(ii) When testing other than full-capacity cooling operation using the full-load indoor airflow rate (*e.g.*, full-load heating), the full-load indoor airflow rate must be within ± 3 percent of the certified-rated full-load cooling airflow (without regard to the resulting external static pressure), unless the unit is designed to operate at a different airflow for cooling and heating mode. If necessary, a test facility setup may be made in order to maintain airflow within the required tolerance; however, no adjustments to the unit under test may be made.

(7) *Condenser head pressure controls.* Condenser head pressure controls, if typically shipped with units of the basic model by the manufacturer or available as an option to the basic model, must be active during testing.

(8) *Standard CFM.* In the referenced sections of AHRI 340/360–2007 (incorporated by reference; see §431.95), all instances of CFM

refer to standard CFM (SCFM). Likewise, all references to airflow or air quantity refer to standard airflow and standard air quantity.

(9) *Capacity rating at part-load.* When testing to determine EER for the part-load rating points (*i.e.* 75-percent load, 50-percent load, and 25-percent load), if the measured capacity expressed as a percent of full-load capacity for a given part-load test is within three percent above or below the target part-load percentage, the EER calculated for the test may be used without any interpolation to determine IEER.

(10) *Condenser air inlet temperature for part-load testing.* When testing to determine EER for the part-load rating points (*i.e.* 75-percent load, 50-percent load, and 25-percent load), the condenser air inlet temperature shall be calculated (using the equation in Table 6 of AHRI 340/360–2007; incorporated by reference; see § 431.95) for the target percent load rather than for the percent load measured in the test. Table 1 of this appendix shows the condenser air inlet temperature corresponding with each target percent load, as calculated using the equation in Table 6 of AHRI 340/360–2007.

TABLE 1 TO APPENDIX A TO SUBPART F OF PART 431—CONDENSER AIR INLET TEMPERATURES FOR PART-LOAD TESTS

Target percent load (%)	Condenser air inlet temperature (°F)
25	65
50	68
75	81.5

[80 FR 79670, Dec. 23, 2015]

APPENDIX B TO SUBPART F OF PART 431—UNIFORM TEST METHOD FOR MEASURING THE ENERGY CONSUMPTION OF DIRECT EXPANSION-DEDICATED OUTDOOR AIR SYSTEMS

NOTE: Beginning July 24, 2023, representations with respect to energy use or efficiency of direct expansion-dedicated outdoor air systems must be based on testing conducted in accordance with this appendix. Manufacturers may elect to use this appendix early.

1. Incorporation by Reference

DOE incorporated by reference in § 431.95, the entire standard for AHRI 920–2020, AHRI 1060–2018; ANSI/ASHRAE 37–2009, ANSI/ASHRAE 41.1–2013, ANSI/ASHRAE 41.6–2014, and ANSI/ASHRAE 198–2013. However, only enumerated provisions of AHRI 920–2020, ANSI/ASHRAE 37–2009, ANSI/ASHRAE 41.6–2014, and ANSI/ASHRAE 198–2013, as listed in this section 1 are required. To the extent there is a conflict between the terms or provisions of a referenced industry standard and the CFR, the CFR provisions control.

1.1. AHRI 920–2020

(a) Section 3—Definitions, as specified in section 2.2.1(a) of this appendix;

(b) Section 5—Test Requirements, as specified in section 2.2.1(b) of this appendix;

(c) Section 6—Rating Requirements, as specified in section 2.2.1(c) of this appendix, omitting section 6.1.2 (but retaining sections 6.1.2.1–6.1.2.8) and 6.6.1;

(d) Section 11—Symbols and Subscripts, as specified in section 2.2.1(d) of this appendix;

(e) Appendix A—References—Normative, as specified in section 2.2.1(e) of this appendix; and

(f) Appendix C—ANSI/ASHRAE Standard 198 and ANSI/ASHRAE Standard 37 Additions, Clarifications and Exceptions—Normative, as specified in section 2.2.1(f) of this appendix.

1.2. ANSI/ASHRAE 37–2009

(a) Section 5.1—Temperature Measuring Instruments (excluding sections 5.1.1 and 5.1.2), as specified in sections 2.2.1(b) and (f) of this appendix;

(b) Section 5.2—Refrigerant, Liquid, and Barometric Pressure Measuring Instruments, as specified in section 2.2.1(b) of this appendix;

(c) Sections 5.3—Air Differential Pressure and Airflow Measurements, as specified in section 2.2.1(b) of this appendix;

(d) Sections 5.5(b)—Volatile Refrigerant Measurement, as specified in section 2.2.1(b) of this appendix;

(e) Section 6.1—Enthalpy Apparatus (excluding 6.1.1 and 6.1.3 through 6.1.6), as specified in section 2.2.1(b) of this appendix;

(f) Section 6.2—Nozzle Airflow Measuring Apparatus, as specified in section 2.2.1(b) of this appendix;

(g) Section 6.3—Nozzles, as specified in section 2.2.1(b) of this appendix;

(h) Section 6.4—External Static Pressure Measurements, as specified in section 2.2.1(b) of this appendix;

(i) Section 6.5—Recommended Practices for Static Pressure Measurements, as specified in section 2.2.1(f) of this appendix;

(j) Section 7.3—Indoor and Outdoor Air Enthalpy Methods, as specified in section 2.2.1(f) of this appendix;

(k) Section 7.4—Compressor Calibration Method, as specified in section 2.2.1(f) of this appendix;

(l) Section 7.5—Refrigerant Enthalpy Method, as specified in section 2.2.1(f) of this appendix;

(m) Section 7.6—Outdoor Liquid Coil Method, as specified in section 2.2.1(f) of this appendix;

(n) Section 7.7—Airflow Rate Measurement (excluding sections 7.7.1.2, 7.7.3, and 7.7.4), as specified in section 2.2.1(b) of this appendix;

(o) Table 1—Applicable Test Methods, as specified in section 2.2.1(f) of this appendix;

(p) Section 8.6—Additional Requirements for the Outdoor Air Enthalpy Method, as specified in section 2.2.1(f) of this appendix;

(q) Table 2b—Test Tolerances (I–P Units), as specified in sections 2.2.1(c) and 2.2(f) of this appendix; and

(r) Errata sheet issued on October 3, 2016, as specified in section 2.2.1(f) of this appendix.

1.3. ANSI/ASHRAE 41.6–2014

(a) Section 4—Classifications, as specified in section 2.2.1(f) of this appendix;

(b) Section 5—Requirements, as specified in section 2.2.1(f) of this appendix;

(c) Section 6—Instruments and Calibration, as specified in section 2.2.1(f) of this appendix;

(d) Section 7.1—Standard Method Using the Cooled-Surface Condensation Hygrometer as specified in section 2.2.1(f) of this appendix; and

(e) Section 7.4—Electronic and Other Humidity Instruments. As specified in section 2.2.1(f) of this appendix.

1.4. ANSI/ASHRAE 198–2013

(a) Section 4.4—Temperature Measuring Instrument, as specified in section 2.2.1(b) of this appendix;

(b) Section 4.5—Electrical Instruments, as specified in section 2.2.1(b) of this appendix;

(c) Section 4.6—Liquid Flow Measurement, as specified in section 2.2.1(b) of this appendix;

(d) Section 4.7—Time and Mass Measurements, as specified in section 2.2.1(b) of this appendix;

(e) Section 6.1—Test Room Requirements, as specified in section 2.2.1(b) of this appendix;

(f) Section 6.6—Unit Preparation, as specified in section 2.2.1(b) of this appendix;

(g) Section 7.1—Preparation of the Test Room(s), as specified in section 2.2.1(b) of this appendix;

(h) Section 7.2—Equipment Installation, as specified in section 2.2.1(b) of this appendix;

(i) Section 8.2—Equilibrium, as specified in section 2.2.1(b) of this appendix; and

(j) Section 8.4—Test Duration and Measurement Frequency, as specified in section 2.2.1(b) of this appendix.

2. Test Method

2.1. Capacity

Moisture removal capacity (in pounds per hour) and supply airflow rate (in standard cubic feet per minute) are determined according to AHRI 920–2020 as specified in section 2.2 of this appendix.

2.2. Efficiency

2.2.1. Determine the ISMRE2 for all DX–DOASes and the ISCOP2 for all heat pump DX–DOASes in accordance with the following sections of AHRI 920–2020 and the additional provisions described in this section.

(a) Section 3—Definitions, including the references to AHRI 1060–2018;

(i) Non-standard Low-static Fan Motor. A supply fan motor that cannot maintain external static pressure as high as specified in Table 7 of AHRI 920–2020 when operating at a manufacturer-specified airflow rate and that is distributed in commerce as part of an individual model within the same basic model of a DX–DOAS that is distributed in commerce with a different motor specified for testing that can maintain the required external static pressure.

(ii) Manufacturer-specified. Information provided by the manufacturer through manufacturer's installation instructions, as defined in Section 3.14 of AHRI 920–2020.

(iii) Reserved

(b) Section 5—Test Requirements, including the references to Sections 5.1, 5.2, 5.3, 5.5, 6.1, 6.2, 6.3, 6.4, and 7.7 (not including Sections 7.7.1.2, 7.7.3, and 7.7.4) of ANSI/ASHRAE 37–2009, and Sections 4.4, 4.5, 4.6, 4.7, 5.1, 6.1, 6.6, 7.1, 7.2, 8.2, and 8.4 of ANSI/ASHRAE 198–2013;

(i) All control settings are to remain unchanged for all Standard Rating Conditions once system set up has been completed, except as explicitly allowed or required by AHRI 920–2020 or as indicated in the supplementary test instructions (STI). Component operation shall be controlled by the unit under test once the provisions in section 2.2.1(c) of this appendix are met.

(ii) Break-in. The break-in conditions and duration specified in section 5.6 of AHRI 920–2020 shall be manufacturer-specified values.

(iii) Reserved

(c) Section 6—Rating Requirements (omitting sections 6.1.2 and 6.6.1), including the references to Table 2b of ANSI/ASHRAE 37–2009, and ANSI/ASHRAE 198–2013.

(i) For water-cooled DX–DOASes, the ''Condenser Water Entering Temperature, Cooling Tower Water'' conditions specified in Table 4 of AHRI 920–2020 shall be used. For water-source heat pump DX–DOASes, the ''Water-Source Heat Pumps'' conditions specified in Table 5 of AHRI 920–2020 shall be used.

(ii) For water-cooled or water-source DX–DOASes with integral pumps, set the external head pressure to 20 ft. of water column, with a −0/+1 ft. condition tolerance and a 1 ft. operating tolerance.

(iii) When using the degradation coefficient method as specified in Section 6.9.2 of AHRI 920–2020, Equation 20 applies to DX–

DOAS without VERS, with deactivated VERS (see Section 5.4.3 of AHRI 920–2020), or sensible-only VERS tested under Standard Rating Conditions other than D.

(iv) Rounding requirements for representations are to be followed as stated in Sections 6.1.2.1 through 6.1.2.8 of AHRI 920–2020;

(d) Section 11—Symbols and Subscripts, including references to AHRI 1060–2018;

(e) Appendix A—References—Normative;

(f) Appendix C—ANSI/ASHRAE 198–2013 and ANSI/ASHRAE 37 Additions, Clarifications and Exceptions—Normative, including references to Sections 5.1, 6.5, 7.3, 7.4, 7.5, 7.6, 8.6, Table 1, Table 2b, and the errata sheet of ANSI/ASHRAE 37–2009, ANSI/ASHRAE 41.1–2013, Sections 4, 5, 6, 7.1, and 7.4 of ANSI/ASHRAE 41.6–2014, and AHRI 1060–2018;

(g) Appendix E—Typical Test Unit Installations—Informative, for information only.

2.2.2. Set-Up and Test Provisions for Specific Components. When testing a DX–DOAS that includes any of the features listed in Table 2.1 of this section, test in accordance with the set-up and test provisions specified in Table 2.1 of this section.

TABLE 2.1—TEST PROVISIONS FOR SPECIFIC COMPONENTS

Component	Description	Test provisions
Return and Exhaust Dampers.	An automatic system that enables a DX–DOAS Unit to supply and use some return air (even if an optional VERS is not utilized) to reduce or eliminate the need for mechanical dehumidification or heating when ventilation air requirements are less than design.	All dampers that allow return air to pass into the supply airstream shall be closed and sealed. Exhaust air dampers of DOAS units with VERS shall be open. Gravity dampers activated by exhaust fan discharge airflow shall be allowed to open by action of the exhaust airflow.
VERS Bypass Dampers ..	An automatic system that enables a DX–DOAS Unit to let outdoor ventilation air and return air bypass the VERS when preconditioning of outdoor ventilation is not beneficial.	Test with the VERS bypass dampers installed, closed, and sealed. However, VERS bypass dampers may be opened if necessary for testing with deactivated VERS for Standard Rating Condition D.
Fire/Smoke/Isolation Dampers.	A damper assembly including means to open and close the damper mounted at the supply or return duct opening of the equipment.	The fire/smoke/isolation dampers shall be removed for testing. If it is not possible to remove such a damper, test with the damper fully open. For any fire/smoke/isolation dampers shipped with the unit but not factory-installed, do not install the dampers for testing.
Furnaces and Steam/Hydronic Heat Coils.	Furnaces and steam/hydronic heat coils used to provide primary or supplementary heating.	Test with the coils in place but providing no heat.
Power Correction Capacitors.	A capacitor that increases the power factor measured at the line connection to the equipment. These devices are a requirement of the power distribution system supplying the unit.	Remove power correction capacitors for testing.
Hail Guards	A grille or similar structure mounted to the outside of the unit covering the outdoor coil to protect the coil from hail, flying debris and damage from large objects.	Remove hail guards for testing.
Ducted Condenser Fans	A condenser fan/motor assembly designed for optional external ducting of condenser air that provides greater pressure rise and has a higher rated motor horsepower than the condenser fan provided as a standard component with the equipment.	Test with the ducted condenser fan installed and operating using zero external static pressure, unless the manufacturer specifies use of an external static pressure greater. than zero, in which case, use the manufacturer-specified external static pressure.
Sound Traps/Sound Attenuators.	An assembly of structures through which the supply air passes before leaving the equipment or through which the return air from the building passes immediately after entering the equipment for which the sound insertion loss is at least 6 dB for the 125 Hz octave band frequency range.	Removable sound traps/sound attenuators shall be removed for testing. Otherwise, test with sound traps/attenuators in place.
Humidifiers	A device placed in the supply air stream for moisture evaporation and distribution. The device may require building steam or water, hot water, electric or gas to operate.	Remove humidifiers for testing.
UV Lights	A lighting fixture and lamp mounted so that it shines light on the conditioning coil, that emits ultraviolet light to inhibit growth of organisms on the conditioning coil surfaces, the condensate drip pan, and/other locations within the equipment.	Remove UV lights for testing.
High-Effectiveness Indoor Air Filtration.	Indoor air filters with greater air filtration effectiveness than MERV 8 or the lowest MERV filter distributed in commerce, whichever is greater.	Test with a MERV 8 filter or the lowest MERV filter distributed in commerce, whichever is greater

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2.2.3. Optional Representations. Test provisions for the determination of the metrics indicated in paragraphs (a) through (d) of this section are optional and are determined according to the applicable provisions in section 2.2.1 of this appendix. The following metrics in AHRI 920–2020 are optional:

(a) $ISMRE2_{70}$;

(b) $COP_{Full,x}$;

(c) $COP_{DOAS,x}$; and

(d) ISMRE2 and ISCOP2 for water-cooled DX–DOASes using the ''Condenser Water Entering Temperature, Chilled Water'' conditions specified in Table 4 of AHRI 920–2020 and for water-source heat pump DX–DOASes using the ''Water-Source Heat Pump, Ground-Source Closed Loop'' conditions specified in Table 5 of AHRI 920–2020.

2.3 Synonymous Terms

(a) Any references to energy recovery or energy recovery ventilator (ERV) in AHRI 920–2020 and ANSI/ASHRAE 198–2013 shall be considered synonymous with ventilation energy recovery system (VERS) as defined in §431.92.

(b) Reserved

[87 FR 45199, July 27, 2022]

APPENDIX C TO SUBPART F OF PART 431 [RESERVED]

APPENDIX D TO SUBPART F OF PART 431—UNIFORM TEST METHOD FOR MEASURING THE ENERGY CONSUMPTION OF VARIABLE REFRIGERANT FLOW MULTI-SPLIT AIR CONDITIONERS AND HEAT PUMPS (OTHER THAN AIR-COOLED WITH RATED COOLING CAPACITY LESS THAN 65,000 BTU/H)

NOTE: Manufacturers must use the results of testing under this appendix to determine compliance with the relevant standard from §431.97 as that standard appeared in the January 1, 2022 edition of 10 CFR parts 200–499. Specifically, representations must be based upon results generated either under this appendix or under 10 CFR 431.96 as it appeared in the 10 CFR parts 200–499 edition revised as of January 1, 2022.

For any amended standards for variable refrigerant flow multi-split air conditioners and heat pumps that rely on integrated energy efficiency ratio (IEER) published after January 1, 2022, manufacturers must use the results of testing under appendix D1 of this subpart to determine compliance. Representations related to energy consumption must be made in accordance with the appropriate appendix that applies (*i.e.*, appendix D or appendix D1) when determining compliance with the relevant standard.

1. Incorporation by Reference

DOE incorporated by reference in §431.95, the entire standard for ANSI/AHRI 1230–2010. However, enumerated provisions of ANSI/AHRI 1230–2010, as listed in this section 1, are excluded. To the extent there is a conflict between the terms or provisions of a referenced industry standard and the CFR, the CFR provisions control.

1.1 ANSI/AHRI 1230–2010:

(a) Section 5.1.2—Manufacturer involvement.

(b) Section 6.6—Verification testing and uncertainty is inapplicable as specified in section 2.2 of this appendix.

1.2 [Reserved.]

2. *General.* Determine the energy efficiency ratio (EER) and coefficient of performance (COP) (as applicable) in accordance with ANSI/AHRI 1230–2010.

NOTE: Sections 3 through 6 of this appendix provide additional instructions for determining EER and COP.

3. *Optional break-in period.* Manufacturers may optionally specify a ''break-in'' period, not to exceed 20 hours, to operate the equipment under test prior to conducting the test method specified in this appendix. A manufacturer who elects to use an optional compressor break-in period in its certification testing should record this period's duration as part of the information in the supplemental testing instructions under 10 CFR 429.43.

4. *Refrigerant line length corrections.* For test set-ups where it is physically impossible for the laboratory to use the required line length listed in Table 3 of the ANSI/AHRI 1230–2010, then the actual refrigerant line length used by the laboratory may exceed the required length and the following cooling capacity correction factors are applied:

Piping length beyond minimum, X (ft)	Piping length beyond minimum, Y (m)	Cooling capacity correction (%)
0> X ≤20	0> Y ≤6.1	1
20> X ≤40	6.1> Y ≤12.2	2
40> X ≤60	12.2> Y ≤18.3	3
60> X ≤80	18.3> Y ≤24.4	4
80> X ≤100	24.4> Y ≤30.5	5
100> X ≤120	30.5>Y ≤36.6	6

5. *Additional provisions for equipment set-up*. The only additional specifications that may be used in setting up the basic model for test are those set forth in the installation and operation manual shipped with the unit. Each unit should be set up for test in accordance with the manufacturer installation and operation manuals. Sections 5.1 through 5.3 of this appendix provide specifications for addressing key information typically found in the installation and operation manuals.

5.1. If a manufacturer specifies a range of superheat, sub-cooling, and/or refrigerant pressure in its installation and operation manual for a given basic model, any value(s) within that range may be used to determine refrigerant charge or mass of refrigerant, unless the manufacturer clearly specifies a rating value in its installation and operation manual, in which case the specified rating value must be used.

5.2. The airflow rate used for testing must be that set forth in the installation and operation manual being shipped to the commercial customer with the basic model and clearly identified as that used to generate the DOE performance ratings. If a rated airflow value for testing is not clearly identified, a value of 400 standard cubic feet per minute (scfm) per ton must be used.

5.3. The test set-up and the fixed compressor speeds (*i.e.*, the maximum, minimum, and any intermediate speeds used for testing) should be recorded and maintained as part of the test data underlying the certified ratings that is required to be maintained under 10 CFR 429.71.

6. *Manufacturer involvement in assessment or enforcement testing*. A manufacturer's representative will be allowed to witness assessment and/or enforcement testing for variable refrigerant flow multi-split air conditioners and heat pumps. The manufacturer's representative will be allowed to inspect and discuss set-up only with a DOE representative. During testing, the manufacturer's representative may adjust only the modulating components that are necessary to achieve steady-state operation in the presence of a DOE representative. Only previously documented specifications for set-up as specified under sections 4 and 5 of this appendix will be used.

[87 FR 63898, Oct. 20, 2022]

Appendix D1 to Subpart F of Part 431—Uniform Test Method for Measuring the Energy Consumption of Variable Refrigerant Flow Multi-Split Air Conditioners and Heat Pumps (Other Than Air-Cooled With Rated Cooling Capacity Less Than 65,000 Btu/h)

NOTE: Manufacturers must use the results of testing under this appendix to determine compliance with any amended standards for variable refrigerant flow multi-split air conditioners and heat pumps provided in §431.97 that are published after January 1, 2022, and that rely on integrated energy efficiency ratio (IEER). Representations related to energy consumption must be made in accordance with the appropriate appendix that applies (*i.e.*, appendix D or appendix D1) when determining compliance with the relevant standard.

1. Incorporation by Reference

DOE incorporated by reference in §431.95, the entire standard for AHRI 1230–2021 and ANSI/ASHRAE 37–2009, as corrected by the Errata sheet for ANSI/ASHRAE 37–2009 issued on March 27, 2019 (''ANSI/ASHRAE 37–2009 (as corrected)''). However, only enumerated provisions of AHRI 1230–2021 and ANSI/ASHRAE 37–2009 are required or excluded, as listed in this section 1. To the extent there is a conflict between the terms or provisions of a referenced industry standard and the CFR, the CFR provisions control.

1.1 Provisions Required

1.1.1 AHRI 1230–2021

(a) Section 3—Definitions, except section 3.11, as specified in section 2 of this appendix,

(b) Section 5—Test Requirements, except section 5.1.2, as specified in sections 2 and 5.1 of this appendix,

(c) Section 6—Rating Requirements, except sections 6.3.3 and 6.5, as specified in sections 2, 4.1, 4.1.1, 4.2, 4.2.1, and 5.1 of this appendix,

(d) Section 11—Calculations is applicable as specified in sections 2, 5.2.1.2, and 5.2.2 of this appendix,

(e) Section 12—Symbols, Subscripts, and Superscripts as specified in section 2 of this appendix,

(f) Appendix E—ANSI/ASHRAE Standard 37–2009 Clarifications/Exceptions—Normative as specified in section 2 of this appendix.

1.1.2 [Reserved]

1.2 Provisions Excluded

1.2.1 ANSI/ASHRAE 37–2009 (as Corrected)

(a) Section 1—Purpose,
(b) Section 2—Scope, and

(c) Section 4—Classification.

2. *General*. Determine IEER and coefficient of performance (COP) (as applicable) in accordance with AHRI 1230–2021 and ANSI/ASHRAE 37–2009 (as corrected). Sections 3 through 5 of this appendix provide additional instructions for determining IEER and COP. In cases where there is a conflict, the language of this appendix takes highest precedence, followed by AHRI 1230–2021, followed by ANSI/ASHRAE 37–2009 (as corrected).

NOTE: The controls verification procedure specified in Appendix C of AHRI 1230–2021 is referenced as part of DOE's certification provisions at § 429.43(b) and product-specific enforcement provisions located at § 429.134(v)(3).

3. Definitions

3.1. *Critical Parameter(s)* are the following settings of modulating components of variable refrigerant flow multi-split air conditioners and heat pumps: compressor speed(s), outdoor fan speed(s), and outdoor variable valve position(s).

4. Test Conditions

4.1 *Test Conditions for Air-Cooled VRF Multi-split Systems with Rated Cooling Capacity Greater Than 65,000 Btu/h*. When testing to certify to the energy conservation standards in § 431.97, test using the "Standard Rating Conditions, Cooling" and "Standard Rating Part-Load Conditions (IEER)" conditions for cooling mode tests and "Standard Rating Conditions (High Temperature Steady-state Test for Heating)" conditions for heat pump heating mode tests, as specified in Table 9 in Section 6 of AHRI 1230–2021.

4.1.1 Representations of COP for air-cooled VRF multi-split systems with rated cooling capacity greater than 65,000 Btu/h made using the "Low Temperature Operation, Heating" condition specified in Table 9 in Section 6 of AHRI 1230–2021 are optional.

4.2 *Test Conditions for Water-source VRF Multi-split Systems*. When testing to certify to the energy conservation standards in § 431.97, test using the "Part-load Conditions (IEER)" conditions specified for "Water Loop Heat Pumps" in Table 10 of AHRI 1230–2021 for cooling mode tests and the "Standard Rating Test" conditions specified for "Water Loop Heat Pumps" in Table 11 in Section 6 of AHRI 1230–2021 for heat pump heating mode tests.

4.2.1 For water-source VRF multi-split systems, representations of EER made using the "Standard Rating Test" conditions specified for "Ground-loop Heat pumps" in Table 10 of Section 6 of AHRI 1230–2021 and representations of COP made using the "Standard Rating Test" conditions specified for "Ground-loop Heat Pumps" in Table 11 of Section 6 of AHRI 1230–2021 are optional.

5. Test Procedure

5.1 *Control Settings*. Control settings must be set in accordance with Sections 5.1.3, 5.1.4, 5.1.5, and 5.2 of AHRI 1230–2021. For systems equipped with head pressure controls, the head pressure controls must be set per manufacturer installation instructions or per factory settings if no instructions are provided. Indoor airflow-control settings must be set in accordance with Section 6.3.1 of AHRI 1230–2021. At each load point, critical parameters must be set to the values certified in the supplemental testing instructions (STI) provided by the manufacturer pursuant to § 429.43(b)(4) of this chapter. In cases in which a certified critical parameter value is not in the STI, the system must operate per commands from the system controls for that parameter. Once set, control settings must remain unchanged for the remainder of the test (except for allowable adjustment of critical parameters as described in section 5.2 of this appendix).

5.2 *Allowable Critical Parameter Adjustments for IEER Cooling Tests*. The following sections describe allowable adjustments to critical parameters after the initial system set-up (during which all control settings, including certified critical parameters, are set). Adjust critical parameters in order to achieve full- and part-load cooling capacity targets and sensible heat ratio (SHR) limits.

5.2.1 *Critical Parameter Adjustments for Meeting Cooling Capacity Targets*. Once critical parameters have been set to the values certified in the STI, if the unit cannot operate within 3% of the target cooling capacity (*i.e.*, within 3% of the load fraction for a given part-load cooling test (75%, 50%, or 25% load) or within 3% of the certified cooling capacity for a 100% full-load cooling test), manually-controlled critical parameters must be adjusted according to the following provisions:

5.2.1.1. *Cooling Capacity is Below Lower Tolerance*. If, for any test, the cooling capacity operates below the lower tolerance for the target cooling capacity, increase the compressor speed(s) beyond the STI-certified value(s) until the cooling capacity operates within 3% of the target cooling capacity. If multiple compressors are present in the system, increase compressor speed by the same absolute increment in RPM or Hz for each compressor for which the following conditions apply:

(a) The STI specifies a non-zero compressor speed for the compressor for that test and

(b) The compressor has not yet reached its maximum capable operating speed. The compressor speed(s) must not be less than the STI-certified value(s) at any point during the test. Upward adjustments to compressor speed are not constrained by a budget on RSS Points Total (See section 5.2.1.2.1 of this appendix).

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5.2.1.2 *Cooling Capacity is Above Upper Tolerance*. If, for any test, the cooling capacity operates above the upper tolerance for the target cooling capacity, adjust any manually-controlled critical parameters per the STI. If the STI does not include a hierarchy of instructions for adjustment of critical parameters to reduce cooling capacity during IEER cooling tests, then reduce only the compressor speed(s) to reduce cooling capacity. If multiple compressors are present in the system, decrease compressor speed by the same absolute increment for each compressor for which the following conditions apply:

(a) The STI specifies a non-zero compressor speed for the compressor for that test and

(b) The compressor has not yet reached minimum speed. Continue reducing cooling capacity in this manner until one of the following occurs:

(1) The unit operates within 3% of the target cooling capacity; or

(2) The RSS point total reaches a budget of 70 points (see section 5.2.1.2.1 of this appendix). For the 75%, 50%, and 25% part-load cooling test points, if the RSS point total reaches 70 during critical parameter adjustments before the capacity operates within 3% of the target cooling capacity, stop adjustment and follow cyclic degradation procedures in accordance with Section 11.2.2.1 of AHRI 1230–2021.

5.2.1.2.1 *Measuring Critical Parameter Variation During Adjustment Period*. When adjusting critical parameters to reduce cooling capacity, critical parameter variation must be calculated each time the critical parameters are adjusted, using the following equations:

(a) First, use equation 5.2–1 to calculate the absolute parameter percent difference () between each adjusted critical parameter and the value for that parameter certified in the STI.

Equation 5.2-1 $$PPD_i = \left| \frac{CP_{i,Adj} - CP_{i,STI}}{CP_{Max}} \right| \times 100$$

Where:

''i'' identifies the critical parameter—either compressors speed(s), outdoor fan speed(s), or outdoor variable valve position(s)

$CP_{i,Adj}$ = The adjusted position of critical parameter ''i'' recorded at each measurement interval. If multiple components corresponding to a single parameter are present (e.g., multiple compressors), calculate the average position across all components corresponding to that parameter at each measurement interval when determining $CP_{i,Adj}$.

$CP_{i,STI}$ = The position of critical parameter ''i'' as certified in the STI. If multiple components corresponding to a single parameter are present, calculate the average position across all components corresponding to that parameter at each measurement interval when determining $CP_{i,STI}$.

CP_{Max} = The maximum operating position for Critical Parameter ''i'' as certified in the STI for the 100% load condition. If multiple components corresponding to a single parameter are present, calculate as the average value across all components corresponding to that critical parameter certified in the STI for the 100% load condition.

(b) Next, use equation 5.2–2 to this section to determine the accrued points for each critical parameter:

Equation 5.2-2 $$Points_i = PPD_i \times NPV_i$$

Where:

''i'' identifies the critical parameter—either compressors speed(s), outdoor fan speed(s), or outdoor variable valve position(s)

NPV_i = the nominal point value for critical parameter ''i'' as follows:

TABLE 5.1—CRITICAL PARAMETER NOMINAL POINT VALUES

Critical parameter	Nominal point value
Compressor Speed(s)	13
Outdoor Fan Speed(s)	7
Outdoor Variable Valve Position(s)	1

(c) Finally, use equation 5.2–3 to this section to calculate the root-sum-squared (RSS) Points Total across all critical parameters.

Equation 5.2-3 $$RSS\ Points = \sqrt{\left(Points_{Compressors}\right)^2 + (Points_{Fans})^2 + (Points_{Valves})^2}$$

5.2.2 *Critical Parameter Adjustments for Meeting SHR Limits*. The SHR for the 100% load test point and the 75% part-load test point must not be higher than 0.82 and 0.85, respectively (measured to the nearest hundredth). If the SHR is above the allowable limit, increase the compressor speed(s) until either the SHR is less than or equal to the allowable limit or the cooling capacity reaches 3% greater than the target cooling capacity for that test, whichever happens first. If multiple compressors are present in the system, increase compressor speed by the same absolute increment for each compressor for which the following conditions apply:

(a) The STI specifies a non-zero compressor speed for the compressor for that test and

(b) The compressor has not yet reached maximum speed. Upwards adjustments to compressor speed are not constrained by a budget on RSS Points Total. Should the SHR remain above the maximum limit when the cooling capacity reaches its upper 3% tolerance, no further compressor adjustments shall be made, and the calculation procedures specified in Section 11.2.2.2 of AHRI 1230–2021 must be applied using the adjusted SHR value obtained after increasing the compressor speed(s).

6. *Set-Up and Test Provisions for Specific Components*. When testing a VRF multi-split system that includes any of the specific components listed in table 6.1 to this appendix, test in accordance with the set-up and test provisions specified in table 6.1.

TABLE 6.1—TEST PROVISIONS FOR SPECIFIC COMPONENTS

Component	Description	Test provisions
Desiccant Dehumidification Components.	An assembly that reduces the moisture content of the supply air through moisture transfer with solid or liquid desiccants.	Disable desiccant dehumidification components for testing.
Air Economizers	An automatic system that enables a cooling system to supply outdoor air to reduce or eliminate the need for mechanical cooling during mild or cold weather.	For any air economizer that is factory-installed, place the economizer in the 100% return position and close and seal the outside air dampers for testing. For any modular air economizer shipped with the unit but not factory-installed, do not install the economizer for testing.
Fresh Air Dampers	An assembly with dampers and means to set the damper position in a closed and one open position to allow air to be drawn into the equipment when the indoor fan is operating.	For any fresh air dampers that are factory-installed, close and seal the dampers for testing. For any modular fresh air dampers shipped with the unit but not factory-installed, do not install the dampers for testing.
Hail Guards	A grille or similar structure mounted to the outside of the unit covering the outdoor coil to protect the coil from hail, flying debris, and damage from large objects.	Remove hail guards for testing.
Low Ambient Cooling Dampers.	An assembly with dampers and means to set the dampers in a position to recirculate the warmer condenser discharge air to allow for reliable operation at low outdoor ambient conditions.	Remove low ambient cooling dampers for testing.
Power Correction Capacitors.	A capacitor that increases the power factor measured at the line connection to the equipment. These devices are a requirement of the power distribution system supplying the unit.	Remove power correction capacitors for testing.
Ventilation Energy Recovery Systems (VERS).	An assembly that preconditions outdoor air entering the equipment through direct or indirect thermal and/or moisture exchange with the exhaust air, which is defined as the building air being exhausted to the outside from the equipment.	For any VERS that is factory-installed, place the VERS in the 100% return position and close and seal the outside air dampers and exhaust air dampers for testing, and do not energize any VERS subcomponents (e.g., energy recovery wheel motors). For any VERS module shipped with the unit but not factory-installed, do not install the VERS for testing.

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[87 FR 63898, Oct. 20, 2022]

APPENDIX E TO SUBPART F OF PART 431 [RESERVED]

EFFECTIVE DATE NOTE: At 87 FR 75169, Dec. 7, 2022, appendix E to subpart F of part 431 was added and reserved, effective Jan. 6, 2023.

APPENDIX F TO SUBPART F OF PART 431—UNIFORM TEST METHOD FOR THE MEASUREMENT OF ENERGY CONSUMPTION OF AIR-COOLED, THREE-PHASE, SMALL COMMERCIAL PACKAGE AIR CONDITIONING AND HEATING EQUIPMENT WITH A COOLING CAPACITY OF LESS THAN 65,000 BTU/H AND AIR-COOLED, THREE-PHASE, VARIABLE REFRIGERANT FLOW MULTI-SPLIT AIR CONDITIONERS AND HEAT PUMPS WITH A COOLING CAPACITY OF LESS THAN 65,000 BTU/H

NOTE: Manufacturers must use the results of testing under this appendix to determine compliance with the relevant standard from §431.97 as that standard appeared in the January 1, 2022, edition of 10 CFR parts 200–499. Specifically, representations must be based upon results generated either under this appendix or under 10 CFR 431.96 as it appeared in the 10 CFR parts 200–499 edition revised as of January 1, 2021.

For any amended standards for air-cooled, three-phase, small commercial package air conditioning and heating equipment with a cooling capacity of less than 65,000 Btu/h and air-cooled, three-phase, variable refrigerant flow multi-split air conditioners and heat pumps with a cooling capacity of less than 65,000 Btu/h that rely on SEER2 and HSPF2 published after January 1, 2021, manufacturers must use the results of testing under appendix F1 to determine compliance. Representations related to energy consumption must be made in accordance with the appropriate appendix that applies (*i.e.*, appendices F or F1) when determining compliance with the relevant standard. Manufacturers may also use appendix F1 to certify compliance with any amended standards that rely on SEER2 and HSPF2 prior to the applicable compliance date for those standards.

1. INCORPORATION BY REFERENCE

DOE incorporated by reference in §431.95, the entire standard for ANSI/AHRI 210/240–2008 and ANSI/AHRI 1230–2010. However, certain enumerated provisions of those standards, as set forth in this section 1, are inapplicable. To the extent there is a conflict between the terms or provisions of a referenced industry standard and the CFR, the CFR provisions control.

1.1 ANSI/AHRI 210/240–2008:

(a) Section 6.5—*Tolerances*

(b) Reserved.

1.2 ANSI/AHRI 1230–2010:

(a) Section 5.1.2—*Manufacturer involvement*

(b) Section 6.6—*Verification testing and uncertainty*

2. GENERAL

2.1 Air-cooled, three-phase, small commercial package air conditioning and heating equipment with a cooling capacity of less than 65,000 Btu/h. Determine the seasonal energy efficiency ratio (SEER) and heating seasonal performance factor (HSPF) (as applicable) in accordance with ANSI/AHRI 210/240–2008. Sections 3 to 6 of this appendix provide additional instructions for determining SEER and HSPF.

2.2 Air-cooled, three-phase, variable refrigerant flow multi-split air conditioners and heat pumps with a cooling capacity of less than 65,000 Btu/h. Determine the SEER and HSPF (as applicable) in accordance with ANSI/AHRI 1230–2010.

Sections 3 through 6 of this appendix provide additional instructions for determining SEER and HSPF.

3. *Optional break-in period*. Manufacturers may optionally specify a ''break-in'' period, not to exceed 20 hours, to operate the equipment under test prior to conducting the test method specified in this appendix. A manufacturer who elects to use an optional compressor break-in period in its certification testing should record this period's duration as part of the information in the supplemental testing instructions under 10 CFR 429.43.

4. *Additional provisions for equipment set-up*. The only additional specifications that may be used in setting up the basic model for test are those set forth in the installation and operation manual shipped with the unit. Each unit should be set up for test in accordance with the manufacturer installation and operation manuals. Sections 3.1 through 3.3 of this appendix provide specifications for addressing key information typically found in the installation and operation manuals.

4.1. If a manufacturer specifies a range of superheat, sub-cooling, and/or refrigerant pressure in its installation and operation manual for a given basic model, any value(s) within that range may be used to determine refrigerant charge or mass of refrigerant, unless the manufacturer clearly specifies a rating value in its installation and operation manual, in which case the specified rating value shall be used.

4.2. The airflow rate used for testing must be that set forth in the installation and operation manuals being shipped to the commercial customer with the basic model and clearly identified as that used to generate the DOE performance ratings. If a rated airflow value for testing is not clearly identified, a value of 400 standard cubic feet per minute (scfm) per ton shall be used.

4.3. For air-cooled, three-phase, variable refrigerant flow multi-split air conditioners and heat pumps with a cooling capacity of less than 65,000 Btu/h, the test set-up and the fixed compressor speeds (*i.e.*, the maximum, minimum, and any intermediate speeds used for testing) should be recorded and maintained as part of the test data underlying the certified ratings that is required to be maintained under 10 CFR 429.71.

5. *Refrigerant line length corrections for air-cooled, three-phase, variable refrigerant flow multi-split air conditioners and heat pumps with a cooling capacity of less than 65,000 Btu/h.* For test setups where it is physically impossible for the laboratory to use the required line length listed in Table 3 of ANSI/AHRI 1230–2010, then the actual refrigerant line length used by the laboratory may exceed the required length and the following cooling capacity correction factors are applied:

Piping length beyond minimum, X (ft)	Piping length beyond minimum, Y (m)	Cooling capacity correction (%)
0≤X ≤20	0≤Y ≤6.1	1
20≤X ≤40	6.1≤Y ≤12.2	2
40≤X ≤60	12.2≤Y ≤18.3	3
60≤X ≤80	18.3≤Y ≤24.4	4
80≤X ≤100	24.4≤Y ≤30.5	5
100 >X ≤120	30.5≤Y ≤36.6	6

6. *Manufacturer involvement in assessment or enforcement testing for air-cooled, three-phase, variable refrigerant flow multi-split air conditioners and heat pumps with a cooling capacity of less than 65,000 Btu/h.* A manufacturer's representative will be allowed to witness assessment and/or enforcement testing. The manufacturer's representative will be allowed to inspect and discuss set-up only with a DOE representative and adjust only the modulating components during testing in the presence of a DOE representative that are necessary to achieve steady-state operation. Only previously documented specifications for set-up as specified under sections 3 and 4 of this appendix will be used.

[87 FR 77327, Dec. 16, 2022; 87 FR 78513, Dec. 22, 2022]

EFFECTIVE DATE NOTE: At 87 FR 77327, Dec. 16, 2022, appendix F to subpart F of part 431 was added, effective Jan. 17, 2023. At 87 FR 78513, Dec. 22, 2022, the amendment was corrected, effective Jan. 17, 2023.

APPENDIX F1 TO SUBPART F OF PART 431—UNIFORM TEST METHOD FOR THE MEASUREMENT OF ENERGY CONSUMPTION OF AIR-COOLED, THREE-PHASE, SMALL COMMERCIAL PACKAGE AIR CONDITIONING AND HEATING EQUIPMENT WITH A COOLING CAPACITY OF LESS THAN 65,000 BTU/H AND AIR-COOLED, THREE-PHASE, VARIABLE REFRIGERANT FLOW MULTI-SPLIT AIR CONDITIONERS AND HEAT PUMPS WITH A COOLING CAPACITY OF LESS THAN 65,000 BTU/H

NOTE: Manufacturers must use the results of testing under this appendix to determine compliance with any amended standards for air-cooled, three-phase, small commercial package air conditioning and heating equipment with a cooling capacity of less than 65,000 Btu/h and air-cooled, three-phase, variable refrigerant flow multi-split air conditioners and heat pumps with a cooling capacity of less than 65,000 Btu/h provided in §431.97 that are published after January 1, 2021, and that rely on seasonal energy efficiency ratio 2 (SEER2) and heating seasonal performance factor 2 (HSPF2). Representations related to energy consumption must be made in accordance with the appropriate appendix that applies (*i.e.*, appendices F or F1) when determining compliance with the relevant standard. Manufacturers may also use this appendix to certify compliance with any amended standards that rely on SEER2 and HSPF2 prior to the applicable compliance date for those standards.

1. *Incorporation by Reference.* DOE incorporated by reference in §431.95, the entire standard for AHRI 210/240–2023 and ANSI/ASHRAE 37–2009. However, certain enumerated provisions of AHRI 210/240–2023 and ANSI/ASHRAE 37–2009, as set forth in this section 1, are inapplicable. To the extent there is a conflict between the terms or provisions of a referenced industry standard and the CFR, the CFR provisions control. Any subsequent amendment to a referenced document by the standard-setting organization will not affect the test procedure in this appendix, unless and until the test procedure is amended by DOE.

1.1. AHRI 210/240–2023:

(a) Section 6 Rating Requirements—6.1 Standard Ratings—6.1.8 Tested Combinations or Tested Units

(b) Section 6 Rating Requirements—6.2 Application Ratings

(c) Section 6 Rating Requirements—6.4 Ratings

(d) Section 6 Rating Requirements—6.5 Uncertainty and Variability

(e) Section 7—Minimum Data Requirements for Published Ratings

(f) Section 8—Operating Requirements

(g) Section 9—Marking and Nameplate Data
(h) Section 10—Conformance Conditions
(i) Appendix C—Certification of Laboratory Facilities Used to Determine Performance of Unitary Air-Conditioning & Air-Source Heat Pump Equipment—Informative
(j) Appendix F—ANSI/ASHRAE Standard 116–2010 Clarifications/Exceptions—Normative—F15.2 and F17
(k) Appendix G—Unit Configuration for Standard Efficiency Determination—Normative
(l) Appendix H—Off-Mode Testing—Normative
(m) Appendix I Verification Testing—Normative

1.2. ANSI/ASHRAE 37–2009:

(a) Section 1—Purpose
(b) Section 2—Scope
(c) Section 4—Classification

2. *General.* Determine the seasonal energy efficiency ratio 2 (SEER2) and heating seasonal performance factor 2 (HSPF2) (as applicable) in accordance with AHRI 210/240–2023 and ANSI/ASHRAE 37–2009. Sections 3 and 4 to this appendix provide additional instructions for determining SEER2 and HSPF2.

3. *Energy Measurement Accuracy.* The Watt-hour (W·h) measurement system(s) shall be accurate within ± 0.5 percent or 0.5 W·h, whichever is greater, for both ON and OFF cycles. If two measurement systems are used, then the meters shall be switched within 15 seconds of the start of the OFF cycle and switched within 15 seconds prior to the start of the ON cycle.

4. *Cycle Stability Requirements.* Conduct three complete compressor OFF/ON cycles. Calculate the degradation coefficient CD for each complete cycle. If all three CD values are within 0.02 of the average CD then stability has been achieved, and the highest CD value of these three shall be used. If stability has not been achieved, conduct additional cycles, up to a maximum of eight cycles total, until stability has been achieved between three consecutive cycles. Once stability has been achieved, use the highest CD value of the three consecutive cycles that establish stability. If stability has not been achieved after eight cycles, use the highest CD from cycle one through cycle eight, or the default CD, whichever is lower.

[87 FR 77328, Dec. 16, 2022]

EFFECTIVE DATE NOTE: At 87 FR 77328, Dec. 16, 2022, appendix F1 to subpart F of part 431 was added, effective Jan. 17, 2023.

APPENDIX G TO SUBPART F OF PART 431—UNIFORM TEST METHOD FOR MEASURING THE ENERGY CONSUMPTION OF SINGLE PACKAGE VERTICAL AIR CONDITIONERS AND SINGLE PACKAGE VERTICAL HEAT PUMPS

NOTE: Prior to December 4, 2023, manufacturers must use the results of testing under either this appendix or § 431.96 as it appeared in the 10 CFR parts 200–499 edition revised as of January 1, 2021, to determine compliance with the relevant standard from § 431.97 as that standard appeared in the January 1, 2021, edition of 10 CFR parts 200–499. On or after December 4, 2023, manufacturers must use the results of testing generated under this appendix to demonstrate compliance with the relevant standard from § 431.97 as that standard appeared in the January 1, 2021, edition of 10 CFR parts 200–499.

Beginning December 4, 2023, if manufacturers make voluntary representations with respect to the integrated energy efficiency ratio (IEER) of single packaged vertical air conditioners and single package vertical heat pumps, such representations must be based on testing conducted in accordance with appendix G1 to this subpart.

For any amended standards for single packaged vertical air conditioners and single package vertical heat pumps based on IEER published after January 1, 2021, manufacturers must use the results of testing under appendix G1 to this subpart to determine compliance. Representations related to energy consumption must be made in accordance with the appropriate appendix that applies (*i.e.*, this appendix or appendix G1) when determining compliance with the relevant standard. Manufacturers may also use appendix G1 to certify compliance with any amended standards prior to the applicable compliance date for those standards.

1. Incorporation by Reference.

DOE incorporated by reference in § 431.95 the entire standard for AHRI 390–2021 and ASHRAE 37–2009. However, only certain enumerated provisions of AHRI 390–2021 and ANSI/ASHRAE 37–2009 are required or excluded as listed in this section 1. To the extent there is a conflict between the terms or provisions of a referenced industry standard and this appendix, the appendix provisions control, followed by AHRI 390–2021, followed by ANSI/ASHRAE 37–2009.

1.1. Only the following provisions of AHRI 390–2021 apply:

(a) Section 3—Definitions (omitting sections 3.1, 3.2, 3.5, 3.12, and 3.15)
(b) Section 5—Test Requirements (omitting section 5.8.5)
(c) Section 6—Rating Requirements (omitting sections 6.1.1 and 6.2 through 6.5)
(d) Appendix A. ''References—Normative''

(e) Appendix D. ''Indoor and Outdoor Air Condition Measurement—Normative''
(f) Appendix E. ''Method of Testing Single Package Vertical Units—Normative''

1.2. All provisions of ANSI/ASHRAE 37–2009 apply except for the following provisions:

(a) Section 1—Purpose
(b) Section 2—Scope
(c) Section 4—Classifications

2. General. Determine cooling capacity (Btu/h) and energy efficiency ratio (EER) for all single package vertical air conditioners and heat pumps and coefficient of performance (COP) for all single package vertical heat pumps, in accordance with the specified sections of AHRI 390–2021 and the specified sections of ANSI/ASHRAE 37–2009. Only identified provisions of AHRI 390–2021 are applicable and certain sections of ANSI/ASHRAE 37–2009 are inapplicable, as set forth in section 1 of this appendix. In addition, the instructions in section 3 of this appendix apply to determining EER and COP. Any subsequent amendment to a referenced document by a standard-setting organization will not affect the test procedure in this appendix, unless and until the test procedure is amended by DOE.

3. Test Conditions. The ''Standard Rating Full Load Capacity Test, Cooling'' conditions for cooling mode tests and ''Standard Rating Full Load Capacity Test, Heating'' conditions for heat pump heating mode tests specified in Table 3 of section 5.8.3 of AHRI 390–2021 shall be used.

3.1. Optional Representations. Representations of COP for single package vertical heat pumps made using the ''Low Temperature Operation, Heating'' condition specified in Table 3 of section 5.8.3 of AHRI 390–2021 are optional and are determined according to the applicable provisions in section 1 of this appendix.

3.2. [Reserved]

[87 FR 75169, Dec. 7, 2022]

EFFECTIVE DATE NOTE: At 87 FR 75169, Dec. 7, 2022, appendix G to subpart F of part 431 was added, effective Jan. 6, 2023.

APPENDIX G1 TO SUBPART F OF PART 431—UNIFORM TEST METHOD FOR MEASURING THE ENERGY CONSUMPTION OF SINGLE PACKAGE VERTICAL AIR CONDITIONERS AND SINGLE PACKAGE VERTICAL HEAT PUMPS

NOTE: Beginning December 4, 2023, if manufacturers make voluntary representations with respect to the integrated energy efficiency ratio (IEER) of single packaged vertical air conditioners and single package vertical heat pumps, such representations must be based on testing conducted in accordance with this appendix.

Manufacturers must use the results of testing under this appendix to determine compliance with any amended standards for single packaged vertical air conditioners and single package vertical heat pumps based on IEER provided in §431.97 that are published after January 1, 2021. Representations related to energy consumption must be made in accordance with the appropriate appendix that applies (*i.e.*, appendix G to this subpart or this appendix) when determining compliance with the relevant standard. Manufacturers may also use this appendix to certify compliance with any amended standards prior to the applicable compliance date for those standards.

1. Incorporation by Reference

DOE incorporated by reference in §431.95 the entire standard for AHRI 390–2021 and ASHRAE 37–2009. However, only certain enumerated provisions of AHRI 390–2021 and ANSI/ASHRAE 37–2009 are required or excluded as listed in this section 1. To the extent there is a conflict between the terms or provisions of a referenced industry standard and this appendix, the appendix provisions control, followed by AHRI 390–2021, followed by ANSI/ASHRAE 37–2009.

1.1. Only the following provisions of AHRI 390–2021 apply:

(a) Section 3—Definitions (omitting sections 3.1, 3.2, 3.5, 3.12, and 3.15)
(b) Section 5—Test Requirements (omitting section 5.8.5)
c) Section 6—Rating Requirements (omitting sections 6.1.1 and 6.3 through 6.5)
(d) Appendix A. ''References—Normative''
(e) Appendix D. ''Indoor and Outdoor Air Condition Measurement—Normative''
(f) Appendix E. ''Method of Testing Single Package Vertical Units—Normative''

1.2. All provisions of ANSI/ASHRAE 37–2009 apply except for the following provisions:

(a) Section 1—Purpose
(b) Section 2—Scope
(c) Section 4—Classifications

2. General. Determine cooling capacity (Btu/h) and integrated energy efficiency ratio (IEER) for all single package vertical air conditioners and heat pumps and coefficient of performance (COP) for all single package vertical heat pumps, in accordance with the specified sections of AHRI 390–2021and the specified sections of ANSI/ASHRAE 37–2009. Only identified provisions of AHRI 390–2021 and ANSI/ASHRAE 37–2009 are applicable, as set forth in section 1 of this appendix. In addition, the instructions in section 4 of this appendix apply to determining IEER and COP. Any subsequent amendment to a referenced document by a standard-setting organization will not affect the test procedure in this appendix, unless and until the test procedure is amended by DOE.

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3. *Test Conditions*. The "Part-Load Standard Rating Conditions" conditions for cooling mode tests and "Standard Rating Full Load Capacity Test, Heating" conditions for heat pump heating mode tests specified in Table 3 of section 5.8.3 of AHRI 390–2021 shall be used.

3.1. *Optional Representations*. Representations of COP for single package vertical heat pumps made using the "Low Temperature Operation, Heating" condition specified in Table 3 of section 5.8.3 of AHRI 390–2021 are optional and are determined according to the applicable provisions in section 1.1 of this appendix.

4. *Set-Up and Test Provisions for Specific Components*. When testing a single package vertical unit (SPVU) that includes any of the features listed in table 4.1 to this appendix, test in accordance with the set-up and test provisions specified in table 4.1 to this appendix.

TABLE 4.1—TEST PROVISIONS FOR SPECIFIC COMPONENTS

Component	Description	Test provisions
Desiccant Dehumidification Components.	An assembly that reduces the moisture content of the supply air through moisture transfer with solid or liquid desiccants.	Disable desiccant dehumidification components for testing.
Air Economizers	An automatic system that enables a cooling system to supply outdoor air to reduce or eliminate the need for mechanical cooling during mid or cold weather.	For any air economizer that is factory-installed, place the economizer in the 100% return position and close and seal the outside air dampers for testing. For any modular air economizer shipped with the unit but not factory-installed, do not install the economizer for testing.
Fresh Air Dampers	An assembly with dampers and means to set the damper position in a closed and one open position to allow air to be drawn into the equipment when the indoor fan is operating.	For any fresh air dampers that are factory-installed, close and seal the dampers for testing. For any modular fresh air dampers shipped with the unit but not factory-installed, do not install the dampers for testing.
Hail Guards	A grille or similar structure mounted to the outside of the unit covering the outdoor coil to protect the coil from hail, flying debris and damage from large objects.	Remove hail guards for testing.
Power Correction Capacitors	A capacitor that increases the power factor measured at the line connection to the equipment.	Remove power correction capacitors for testing.
Ventilation Energy Recovery System (VERS).	An assembly that preconditions outdoor air entering the equipment through direct or indirect thermal and/or moisture exchange with the exhaust air, which is defined as the building air being exhausted to the outside from the equipment.	For any VERS that is factory-installed, place the VERS in the 100% return position and close and seal the outside air dampers and exhaust air dampers for testing, and do not energize any VERS subcomponents (*e.g.,* energy recovery wheel motors). For any VERS module shipped with the unit but not factory-installed, do not install the VERS for testing.
Barometric Relief Dampers	An assembly with dampers and means to automatically set the damper position in a closed position and one or more open positions to allow venting directly to the outside a portion of the building air that is returning to the unit, rather than allowing it to recirculate to the indoor coil and back to the building.	For any barometric relief dampers that are factory-installed, close and seal the dampers for testing. For any modular barometric relief dampers shipped with the unit but not factory-installed, do not install the dampers for testing.
UV Lights	A lighting fixture and lamp mounted so that it shines light on the indoor coil, that emits ultraviolet light to inhibit growth of organisms on the indoor coil surfaces, the condensate drip pan, and/other locations within the equipment.	Turn off UV lights for testing.
Steam/Hydronic Heat Coils	Coils used to provide supplemental heating	Test with steam/hydronic heat coils in place but providing no heat.
Hot Gas Reheat	A heat exchanger located downstream of the indoor coil that heats the Supply Air during cooling operation using high pressure refrigerant in order to increase the ratio of moisture removal to Cooling Capacity provided by the equipment.	De-activate refrigerant reheat coils for testing so as to provide the minimum (none if possible) reheat achievable by the system controls.

TABLE 4.1—TEST PROVISIONS FOR SPECIFIC COMPONENTS—Continued

Component	Description	Test provisions
Sound Traps/Sound Attenuators.	An assembly of structures through which the Supply Air passes before leaving the equipment or through which the return air from the building passes immediately after entering the equipment for which the sound insertion loss is at least 6 dB for the 125 Hz octave band frequency range.	Removable sound traps/sound attenuators shall be removed for testing. Otherwise, test with sound traps/attenuators in place.
Fire/Smoke/Isolation Dampers	A damper assembly including means to open and close the damper mounted at the supply or return duct opening of the equipment.	For any fire/smoke/isolation dampers that are factory-installed, set the dampers in the fully open position for testing. For any modular fire/smoke/isolation dampers shipped with the unit but not factory-installed, do not install the dampers for testing.

[87 FR 75170, Dec. 7, 2022]

EFFECTIVE DATE NOTE: At 87 FR 75170, Dec. 7, 2022, appendix G1 to subpart F of part 431 was added, effective Jan. 6, 2023.

Subpart G—Commercial Water Heaters, Hot Water Supply Boilers and Unfired Hot Water Storage Tanks

SOURCE: 69 FR 61983, Oct. 21, 2004, unless otherwise noted.

§431.101 Purpose and scope.

This subpart contains energy conservation requirements for certain commercial water heaters, hot water supply boilers and unfired hot water storage tanks, pursuant to Part C of Title III of the Energy Policy and Conservation Act, as amended, 42 U.S.C. 6311–6317.

[69 FR 61983, Oct. 21, 2004, as amended at 70 FR 60415, Oct. 18, 2005]

§431.102 Definitions concerning commercial water heaters, hot water supply boilers, unfired hot water storage tanks, and commercial heat pump water heaters.

The following definitions apply for purposes of this subpart G, and of subparts J through M of this part. Any words or terms not defined in this section or elsewhere in this part shall be defined as provided in section 340 of the Act, 42 U.S.C. 6311.

Air-source commercial heat pump water heater means a commercial heat pump water heater that utilizes indoor or outdoor air as the heat source.

Basic model means all water heaters, hot water supply boilers, or unfired hot water storage tanks manufactured by one manufacturer within a single equipment class, having the same primary energy source (e.g., gas or oil) and that have essentially identical electrical, physical and functional characteristics that affect energy efficiency.

Coefficient of performance (COP_h) means the dimensionless ratio of the rate of useful heat transfer gained by the water (expressed in Btu/h), to the rate of electric power consumed during operation (expressed in Btu/h).

Commercial heat pump water heater (CHPWH) means a water heater (including all ancillary equipment such as fans, blowers, pumps, storage tanks, piping, and controls, as applicable) that uses a refrigeration cycle, such as vapor compression, to transfer heat from a low-temperature source to a higher-temperature sink for the purpose of heating potable water, and has a rated electric power input greater than 12 kW. Such equipment includes, but is not limited to, air-source heat pump water heaters, water-source heat pump water heaters, and direct geo-exchange heat pump water heaters.

Direct geo-exchange commercial heat pump water heater means a commercial heat pump water heater that utilizes the earth as a heat source and allows for direct exchange of heat between the earth and the refrigerant in the evaporator coils.

Flow-activated instantaneous water heater means an instantaneous water heater or hot water supply boiler that activates the burner or heating element only if heated water is drawn from the unit.

Fuel input rate means the maximum measured rate at which gas-fired or oil-fired commercial water heating equipment uses energy as determined using test procedures prescribed under § 431.106 of this part.

Ground-source closed-loop commercial heat pump water heater means a commercial heat pump water heater that utilizes a fluid circulated through a closed piping loop as a medium to transfer heat from the ground to the refrigerant in the evaporator. The piping loop may be buried inside the ground in horizontal trenches or vertical bores, or submerged in a surface water body.

Ground water-source commercial heat pump water heater means a commercial heat pump water heater that utilizes ground water as the heat source.

Hot water supply boiler means a packaged boiler (defined in § 431.82 of this part) that is industrial equipment and that:

(1) Has a rated input from 300,000 Btu/h to 12,500,000 Btu/h and of at least 4,000 Btu/h per gallon of stored water;

(2) Is suitable for heating potable water; and

(3) Meets either or both of the following conditions:

(i) It has the temperature and pressure controls necessary for heating potable water for purposes other than space heating; or

(ii) The manufacturer's product literature, product markings, product marketing, or product installation and operation instructions indicate that the boiler's intended uses include heating potable water for purposes other than space heating.

Indoor water-source commercial heat pump water heater means a commercial heat pump water heater that utilizes indoor water as the heat source.

Instantaneous water heater means a water heater that uses gas, oil, or electricity, including:

(1) Gas-fired instantaneous water heaters with a rated input both greater than 200,000 Btu/h and not less than 4,000 Btu/h per gallon of stored water;

(2) Oil-fired instantaneous water heaters with a rated input both greater than 210,000 Btu/h and not less than 4,000 Btu/h per gallon of stored water; and

(3) Electric instantaneous water heaters with a rated input both greater than 12 kW and not less than 4,000 Btu/h per gallon of stored water.

Rated input means the maximum rate at which commercial water heating equipment is rated to use energy as specified on the nameplate.

R-value means the thermal resistance of insulating material as determined using ASTM C177–13 or C518–15 (incorporated by reference; see § 431.105) and expressed in (°F·ft^2·h/Btu).

Residential-duty commercial water heater means any gas-fired storage, oil-fired storage, or electric instantaneous commercial water heater that meets the following conditions:

(1) For models requiring electricity, uses single-phase external power supply;

(2) Is not designed to provide outlet hot water at temperatures greater than 180 °F; and

(3) Does not meet any of the following criteria:

Water heater type	Indicator of non-residential application
Gas-fired Storage.	Rated input >105 kBtu/h; Rated storage volume >120 gallons.
Oil-fired Storage.	Rated input >140 kBtu/h; Rated storage volume >120 gallons.
Electric Instantaneous.	Rated input >58.6 kW; Rated storage volume >2 gallons.

Standby loss means:

(1) For electric commercial water heating equipment (not including commercial heat pump water heaters), the average hourly energy required to maintain the stored water temperature expressed as a percent per hour (%/h) of the heat content of the stored water above room temperature and determined in accordance with appendix B or D to subpart G of part 431 (as applicable), denoted by the term "S"; or

(2) For gas-fired and oil-fired commercial water heating equipment, the average hourly energy required to maintain the stored water temperature expressed in British thermal units per hour (Btu/h) based on a 70 °F temperature differential between stored water and ambient room temperature and determined in accordance with appendix

A or C to subpart G of part 431 (as applicable), denoted by the term ''SL.''

Storage-type instantaneous water heater means an instantaneous water heater that includes a storage tank with a storage volume greater than or equal to 10 gallons.

Storage water heater means a water heater that uses gas, oil, or electricity to heat and store water within the appliance at a thermostatically-controlled temperature for delivery on demand, including:

(1) Gas-fired storage water heaters with a rated input both greater than 75,000 Btu/h and less than 4,000 Btu/h per gallon of stored water;

(2) Oil-fired storage water heaters with a rated input both greater than 105,000 Btu/h and less than 4,000 Btu/h per gallon of stored water; and

(3) Electric storage water heaters with a rated input both greater than 12 kW and less than 4,000 Btu/h per gallon of stored water.

Tank surface area means, for the purpose of determining portions of a tank requiring insulation, those areas of a storage tank, including hand holes and manholes, in its uninsulated or pre-insulated state, that do not have pipe penetrations or tank supports attached.

Thermal efficiency for an instantaneous water heater, a storage water heater or a hot water supply boiler means the ratio of the heat transferred to the water flowing through the water heater to the amount of energy consumed by the water heater as measured during the thermal efficiency test procedure prescribed in this subpart.

Unfired hot water storage tank means a tank used to store water that is heated externally, and that is industrial equipment.

[69 FR 61983, Oct. 21, 2004, as amended at 76 FR 12503, Mar. 7, 2011; 78 FR 79599, Dec. 31, 2013; 79 FR 40586, July 11, 2014; 81 FR 79321, Nov. 10, 2016]

TEST PROCEDURES

§ 431.105 Materials incorporated by reference.

(a) *General*. DOE incorporates by reference the following test procedures into subpart G of part 431. The materials listed have been approved for incorporation by reference by the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. Any subsequent amendment to the listed materials by the standard-setting organization will not affect the DOE regulations unless and until such regulations are amended by DOE. Materials are incorporated as they exist on the date of the approval, and a notice of any change in the materials will be published in the FEDERAL REGISTER. All approved materials are available for inspection at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call (202) 741–6030, or go to: *http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html*. Also, this material is available for inspection at U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Program, 6th Floor, 950 L'Enfant Plaza, SW., Washington, DC 20024, (202) 586–2945, or go to: *http://www1.eere.energy.gov/buildings/appliance_standards* The referenced test procedure standards are listed below by relevant standard-setting organization, along with information on how to obtain copies from those sources.

(b) *ASHRAE*. American Society of Heating, Refrigerating and Air-Conditioning Engineers, 1791 Tullie Circle NE. Atlanta, GA 30329, (800) 527–4723, or go to *https://www.ashrae.org*.

(1) ANSI/ASHRAE Standard 118.1–2012, ''Method of Testing for Rating Commercial Gas, Electric, and Oil Service Water-Heating Equipment,'' approved by ASHRAE on October 26, 2012, IBR approved for appendix E to this subpart, as follows:

(i) Section 3—Definitions and Symbols;

(ii) Section 4—Classifications by Mode of Operation (sections 4.4, and 4.5 only);

(iii) Section 6—Instruments (except sections 6.3, 6.4 and 6.6);

(iv) Section 7—Apparatus (except section 7.4, Figures 1 through 4, section 7.7.5, Table 2, and section 7.7.7.4);

(v) Section 8—Methods of Testing:

(A) Section 8.2—Energy Supply, Section 8.2.1—Electrical Supply;

(B) Section 8.7—Water Temperature Control;

(vi) Section 9—Test Procedures: 9.1—Input Rating, Heating Capacity, Thermal Efficiency, Coefficient of Performance (COP), and Recovery Rating; 9.1.1—Full Input Rating;

(vii) Section 10—Calculation of Results: Section 10.3—Heat-Pump Water Heater Water-Heating Capacity, Coefficient of Performance (COP), and Recovery Rating; Section 10.3.1—Type IV and Type V Full-Capacity Test Method.

(2) [Reserved]

(c) *ASTM*. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428–2959, (610) 832–9585, or go to *http://www.astm.org*.

(1) ASTM C177–13, ''Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus,'' approved September 15, 2013, IBR approved for § 431.102.

(2) ASTM C518–15, ''Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus,'' approved September 1, 2015, IBR approved for § 431.102t.

(3) ASTM D2156–09 (Reapproved 2013), ''Standard Test Method for Smoke Density in Flue Gases from Burning Distillate Fuels,'' approved October 1, 2013, IBR approved for appendices A and C to this subpart.

(d) CSA Group, 5060 Spectrum Way, Suite 100, Mississauga, Ontario, Canada L4W 5N6, 800–463–6727, or go to *http://www.csagroup.org/*.

(1) ANSI Z21.10.3–2015 * CSA 4.3–2015 (''ANSI Z21.10.3–2015''), ''Gas-fired water heaters, volume III, storage water heaters with input ratings above 75,000 Btu per hour, circulating and instantaneous,'' approved by ANSI on October 5, 2015, IBR approved for appendices A, B, and C to this subpart, as follows:

(i) Annex E (normative) Efficiency test procedures—E.1—Method of test for measuring thermal efficiency, paragraph c—Vent requirements; and

(ii) Annex E (normative) Efficiency test procedures—E.1—Method of test for measuring thermal efficiency, paragraph f—Installation of temperature sensing means.

(2) [Reserved]

[77 FR 28996, May 16, 2012, as amended at 81 FR 79322, Nov. 10, 2016]

§ 431.106 Uniform test method for the measurement of energy efficiency of commercial water heating equipment.

(a) *Scope*. This section contains test procedures for measuring, pursuant to EPCA, the energy efficiency of commercial water heating equipment.

(b) *Testing and calculations*. Determine the energy efficiency of commercial water heating equipment by conducting the applicable test procedure(s):

(1) *Residential-duty commercial water heaters*. Test in accordance with appendix E to subpart B of part 430 of this chapter.

(2) *Commercial water heating equipment other than residential-duty commercial water heaters*. Test in accordance with the appropriate test procedures in appendices to subpart G of this part.

(i) *Gas-fired and oil-fired storage water heaters and storage-type instantaneous water heaters*. Test according to appendix A to subpart G of this part.

(ii) *Electric storage water heaters and storage-type instantaneous water heaters*. Test according to appendix B to subpart G of this part.

(iii) *Gas-fired and oil-fired instantaneous water heaters and hot water supply boilers (other than storage-type instantaneous water heaters)*. Test according to appendix C to subpart G of this part.

(iv) *Electric instantaneous water heaters (other than storage-type instantaneous water heaters)*. Test according to appendix D to subpart G of this part.

(v) *Commercial heat pump water heaters*. Test according to appendix E to subpart G of this part.

[81 FR 79322, Nov. 10, 2016]

ENERGY CONSERVATION STANDARDS

§ 431.110 Energy conservation standards and their effective dates.

(a) Each commercial storage water heater, instantaneous water heater, unfired hot water storage tank and hot water supply boiler (excluding residential-duty commercial water heaters) must meet the applicable energy conservation standard level(s) as specified in the table in this paragraph. Any packaged boiler that provides service water that meets the definition of ''commercial packaged boiler'' in subpart E of this part, but does not meet the definition of ''hot water supply boiler'' in subpart G, must meet the requirements that apply to it under subpart E.

Equipment category	Size	Energy conservation standard[a]		
		Maximum standby loss[c] (equipment manufactured on and after October 29, 2003)[b]	Minimum thermal efficiency (equipment manufactured on and after October 29, 2003 and before October 9, 2015)[b] (%)	Minimum thermal efficiency (equipment manufactured on and after October 9, 2015)[b] (%)
Electric storage water heaters	All	$0.30 + 27/V_m$ (%/hr)	N/A	N/A
Gas-fired storage water heaters.	≤155,000 Btu/hr	$Q/800 + 110(V_r)^{1/2}$ (Btu/hr)	80	80
	>155,000 Btu/hr	$Q/800 + 110(V_r)^{1/2}$ (Btu/hr)	80	80
Oil-fired storage water heaters.	≤155,000 Btu/hr	$Q/800 + 110(V_r)^{1/2}$ (Btu/hr)	78	80
	>155,000 Btu/hr	$Q/800 + 110(V_r)^{1/2}$ (Btu/hr)	78	80
Gas-fired instantaneous water heaters and hot water supply boilers.	<10 gal	N/A	80	80
	≥10 gal	$Q/800 + 110(V_r)^{1/2}$ (Btu/hr)	80	80
Oil-fired instantaneous water heaters and hot water supply boilers.	<10 gal	N/A	80	80
	≥10 gal	$Q/800 + 110(V_r)^{1/2}$ (Btu/hr)	78	78

Equipment category	Size	Minimum thermal insulation
Unfired hot water storage tank	All	R–12.5

[a] V_m is the measured storage volume (in gallons), and V_r is the rated volume (in gallons). Q is the nameplate input rate in Btu/hr.

[b] For hot water supply boilers with a capacity of less than 10 gallons: (1) The standards are mandatory for products manufactured on and after October 21, 2005, and (2) products manufactured prior to that date, and on or after October 23, 2003, must meet either the standards listed in this table or the applicable standards in subpart E of this part for a ''commercial packaged boiler.''

[c] Water heaters and hot water supply boilers having more than 140 gallons of storage capacity need not meet the standby loss requirement if: (1) The tank surface area is thermally insulated to R–12.5 or more; (2) a standing pilot light is not used; and (3) for gas or oil-fired storage water heaters, they have a fire damper or fan-assisted combustion.

(b) Each residential-duty commercial water heater must meet the applicable energy conservation standard level(s) as follows:

Product class	Specifications[a]	Draw pattern	Uniform energy factor[b]
Gas-fired Storage	>75 kBtu/hr and ≤105 kBtu/hr and ≤120 gal.	Very Small	$0.2674 - (0.0009 \times V_r)$
		Low	$0.5362 - (0.0012 \times V_r)$
		Medium	$0.6002 - (0.0011 \times V_r)$
		High	$0.6597 - (0.0009 \times V_r)$
Oil-fired Storage	>105 kBtu/hr and ≤140 kBtu/hr and ≤120 gal.	Very Small	$0.2932 - (0.0015 \times V_r)$
		Low	$0.5596 - (0.0018 \times V_r)$
		Medium	$0.6194 - (0.0016 \times V_r)$
		High	$0.6740 - (0.0013 \times V_r)$
Electric Instantaneous	>12 kW and ≤58.6 kW and ≤2 gal.	Very Small	0.80
		Low	0.80
		Medium	0.80
		High	0.80

[a] Additionally, to be classified as a residential-duty commercial water heater, a commercial water heater must meet the following conditions: (1) if the water heater requires electricity, it must use a single-phase external power supply; and (2) the water heater must not be designed to heat water to temperatures greater than 180 °F.

[b] V_r is the rated storage volume (in gallons), as determined pursuant to 10 CFR 429.44.

[81 FR 96238, Dec. 29, 2016]

APPENDIX A TO SUBPART G OF PART 431—UNIFORM TEST METHOD FOR THE MEASUREMENT OF THERMAL EFFICIENCY AND STANDBY LOSS OF GAS-FIRED AND OIL-FIRED STORAGE WATER HEATERS AND STORAGE-TYPE INSTANTANEOUS WATER HEATERS

NOTE: Prior to November 6, 2017, manufacturers must make any representations with respect to the energy use or efficiency of the subject commercial water heating equipment in accordance with the results of testing pursuant to this appendix or the procedures in 10 CFR 431.106 that were in place on January 1, 2016. On and after November 6, 2017, manufacturers must make any representations with respect to energy use or efficiency of gas-fired and oil-fired storage water heaters and storage-type instantaneous water heaters in accordance with the results of testing pursuant to this appendix to demonstrate compliance with the energy conservation standards at 10 CFR 431.110.

1. General

Determine the thermal efficiency and standby loss (as applicable) in accordance with the following sections of this appendix. Certain sections reference sections of Annex E.1 of ANSI Z21.10.3–2015 (incorporated by reference; see § 431.105). Where the instructions contained in the sections below conflict with instructions in Annex E.1 of ANSI Z21.10.3–2015, the instructions contained in this appendix control.

2. Test Set-Up

2.1. *Placement of Water Heater.* A water heater for installation on combustible floors must be placed on a ¾-inch plywood platform supported by three 2 x 4-inch runners. If the water heater is for installation on noncombustible floors, suitable noncombustible material must be placed on the platform. When the use of the platform for a large water heater is not practical, the water heater may be placed on any suitable flooring. A wall-mounted water heater must be mounted on a simulated wall section.

2.2. *Installation of Temperature Sensors.* Inlet and outlet water piping must be turned vertically downward from the connections on the water heater so as to form heat traps. Temperature sensors for measuring supply and outlet water temperatures must be installed upstream from the inlet heat trap piping and downstream from the outlet heat trap piping, respectively, in accordance with Figure 2.1, 2.2, or 2.3 (as applicable based on the location of inlet and outlet piping connections) of this section.

The water heater must meet the requirements shown in Figure 2.1, 2.2, or 2.3 (as applicable) at all times during the conduct of the thermal efficiency and standby loss tests. Any factory-supplied heat traps must be installed per the installation instructions while ensuring the requirements in Figure 2.1, 2.2, or 2.3 are met. All dimensions specified in Figure 2.1, 2.2, and 2.3 and in this section are measured from the outer surface of the pipes and water heater outer casing (as applicable).

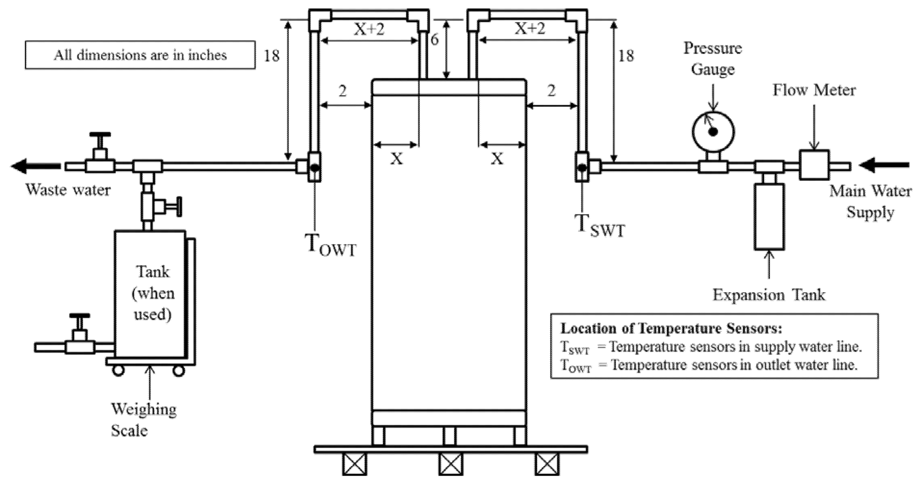

Figure 2.1. Set-up for thermal efficiency and standby loss test for water heaters equipped with vertical (top) connections

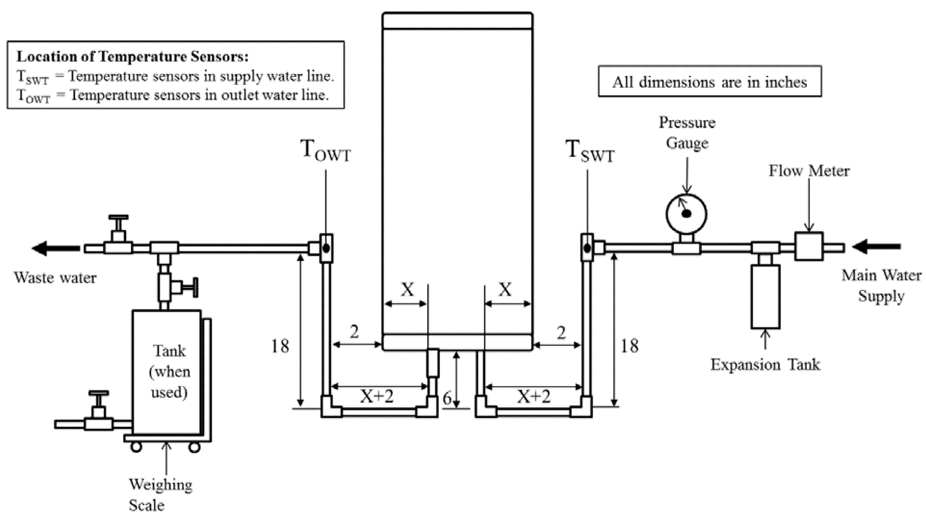

Figure 2.2. Set-up for thermal efficiency and standby loss test for water heaters equipped with vertical (bottom) connections

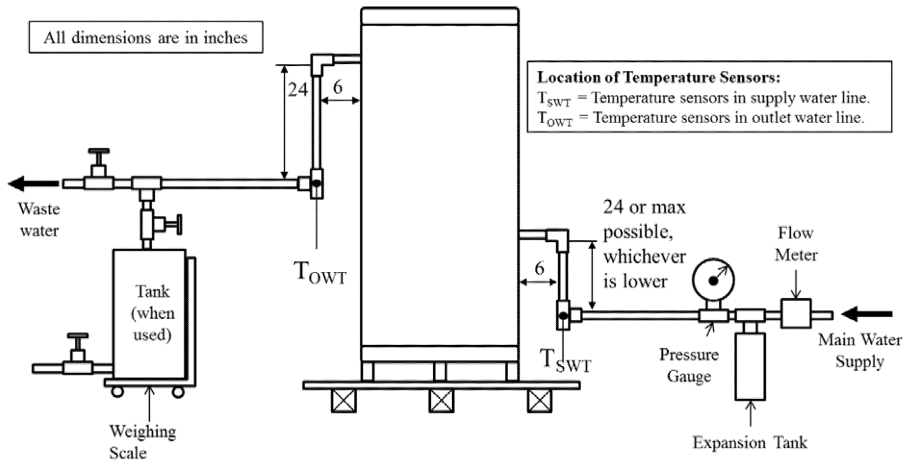

Figure 2.3. Set-up for thermal efficiency and standby loss test for water heaters equipped with horizontal connections

2.3 *Installation of Temperature Sensors for Measurement of Mean Tank Temperature*. Install temperature sensors inside the tank for measurement of mean tank temperature according to the instructions in paragraph f of Annex E.1 of ANSI Z21.10.3–2015 (incorporated by reference; see § 431.105). Calculate the mean tank temperature as the average of the six installed temperature sensors.

2.4. *Piping Insulation*. Insulate all water piping external to the water heater jacket, including heat traps and piping that are installed by the manufacturer or shipped with the unit, for at least 4 ft of piping length from the connection at the appliance, with material having an R-value not less than 4 °F·ft^2·h/Btu. Ensure that the insulation does not contact any appliance surface except at the location where the pipe connections penetrate the appliance jacket or enclosure.

2.5. *Temperature and Pressure Relief Valve Insulation*. If the manufacturer has not provided a temperature and pressure relief valve, one shall be installed and insulated as specified in section 2.4 of this appendix.

2.6. *Vent Requirements*. Follow the requirements for venting arrangements specified in paragraph c of Annex E.1 of ANSI Z21.10.3–2015 (incorporated by reference; see § 431.105).

2.7. *Energy Consumption*. Install equipment that determines, within ± 1 percent:

2.7.1. The quantity and rate of fuel consumed.

2.7.2. The quantity of electricity consumed by factory-supplied water heater components.

3. Test Conditions

3.1. *Water Supply*

3.1.1. *Water Supply Pressure*. The pressure of the water supply must be maintained between 40 psi and the maximum pressure specified by the manufacturer of the unit being tested. The accuracy of the pressure-measuring devices must be within ± 1.0 pounds per square inch (psi).

3.1.2. *Water Supply Temperature*. During the steady-state verification period and the thermal efficiency test, the temperature of the supply water must be maintained at 70 °F ± 2 °F.

3.1.3. Isolate the water heater using a shutoff valve in the supply line with an expansion tank installed in the supply line downstream of the shutoff valve. There must be no shutoff means between the expansion tank and the appliance inlet.

3.2. *Gas Pressure for Gas-Fired Equipment*. The supply gas pressure must be within the range specified by the manufacturer on the nameplate of the unit being tested. The difference between the outlet pressure of the gas appliance pressure regulator and the value specified by the manufacturer on the nameplate of the unit being tested must not exceed the greater of: ± 10 percent of the nameplate value or ± 0.2 inches water column (in. w.c.). Obtain the higher heating value of the gas burned.

3.3. *Ambient Room Temperature*. During the soak-in period (as applicable), the steady-state verification period, the thermal efficiency test, and the standby loss test, maintain the ambient room temperature at 75 °F ± 10 °F at all times. Measure the ambient room temperature at 1-minute intervals during these periods, except for the soak-in period. Measure the ambient room temperature once before beginning the soak-in period, and ensure no actions are taken during the soak-in period that would cause the ambient room temperature to deviate from the allowable range. Measure the ambient room temperature at the vertical mid-point of the water heater and approximately 2 feet from the water heater jacket. Shield the sensor against radiation. Calculate the average ambient room temperature separately for the thermal efficiency test and standby loss test. During the thermal efficiency and standby loss tests, the ambient room temperature must not vary by more than ± 5.0 °F at any reading from the average ambient room temperature.

3.4. *Test Air Temperature*. During the steady-state verification period, the thermal efficiency test, and the standby loss test, the test air temperature must not vary by more than ± 5 °F from the ambient room temperature at any reading. Measure the test air temperature at 1-minute intervals during these periods and at a location within two feet of the air inlet of the water heater or the combustion air intake vent, as applicable. Shield the sensor against radiation. For units with multiple air inlets, measure the test air temperature at each air inlet, and maintain the specified tolerance on deviation from the ambient room temperature at each air inlet. For units without a dedicated air inlet, measure the test air temperature within two feet of any location on the water heater where combustion air is drawn.

3.5. *Maximum Air Draft*. During the steady-state verification period, the thermal efficiency test, and the standby loss test, the water heater must be located in an area protected from drafts of more than 50 ft/min. Prior to beginning the steady-state verification period and the standby loss test, measure the air draft within three feet of the jacket or enclosure of the water heater to ensure this condition is met. Ensure that no other changes that would increase the air draft are made to the test set-up or conditions during the conduct of the tests.

3.6. *Setting the Tank Thermostat*. Before starting the steady-state verification period (as applicable) or before the soak-in period (as applicable), the thermostat setting must first be obtained by starting with the water in the system at 70 °F ± 2 °F. Set the thermostat to ensure:

3.6.1. With the supply water temperature set as per section 3.1.2 of this appendix (*i.e.*, 70 °F ± 2 °F), the water flow rate can be varied so that the outlet water temperature is constant at 70 °F ± 2 °F above the supply water temperature while the burner is firing at full firing rate; and

3.6.2. After the water supply is turned off and the thermostat reduces the fuel supply to a minimum, the maximum water temperature measured by the topmost tank temperature sensor (*i.e.*, the highest of the 6 temperature sensors used for calculating mean tank temperature, as required by section 2.3 of this appendix) is 140 °F ± 5 °F.

3.7. *Additional Requirements for Oil-Fired Equipment*.

3.7.1. *Venting Requirements*. Connect a vertical length of flue pipe to the flue gas outlet of sufficient height so as to meet the minimum draft specified by the manufacturer.

3.7.2. *Oil Supply*. Adjust the burner rate so that the following conditions are met:

3.7.2.1. The CO_2 reading is within the range specified by the manufacturer;

3.7.2.2. The fuel pump pressure is within ± 10 percent of manufacturer's specifications;

3.7.2.3. If either the fuel pump pressure or range for CO_2 reading are not specified by the manufacturer on the nameplate of the unit, in literature shipped with the unit, or in supplemental test report instructions included with a certification report, then a default value of 100 psig is to be used for fuel pump pressure, and a default range of 9–12 percent is to be used for CO_2 reading; and

3.7.2.4. Smoke in the flue does not exceed No. 1 smoke as measured by the procedure in ASTM D2156–09 (Reapproved 2013) (incorporated by reference, see § 431.105). To determine the smoke spot number, connect the smoke measuring device to an open-ended tube. This tube must project into the flue ¼ to ½ of the pipe diameter.

3.7.2.5. If no settings on the water heater have been changed and the water heater has not been turned off since the end of a previously run thermal efficiency or standby loss test, measurement of the CO_2 reading and conduct of the smoke spot test are not required prior to beginning a test. Otherwise, measure the CO_2 reading and determine the smoke spot number, with the burner firing, before the beginning of the steady-state verification period prior to the thermal efficiency test, and prior to beginning the standby loss test.

3.8. *Data Collection Intervals*. Follow the data recording intervals specified in the following sections.

3.8.1. *Soak-In Period*. For units that require a soak-in period, measure the ambient room temperature, in °F, prior to beginning the soak-in period.

3.8.2. *Steady-State Verification Period and Thermal Efficiency Test*. For the steady-state verification period and the thermal efficiency test, follow the data recording intervals specified in Table 3.1 of this appendix.

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TABLE 3.1—DATA TO BE RECORDED BEFORE AND DURING THE STEADY-STATE VERIFICATION PERIOD AND THERMAL EFFICIENCY TEST

Item recorded	Before steady-state verification period	Every 1 minute [a]	Every 10 minutes
Gas supply pressure, in w.c.	X		
Gas outlet pressure, in w.c.	X		
Barometric pressure, in Hg	X		
Fuel higher heating value, Btu/ft^3 (gas) or Btu/lb (oil)	X		
Oil pump pressure, psig (oil only)	X		
CO_2 reading, % (oil only)	X [b]		
Oil smoke spot reading (oil only)	X [b]		
Air draft, ft/min	X		
Time, minutes/seconds		X	
Fuel weight or volume, lb (oil) or ft^3 (gas)			X [c]
Supply water temperature (T_{SWT}), °F		X	
Outlet water temperature (T_{OWT}), °F		X	
Ambient room temperature, °F		X	
Test air temperature, °F		X	
Water flow rate, (gpm)		X	

Notes:

[a] These measurements are to be recorded at the start of the steady-state verification period and the end of the thermal efficiency test, as well as every minute during both periods.

[b] The smoke spot test and CO_2 reading are not required prior to beginning the steady-state verification period if no settings on the water heater have been changed and the water heater has not been turned off since the end of a previously-run efficiency test (*i.e.,* thermal efficiency or standby loss).

[c] Fuel and electricity consumption over the course of the entire thermal efficiency test must be measured and used in calculation of thermal efficiency.

3.8.3. Standby Loss Test. For the standby loss test, follow the data recording intervals specified in Table 3.2 of this appendix. Additionally, the fuel and electricity consumption over the course of the entire test must be measured and used in calculation of standby loss.

TABLE 3.2—DATA TO BE RECORDED BEFORE AND DURING THE STANDBY LOSS TEST

Item recorded	Before test	Every 1 minute [a]
Gas supply pressure, in w.c..	X	
Gas outlet pressure, in w.c..	X	
Barometric pressure, in Hg.	X	
Fuel higher heating value, Btu/ft^3 (gas) or Btu/lb (oil).	X	
Oil pump pressure, psig (oil only).	X	
CO_2 reading, % (oil only).	X [b]	
Oil smoke spot reading (oil only).	X [b]	
Air draft, ft/min	X	
Time, minutes/seconds.		X
Mean tank temperature, °F.		X [c]
Ambient room temperature, °F.		X
Test air temperature, °F.		X

Notes:

[a] These measurements are to be recorded at the start and end of the test, as well as every minute during the test.

[b] The smoke spot test and CO_2 reading are not required prior to beginning the standby loss test if no settings on the water heater have been changed and the water heater has not been turned off since the end of a previously-run efficiency test (*i.e.,* thermal efficiency or standby loss).

[c] Mean tank temperature is calculated as the average of the 6 tank temperature sensors, installed per section 2.3 of this appendix.

4. *Determination of Storage Volume.* Determine the storage volume by subtracting the tare weight, measured while the system is dry and empty, from the weight of the system when filled with water and dividing the resulting net weight of water by the density of water at the measured water temperature. The volume of the water contained in the water heater must be computed in gallons.

5. *Thermal Efficiency Test.* Before beginning the steady-state verification period, record the applicable parameters as specified in section 3.8.2 of this appendix. Begin drawing water from the unit by opening the main supply, and adjust the water flow rate to achieve an outlet water temperature of 70 °F ± 2 °F above supply water temperature. The thermal efficiency test shall be deemed complete when there is a continuous, one-hour-long period where the steady-state conditions specified in section 5.1 of this appendix have been met, as confirmed by consecutive readings of the relevant parameters recorded at 1-minute intervals (except for fuel input rate, which is determined at 10-minute intervals, as specified in section 5.4 of this appendix). During the one-hour-long period, the water heater must fire continuously at its full firing rate (*i.e.,* no modulations or cut-outs) and no settings can be changed on the unit being tested at any time. The first 30

minutes of the one-hour-period where the steady-state conditions in section 5.1 of this appendix are met is the steady-state verification period. The final 30 minutes of the one-hour-period where the steady-state conditions in section 5.1 of this appendix are met is the thermal efficiency test. The last reading of the steady-state verification period must be the first reading of the thermal efficiency test (*i.e.*, the thermal efficiency test starts immediately once the steady-state verification period ends).

5.1. *Steady-State Conditions*. The following conditions must be met at consecutive readings taken at 1-minute intervals (except for fuel input rate, for which measurements are taken at 10-minute intervals) to verify the water heater has achieved steady-state operation during the steady-state verification period and thermal efficiency test.

5.1.1. The water flow rate must be maintained within ± 0.25 gallons per minute (gpm) of the initial reading at the start of the steady-state verification period;

5.1.2. Outlet water temperature must be maintained at 70 °F ± 2 °F above supply water temperature;

5.1.3. Fuel input rate must be maintained within ± 2 percent of the rated input certified by the manufacturer;

5.1.4. The supply water temperature must be maintained within ± 0.50 °F of the initial reading at the start of the steady-state verification period; and

5.1.5. The rise between the supply and outlet water temperatures must be maintained within ± 0.50 °F of its initial value taken at the start of the steady-state verification period for units with rated input less than 500,000 Btu/h, and maintained within ± 1.00 °F of its initial value for units with rated input greater than or equal to 500,000 Btu/h.

5.2. *Water Flow Measurement*. Measure the total weight of water heated during the 30-minute thermal efficiency test with either a scale or a water flow meter. With either method, the error of measurement of weight of water heated must not exceed 1 percent of the weight of the total draw.

5.3. *Determination of Fuel Input Rate*. During the steady-state verification period and the thermal efficiency test, record the fuel consumed at 10-minute intervals. Calculate the fuel input rate over each 10-minute period using the equations in section 5.4 of this appendix. The measured fuel input rates for these 10-minute periods must not vary by more than ± 2 percent between any two readings. Determine the overall fuel input rate using the fuel consumption for the entire duration of the thermal efficiency test.

5.4. *Fuel Input Rate Calculation*. To calculate the fuel input rate, use the following equation:

$$Q = \frac{Q_s * C_s * H}{t}$$

Where,

Q = Fuel input rate, expressed in Btu/h

Q_s = Total fuel flow as metered, expressed in ft^3 for gas-fired equipment and lb for oil-fired equipment

C_s = Correction applied to the heating value of a gas H, when it is metered at temperature and/or pressure conditions other than the standard conditions for which the value of H is based. Cs=1 for oil-fired equipment.

H = Higher heating value of fuel, expressed in Btu/ft^3 for gas-fired equipment and Btu/lb for oil-fired equipment.

t = Duration of measurement of fuel consumption

5.5. *Thermal Efficiency Calculation*. Thermal efficiency must be calculated using data from the 30-minute thermal efficiency test. Calculate thermal efficiency, E_t, using the following equation:

$$E_t = \frac{K * W * (\theta_2 - \theta_1)}{(C_s * Q * H) + E_c}$$

Where,

K = 1.004 Btu/lb· °F, the nominal specific heat of water at 105 °F

W = Total weight of water heated, expressed in lb

θ_1 = Average supply water temperature, expressed in °F

θ_2 = Average outlet water temperature, expressed in °F

Q = Total fuel flow as metered, expressed in ft^3 for gas-fired equipment and lb for oil-fired equipment.

C_s = Correction applied to the heating value of a gas H, when it is metered at temperature and/or pressure conditions other than the standard conditions for which the value of H is based. C_s=1 for oil-fired equipment

H. = Higher heating value of the fuel, expressed in Btu/ft^3 for gas-fired equipment and Btu/lb for oil-fired equipment.

E_c = Electrical consumption of the water heater and, when used, the test set-up recirculating pump, expressed in Btu

6. Standby Loss Test

6.1. If no settings on the water heater have changed and the water heater has not been turned off since a previously run thermal efficiency or standby loss test, skip to section 6.3 of this appendix. Otherwise, conduct the soak-in period according to section 6.2 of this appendix.

6.2. *Soak-In Period*. Conduct a soak-in period, in which the water heater must sit without any draws taking place for at least 12 hours. Begin the soak-in period after setting the tank thermostat as specified in section 3.6 of this appendix, and maintain these thermostat settings throughout the soak-in period.

6.3. Begin the standby loss test at the first cut-out following the end of the soak-in period (if applicable); or at a cut-out following the previous thermal efficiency or standby loss test (if applicable). Allow the water heater to remain in standby mode. Do not change any settings on the water heater at any point until measurements for the standby loss test are finished. Begin recording the applicable parameters specified in section 3.8.3 of this appendix.

6.4. At the second cut-out, record the time and ambient room temperature, and begin measuring the fuel and electricity consumption. Record the initial mean tank temperature and initial ambient room temperature. For the remainder of the test, continue recording the applicable parameters specified in section 3.8.3 of this appendix.

6.5. Stop the test after the first cut-out that occurs after 24 hours, or at 48 hours, whichever comes first.

6.6. Immediately after conclusion of the standby loss test, record the total fuel flow and electrical energy consumption, the final ambient room temperature, the duration of the standby loss test, and if the test ends at 48 hours without a cut-out, the final mean tank temperature, or if the test ends after a cut-out, the maximum mean tank temperature that occurs after the cut-out. Calculate the average of the recorded values of the mean tank temperature and of the ambient room temperature taken at each measurement interval, including the initial and final values.

6.7. *Standby Loss Calculation*. To calculate the standby loss, follow the steps below:

6.7.1. The standby loss expressed as a percentage (per hour) of the heat content of the stored water above room temperature must be calculated using the following equation:

$$S = \frac{E_c + (C_s)(Q_s)(H) - \left(\frac{k(V_a)(\Delta T_4)}{E_t/100}\right)}{k(V_a)(\Delta T_3)(t)} \times 100$$

Where,

ΔT_3 = Average value of the mean tank temperature minus the average value of the ambient room temperature, expressed in °F

ΔT_4 = Final mean tank temperature measured at the end of the test minus the initial mean tank temperature measured at the start of the test , expressed in °F

k = 8.25 Btu/gallon· °F, the nominal specific heat of water

V_a = Volume of water contained in the water heater in gallons measured in accordance with section 4 of this appendix

E_t = Thermal efficiency of the water heater determined in accordance with this appendix, expressed in %

E_c = Electrical energy consumed by the water heater during the duration of the test in Btu

t = Total duration of the test in hours

C_s = Correction applied to the heating value of a gas H, when it is metered at temperature and/or pressure conditions other than the standard conditions for which the value of H is based. C_s=1 for oil-fired equipment.

Q_s = Total fuel flow as metered, expressed in ft^3 (gas) or lb (oil)

H = Higher heating value of fuel, expressed in Btu/ft^3 (gas) or Btu/lb (oil)

S = Standby loss, the average hourly energy required to maintain the stored water temperature expressed as a percentage of the heat content of the stored water above room temperature

6.7.2. The standby loss expressed in Btu per hour must be calculated as follows:

SL (Btu per hour) = S (% per hour) × 8.25 (Btu/gal- °F) × Measured Volume (gal) × 70 (°F).

Where, SL refers to the standby loss of the water heater, defined as the amount of energy required to maintain the stored water temperature expressed in Btu per hour

[81 FR 79323, Nov. 10, 2016]

APPENDIX B TO SUBPART G OF PART 431—UNIFORM TEST METHOD FOR THE MEASUREMENT OF STANDBY LOSS OF ELECTRIC STORAGE WATER HEATERS AND STORAGE-TYPE INSTANTANEOUS WATER HEATERS

Note: Prior to November 6, 2017, manufacturers must make any representations with respect to the energy use or efficiency of the subject commercial water heating equipment in accordance with the results of testing pursuant to this appendix or the procedures in 10 CFR 431.106 that were in place on January 1, 2016. On and after November 6, 2017, manufacturers must make any representations with respect to energy use or efficiency of electric storage water heaters and storage-type instantaneous water heaters in accordance with the results of testing pursuant to this appendix to demonstrate compliance with the energy conservation standards at 10 CFR 431.110.

1. General

Determine the standby loss in accordance with the following sections of this appendix. Certain sections reference sections of Annex E.1 of ANSI Z21.10.3–2015 (incorporated by reference; see § 431.105). Where the instructions contained in the sections below conflict with instructions in Annex E.1 of ANSI Z21.10.3–2015, the instructions contained in this appendix control.

2. Test Set-Up

2.1. *Placement of Water Heater*. A water heater for installation on combustible floors must be placed on a ¾-inch plywood platform supported by three 2 × 4-inch runners. If the water heater is for installation on noncombustible floors, suitable noncombustible material must be placed on the platform. When the use of the platform for a large water heater is not practical, the water heater may be placed on any suitable flooring. A wall-mounted water heater must be mounted on a simulated wall section.

2.2. *Installation of Temperature Sensors*. Inlet and outlet piping must be turned vertically downward from the connections on a tank-type water heater so as to form heat traps. Temperature sensors for measuring supply water temperature must be installed upstream of the inlet heat trap piping, in accordance with Figure 2.1, 2.2, or 2.3 (as applicable) of this appendix.

The water heater must meet the requirements shown in either Figure 2.1, 2.2, or 2.3 (as applicable) at all times during the conduct of the standby loss test. Any factory-supplied heat traps must be installed per the installation instructions while ensuring the requirements in Figure 2.1, 2.2, or 2.3 are met. All dimensions specified in Figure 2.1, 2.2, and 2.3 are measured from the outer surface of the pipes and water heater outer casing (as applicable).

sfrattini on LAPCK6H6L3 with DISTILLER
VerDate Sep<11>2014 13:03 Aug 22, 2023 Jkt 259032 PO 00000 Frm 00995 Fmt 8010 Sfmt 8002 C:\MCWORK\259032.XXX PC31

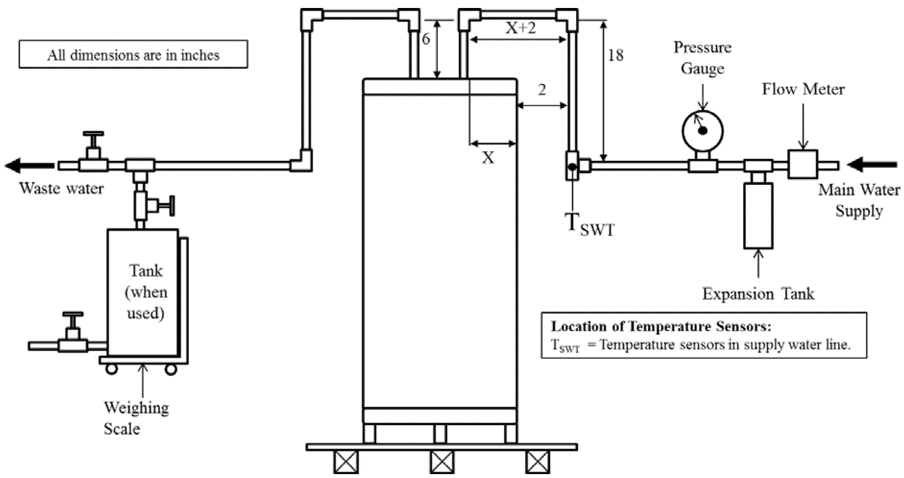

Figure 2.1. Set-up for standby loss test for electric storage water heaters equipped with vertical (top) connections

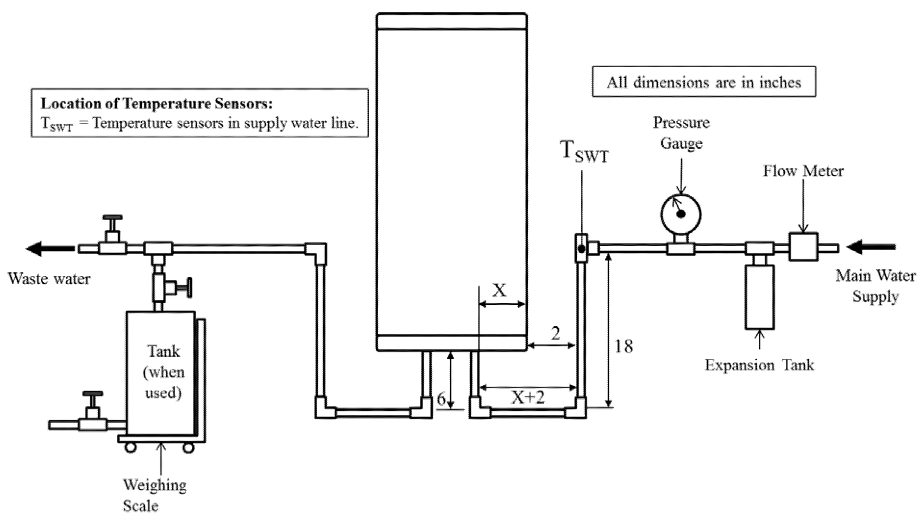

Figure 2.2. Set-up for standby loss test for electric storage water heaters equipped with vertical (bottom) connections

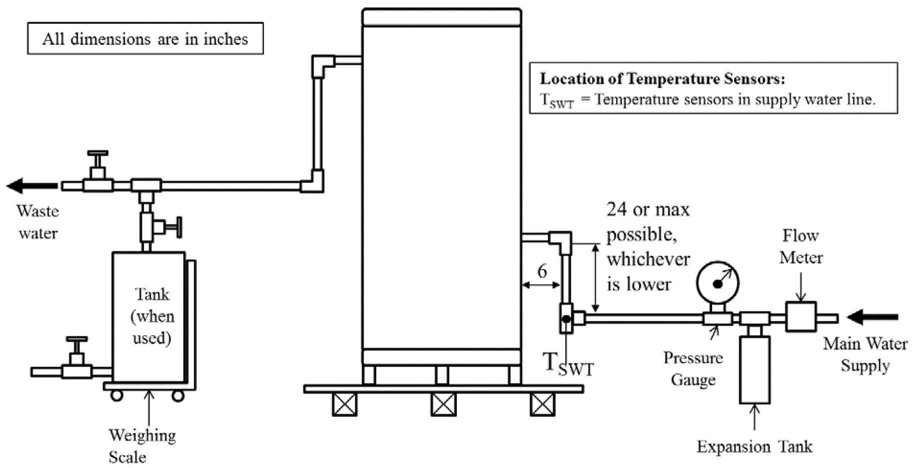

Figure 2.3. Set-up for standby loss test for electric storage water heaters equipped with horizontal connections

2.3. Installation of *Temperature Sensors for Measurement of Mean Tank Temperature*. Install temperature sensors inside the tank for measurement of mean tank temperature according to the instructions in paragraph f of Annex E.1 of ANSI Z21.10.3–2015 (incorporated by reference; see § 431.105 rt). Calculate the mean tank temperature as the average of the six installed temperature sensors.

2.4. *Piping Insulation*. Insulate all water piping external to the water heater jacket, including heat traps and piping that is installed by the manufacturer or shipped with the unit, for at least 4 ft of piping length from the connection at the appliance, with material having an R-value not less than 4 °F·ft²·h/Btu. Ensure that the insulation does not contact any appliance surface except at the location where the pipe connections penetrate the appliance jacket or enclosure.

2.5. *Temperature and Pressure Relief Valve Insulation*. If the manufacturer or has not provided a temperature and pressure relief valve, one shall be installed and insulated as specified in section 2.4 of this appendix.

2.6. *Energy Consumption*. Install equipment that determines, within ± 1 percent, the quantity of electricity consumed by factory-supplied water heater components.

3. Test Conditions

3.1. Water Supply

3.1.1. *Water Supply Pressure*. The pressure of the water supply must be maintained between 40 psi and the maximum pressure specified by the manufacturer of the unit being tested. The accuracy of the pressure-measuring devices must be within ± 1.0 pounds per square inch (psi).

3.1.2. *Water Supply Temperature*. When filling the tank with water prior to the soak-in period, maintain the supply water temperature at 70 °F ± 2 °F.

3.1.3. Isolate the water heater using a shutoff valve in the supply line with an expansion tank installed in the supply line downstream of the shutoff valve. There must be no shutoff means between the expansion tank and the appliance inlet.

3.2. *Electrical Supply*. Maintain the electrical supply voltage to within ± 5 percent of the voltage specified on the water heater nameplate. If a voltage range is specified on the nameplate, maintain the voltage to within ± 5 percent of the center of the voltage range specified on the nameplate.

3.3. *Ambient Room Temperature*. During the soak-in period and the standby loss test, maintain the ambient room temperature at 75 °F ± 10 °F at all times. Measure the ambient room temperature at 1-minute intervals during these periods, except for the soak-in period. Measure the ambient room temperature once before beginning the soak-in period, and ensure no actions are taken during the soak-in period that would cause the ambient room temperature to deviate from the allowable range. Measure the ambient room temperature at the vertical mid-point of the water heater and approximately 2 feet from the water heater jacket. Shield the sensor against radiation. Calculate the average ambient room temperature for the standby loss test. During the standby loss test, the ambient room temperature must not vary by more than ± 5.0 °F at any reading from the average ambient room temperature.

3.4. Maximum Air Draft. During the standby loss test, the water heater must be located in an area protected from drafts of more than 50 ft/min. Prior to beginning the standby loss test, measure the air draft within three feet of the jacket of the water heater to ensure this condition is met. Ensure that no other changes that would increase the air draft are made to the test set-up or conditions during the conduct of the test.

3.5. Setting the Tank Thermostat(s). Before starting the required soak-in period, the thermostat setting(s) must first be obtained as explained in the following sections. The thermostat setting(s) must be obtained by starting with the tank full of water at 70 °F ± 2 °F. After the tank is completely filled with water at 70 °F ± 2 °F, turn off the water flow, and set the thermostat(s) as follows.

3.5.1. For water heaters with a single thermostat, the thermostat setting must be set so that the maximum mean tank temperature after cut-out is 140 °F ± 5 °F.

3.5.2. For water heaters with multiple adjustable thermostats, set only the topmost and bottommost thermostats, and turn off any other thermostats for the duration of the standby loss test. Set the topmost thermostat first to yield a maximum mean water temperature after cut-out of 140 °F ± 5 °F, as calculated using only the temperature readings measured at locations in the tank higher than the heating element corresponding to the topmost thermostat (the lowermost heating element corresponding to the topmost thermostat if the thermostat controls more than one element). While setting the topmost thermostat, all lower thermostats must be turned off so that no elements below that (those) corresponding to the topmost thermostat are in operation. After setting the topmost thermostat, set the bottommost thermostat to yield a maximum mean water temperature after cut-out of 140 °F ± 5 °F. When setting the bottommost thermostat, calculate the mean tank temperature using all the temperature sensors installed in the tank as per section 2.3 of this appendix.

3.6. *Data Collection Intervals.* Follow the data recording intervals specified in the following sections.

3.6.1. Soak-In Period. Measure the ambient room temperature, in °F, every minute during the soak-in period.

3.6.2. Standby Loss Test. Follow the data recording intervals specified in Table 3.1 of this appendix. Additionally, the electricity consumption over the course of the entire test must be measured and used in calculation of standby loss.

TABLE 3.1—DATA TO BE RECORDED BEFORE AND DURING THE STANDBY LOSS TEST

Item recorded	Before test	Every 1 minute [a]
Air draft, ft/min	X	
Time, minutes/seconds.		X
Mean tank temperature, °F.		X [b]
Ambient room temperature, °F.		X

Notes:
[a] These measurements are to be recorded at the start and end of the test, as well as every minute during the test.
[b] Mean tank temperature is calculated as the average of the 6 tank temperature sensors, installed per section 2.3 of this appendix.

4. Determination of Storage Volume. Determine the storage volume by subtracting the tare weight, measured while the system is dry and empty, from the weight of the system when filled with water and dividing the resulting net weight of water by the density of water at the measured water temperature. The volume of water contained in the water heater must be computed in gallons.

5. Standby Loss Test

*5.*1. If no settings on the water heater have changed and the water heater has not been turned off since a previously run standby loss test, skip to section 5.3 of this appendix. Otherwise, conduct the soak-in period according to section 5.2 of this appendix.

5.2. *Soak-In Period.* Conduct a soak-in period, in which the water heater must sit without any draws taking place for at least 12 hours. Begin the soak-in period after setting the tank thermostat(s) as specified in section 3.5 of this appendix, and maintain these settings throughout the soak-in period.

5.3. Begin the standby loss test at the first cut-out following the end of the soak-in period (if applicable), or at a cut-out following the previous standby loss test (if applicable). Allow the water heater to remain in standby mode. At this point, do not change any settings on the water heater until measurements for the standby loss test are finished. Begin recording applicable parameters as specified in section 3.6.2 of this appendix.

5.4. At the second cut-out, record the time and ambient room temperature, and begin measuring the electric consumption. Record the initial mean tank temperature and initial ambient room temperature. For the remainder of the test, continue recording the applicable parameters specified in section 3.6.2 of this appendix.

5.5. Stop the test after the first cut-out that occurs after 24 hours, or at 48 hours, whichever comes first.

5.6. Immediately after conclusion of the standby loss test, record the total electrical energy consumption, the final ambient room temperature, the duration of the standby loss test, and if the test ends at 48 hours without a cut-out, the final mean tank temperature, or if the test ends after a cut-out, the maximum mean tank temperature that occurs after the cut-out. Calculate the average of the recorded values of the mean tank temperature and of the ambient air temperatures taken at each measurement interval, including the initial and final values.

5.7. *Standby Loss Calculation*. To calculate the standby loss, follow the steps below:

5.7.1 The standby loss expressed as a percentage (per hour) of the heat content of the stored water above room temperature must be calculated using the following equation:

$$S = \frac{E_c - \left(\frac{k(V_a)(\Delta T_4)}{E_t/100}\right)}{k(V_a)(\Delta T_3)(t)} \times 100$$

Where,

ΔT_3 = Average value of the mean tank temperature minus the average value of the ambient room temperature, expressed in °F

ΔT_4 = Final mean tank temperature measured at the end of the test minus the initial mean tank temperature measured at the start of the test, expressed in °F

k = 8.25 Btu/gallon· °F, the nominal specific heat of water

V_a = Volume of water contained in the water heater in gallons measured in accordance with section 4 of this appendix

E_t = Thermal efficiency = 98 percent for electric water heaters with immersed heating elements

E_c = Electrical energy consumed by the water heater during the duration of the test in Btu

t = Total duration of the test in hours

S = Standby loss, the average hourly energy required to maintain the stored water temperature expressed as a percentage of the heat content of the stored water above room temperature

[81 FR 79328, Nov. 10, 2016]

Appendix C to Subpart G of Part 431—Uniform Test Method for the Measurement of Thermal Efficiency and Standby Loss of Gas-Fired and Oil-Fired Instantaneous Water Heaters and Hot Water Supply Boilers (Other Than Storage-Type Instantaneous Water Heaters)

NOTE: Prior to November 6, 2017, manufacturers must make any representations with respect to the energy use or efficiency of the subject commercial water heating equipment in accordance with the results of testing pursuant to this appendix or the procedures in 10 CFR 431.106 that were in place on January 1, 2016. On and after November 6, 2017, manufacturers must make any representations with respect to energy use or efficiency of gas-fired and oil-fired instantaneous water heaters and hot water supply boilers (other than storage-type instantaneous water heaters) in accordance with the results of testing pursuant to this appendix to demonstrate compliance with the energy conservation standards at 10 CFR 431.110.

1. General

Determine the thermal efficiency and standby loss (as applicable) in accordance with the following sections of this appendix. Certain sections reference sections of Annex E.1 of ANSI Z21.10.3–2015 (incorporated by reference; see § 431.105). Where the instructions contained in the sections below conflict with instructions in Annex E.1 of ANSI Z21.10.3–2015, the instructions contained in this appendix control.

2. Test Set-Up

2.1. *Placement of Water Heater*. A water heater for installation on combustible floors must be placed on a ¾-inch plywood platform supported by three 2 x 4-inch runners. If the water heater is for installation on noncombustible floors, suitable noncombustible material must be placed on the platform. When the use of the platform for a large water heater is not practical, the water heater may be placed on any suitable flooring. A wall-mounted water heater must be mounted on a simulated wall section.

2.2. *Test Configuration*. If the instantaneous water heater or hot water supply boiler is not required to be tested using a recirculating loop, then set up the unit in accordance with Figures 2.1, 2.2, or 2.3 of this appendix (as applicable). If the unit is required to be tested using a recirculating loop, then set up the unit as per Figure 2.4 of this appendix.

sfrattini on LAPCK6H6L3 with DISTILLER
VerDate Sep<11>2014 13:03 Aug 22, 2023 Jkt 259032 PO 00000 Frm 00999 Fmt 8010 Sfmt 8002 C:\MCWORK\259032.XXX PC31
ER10NO16.019</GPH>

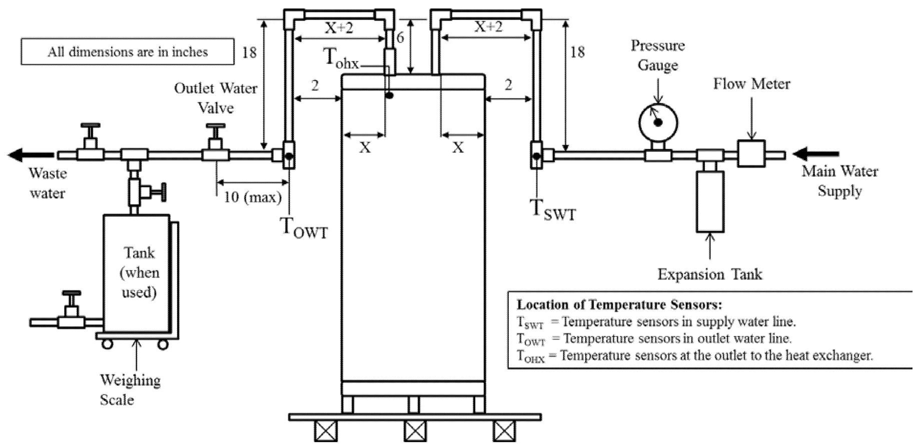

Figure 2.1. Set-up for thermal efficiency and standby loss test for gas-fired and oil-fired instantaneous water heaters and hot water supply boilers (other than storage-type instantaneous water heaters) equipped with vertical (top) connections not requiring a recirculating loop.

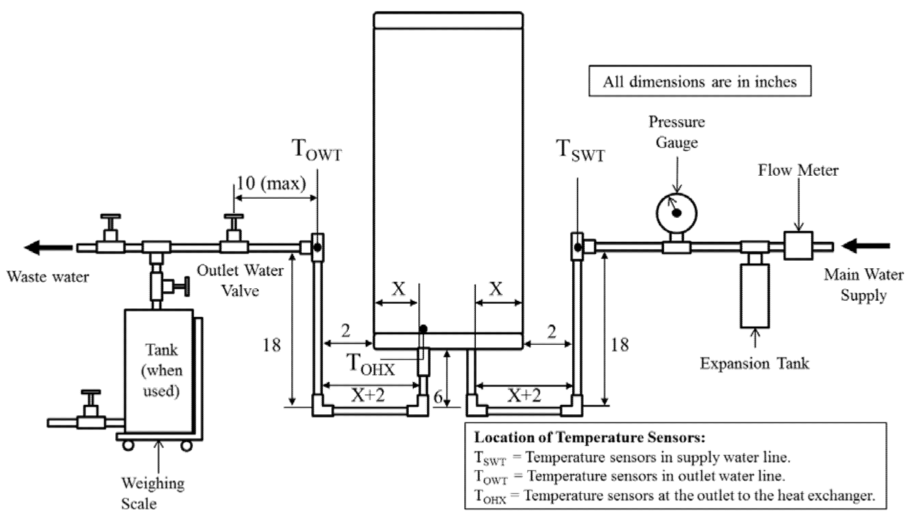

Figure 2.2. Set-up for thermal efficiency and standby loss test for gas-fired and oil-fired instantaneous water heaters and hot water supply boilers (other than storage-type instantaneous water heaters) equipped with vertical (bottom) connections not requiring a recirculating loop.

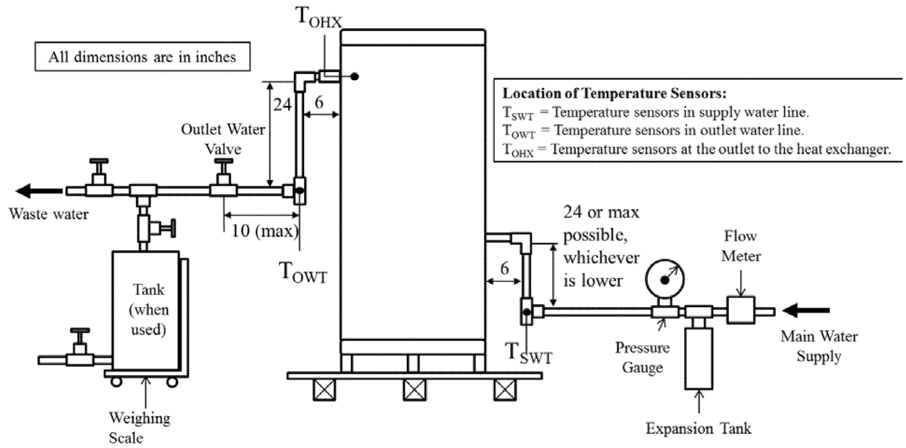

Figure 2.3. Set-up for thermal efficiency and standby loss test for gas-fired and oil-fired instantaneous water heaters and hot water supply boilers (other than storage-type instantaneous water heaters) equipped with horizontal connections not requiring a recirculating loop.

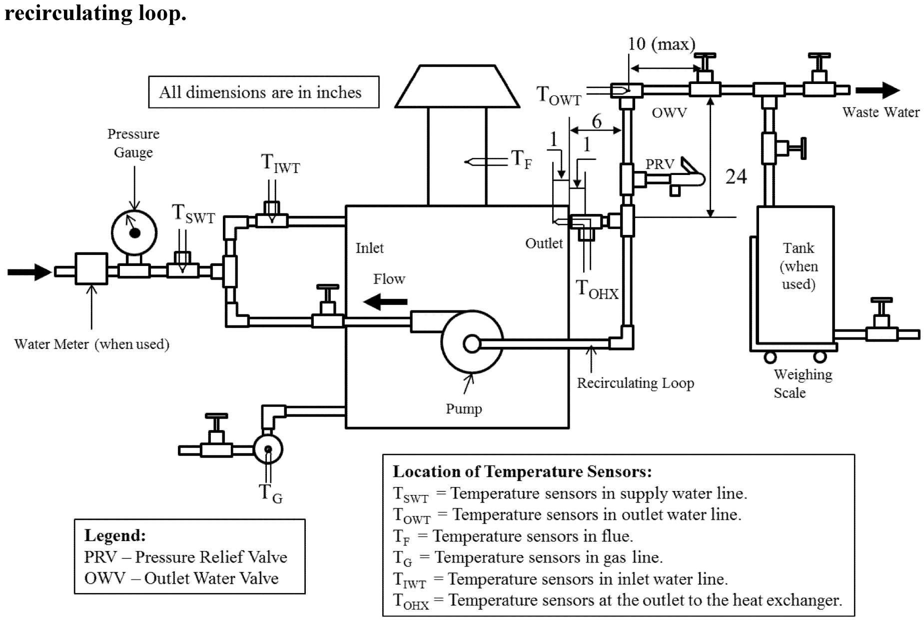

Figure 2.4. Set-up for thermal efficiency and standby loss test for gas-fired and oil-fired instantaneous water heaters and hot water supply boilers (other than storage-type instantaneous water heaters) requiring a recirculating loop for testing.

2.2.1. If the instantaneous water heater or hot water supply boiler does not have any external piping, install an outlet water valve within 10 inches of piping length of the water heater jacket or enclosure. If the instantaneous water heater or hot water supply boiler includes external piping assembled at the manufacturer's premises prior to shipment, install water valves in the outlet piping within 5 inches of the end of the piping supplied with the unit.

2.2.2. If the water heater is not able to achieve an outlet water temperature of 70 °F ± 2 °F (T_{OWT}) above the supply water temperature at full firing rate, a recirculating loop with pump as shown in Figure 2.4 of this appendix must be used.

2.2.2.1. If a recirculating loop with a pump is used, then ensure that the inlet water temperature labeled as T_{IWT} in Figure 2.4 of this appendix, is greater than or equal to 70 °F and less than or equal to 120 °F at all times during the thermal efficiency test and steady-state verification period (as applicable).

2.3. Installation of Temperature Sensors

2.3.1. *Without Recirculating Loop.*

2.3.1.1. *Vertical Connections.* Use Figure 2.1 (for top connections) and 2.2 (for bottom connections) of this appendix.

2.3.1.2. *Horizontal Connections.* Use Figure 2.3 of this appendix.

2.3.2. *With Recirculating Loop.* Set up the recirculating loop as shown in Figure 2.4 of this appendix.

2.3.3. For water heaters with multiple outlet water connections leaving the water heater jacket that are required to be operated to achieve the rated input, temperature sensors must be installed for each outlet water connection leaving the water heater jacket or enclosure that is used during testing, in accordance with the provisions in sections 2.3.1 and 2.3.2 of this appendix (as applicable).

2.4. *Piping Insulation.* Insulate all water piping external to the water heater jacket or enclosure, including piping that is installed by the manufacturer or shipped with the unit, for at least 4 ft of piping length from the connection at the appliance with material having an R-value not less than 4 °F·ft²·h/Btu. Ensure that the insulation does not contact any appliance surface except at the location where the pipe connections penetrate the appliance jacket or enclosure.

2.5. *Temperature and Pressure Relief Valve Insulation.* If the manufacturer has not provided a temperature and pressure relief valve, one shall be installed and insulated as specified in section 2.4 of this appendix. The temperature and pressure relief valve must be installed in the outlet water piping, between the unit being tested and the outlet water valve.

2.6. *Vent Requirements.* Follow the requirements for venting arrangements specified in paragraph c of Annex E.1 of ANSI Z21.10.3–2015 (incorporated by reference; see §431.105).

2.7. *Energy Consumption.* Install equipment that determines, within ± 1 percent:

2.7.1. The quantity and rate of fuel consumed.

2.7.2. The quantity of electricity consumed by factory-supplied water heater components, and of the test loop recirculating pump, if used.

3. Test Conditions

3.1. Water Supply

3.1.1. *Water Supply Pressure.* The pressure of the water supply must be maintained between 40 psi and the maximum pressure specified by the manufacturer of the unit being tested. The accuracy of the pressure-measuring devices must be within ± 1.0 psi.

3.1.2. *Water Supply Temperature.* During the thermal efficiency test and steady-state verification period (as applicable), the temperature of the supply water (T_{SWT}) must be maintained at 70 °F ± 2 °F.

3.2. *Gas Pressure for Gas-Fired Equipment.* The supply gas pressure must be within the range specified by the manufacturer on the nameplate of the unit being tested. The difference between the outlet pressure of the gas appliance pressure regulator and the value specified by the manufacturer on the nameplate of the unit being tested must not exceed the greater of: ± 10 percent of the nameplate value or ± 0.2 inches water column (in. w.c.). Obtain the higher heating value of the gas burned.

3.3. *Ambient Room Temperature.* Maintain the ambient room temperature at 75 °F ± 10 °F at all times during the steady-state verification period, the thermal efficiency test, and the standby loss test (as applicable). Measure the ambient room temperature at 1-minute intervals during these periods. Measure the ambient room temperature at the vertical mid-point of the water heater and approximately 2 feet from the water heater jacket or enclosure. Shield the sensor against radiation. Calculate the average ambient room temperature separately for the thermal efficiency test and the standby loss test. During the thermal efficiency and standby loss tests, the ambient room temperature must not vary by more than ± 5.0 °F at any reading from the average ambient room temperature.

3.4. *Test Air Temperature.* During the steady-state verification period, the thermal efficiency test, and the standby loss test (as applicable), the test air temperature must not vary by more than ± 5 °F from the ambient room temperature at any reading. Measure the test air temperature at 1-minute intervals during these periods and at a location within two feet of the air inlet of the water heater or the combustion air intake vent, as applicable. Shield the sensor against radiation. For units with multiple air inlets, measure the test air temperature at each air inlet, and maintain the specified tolerance on deviation from the ambient room temperature at each air inlet. For units without a dedicated air inlet, measure the test air temperature within two feet of any location on the water heater where combustion air is drawn.

3.5. Maximum Air Draft. During the steady-state verification period, the thermal efficiency test, and the standby loss test (as applicable), the water heater must be located in an area protected from drafts of more than 50 ft/min. Prior to beginning the steady-state verification period and the standby loss test, measure the air draft within three feet of the jacket or enclosure of the water heater to ensure this condition is met. Ensure that no other changes that would increase the air draft are made to the test set-up or conditions during the conduct of the tests.

3.6. Primary Control

3.6.1. *Thermostatically-Activated Water Heaters With an Internal Thermostat.* Before starting the thermal efficiency test and the standby loss test (unless the thermostat is already set before the thermal efficiency test), the thermostat setting must be obtained. Set the thermostat to ensure:

3.6.1.1. With supply water temperature set as per section 3.1.2 of this appendix (*i.e.*, 70 °F ± 2 °F) the water flow rate can be varied so that the outlet water temperature is constant at 70 °F ± 2 °F above the supply water temperature, while the burner is firing at full firing rate; and

3.6.1.2. After the water supply is turned off and the thermostat reduces the fuel supply to a minimum, the maximum heat exchanger outlet water temperature (T_{OHX}) is 140 °F ± 5 °F.

3.6.1.3. If the water heater includes a built-in safety mechanism that prevents it from achieving a heat exchanger outlet water temperature of 140 °F ± 5 °F, adjust the thermostat to its maximum setting.

3.6.2. *Flow-Activated Instantaneous Water Heaters and Thermostatically-Activated Instantaneous Water Heaters With an External Thermostat.* Energize the primary control such that it is always calling for heating and the burner is firing at the full firing rate. Maintain the supply water temperature as per section 3.1.2 of this appendix (*i.e.*, 70 °F ± 2 °F). Set the control so that the outlet water temperature (T_{OWT}) is 140 °F ± 5 °F. If the water heater includes a built-in safety mechanism that prevents it from achieving a heat exchanger outlet water temperature of 140 °F ± 5 °F, adjust the control to its maximum setting.

3.7. Units With Multiple Outlet Water Connections

3.7.1. For each connection leaving the water heater that is required for the unit to achieve the rated input, the outlet water temperature must not differ from that of any other outlet water connection by more than 2 °F during the steady-state verification period and thermal efficiency test.

3.7.2. Determine the outlet water temperature representative for the entire unit at every required measurement interval by calculating the average of the outlet water temperatures measured at each connection leaving the water heater jacket or enclosure that is used during testing. Use the outlet water temperature representative for the entire unit in all calculations for the thermal efficiency and standby loss tests, as applicable.

3.8. *Additional Requirements for Oil-Fired Equipment.*

3.8.1. Venting Requirements. Connect a vertical length of flue pipe to the flue gas outlet of sufficient height so as to meet the minimum draft specified by the manufacturer.

3.8.2. *Oil Supply.* Adjust the burner rate so that the following conditions are met:

3.8.2.1. The CO_2 reading is within the range specified by the manufacturer;

3.8.2.2. The fuel pump pressure is within ± 10 percent of manufacturer's specifications;

3.8.2.3. If either the fuel pump pressure or range for CO_2 reading are not specified by the manufacturer on the nameplate of the unit, in literature shipped with the unit, or in supplemental test report instructions included with a certification report, then a default value of 100 psig is to be used for fuel pump pressure, and a default range of 9–12 percent is to be used for CO_2 reading; and

3.8.2.4. Smoke in the flue does not exceed No. 1 smoke as measured by the procedure in ASTM D2156–09 (Reapproved 2013) (incorporated by reference, see §431.105). To determine the smoke spot number, the smoke measuring device shall be connected to an open-ended tube. This tube must project into the flue ¼ to ½ of the pipe diameter.

3.8.2.5. If no settings on the water heater have been changed and the water heater has not been turned off since the end of a previously run thermal efficiency (or standby loss test for thermostatically-activated instantaneous water heaters with an internal thermostat), measurement of the CO_2 reading and conduct of the smoke spot test are not required prior to beginning a test. Otherwise, measure the CO_2 reading and determine the smoke spot number, with the burner firing, before beginning measurements for the steady-state verification period (prior to beginning the thermal efficiency test or standby loss test, as applicable). However, measurement of the CO_2 reading and conduct of the smoke spot test are not required for the standby loss test for thermostatically-activated instantaneous water heaters with an external thermostat and flow-activated instantaneous water heaters.

3.9. Data Collection Intervals. Follow the data recording intervals specified in the following sections.

3.9.1. *Steady-State Verification Period and Thermal Efficiency Test*. For the steady-state verification period and the thermal efficiency test, follow the data recording intervals specified in Table 3.1 of this appendix. These data recording intervals must also be followed if conducting a steady-state verification period prior to conducting the standby loss test.

TABLE 3.1—DATA TO BE RECORDED BEFORE AND DURING THE STEADY-STATE VERIFICATION PERIOD AND THERMAL EFFICIENCY TEST

Item recorded	Before steady-state verification period	Every 1 minute[a]	Every 10 minutes
Gas supply pressure, in w.c.	X		
Gas outlet pressure, in w.c.	X		
Barometric pressure, in Hg	X		
Fuel higher heating value, Btu/ft^3 (gas) or Btu/lb (oil)	X		
Oil pump pressure, psig (oil only)	X		
CO_2 reading, % (oil only)	X[b]		
Oil smoke spot reading (oil only)	X[b]		
Air draft, ft/min	X		
Time, minutes/seconds		X	
Fuel weight or volume, lb (oil) or ft^3 (gas)			X[c]
Supply water temperature (T_{SWT}), °F		X	
Inlet water temperature (T_{IWT}), °F		X[d]	
Outlet water temperature (T_{OWT}), °F		X	
Ambient room temperature, °F		X	
Test air temperature, °F		X	
Water flow rate, gpm		X	

Notes:

[a] These measurements are to be recorded at the start and end of both the steady-state verification period and the thermal efficiency test, as well as every minute during both periods.

[b] The smoke spot test and CO_2 reading are not required prior to beginning the steady-state verification period if no settings on the water heater have been changed and the water heater has not been turned off since the end of a previously-run efficiency test (*i.e.,* thermal efficiency or standby loss).

[c] Fuel and electricity consumption over the course of the entire thermal efficiency test must be measured and used in calculation of thermal efficiency.

[d] Only measured when a recirculating loop is used.

3.9.2. *Standby Loss Test*. For the standby loss test, follow the data recording intervals specified in Table 3.2 of this appendix. (Follow the data recording intervals specified in Table 3.1 of this appendix of the steady-state verification period, if conducted prior to the standby loss test.) Additionally, the fuel and electricity consumption over the course of the entire test must be measured and used in calculation of standby loss.

TABLE 3.2—DATA TO BE RECORDED BEFORE AND DURING THE STANDBY LOSS TEST

Item recorded	Before test	Every 1 minute[a]
Gas supply pressure, in w.c.	X	
Gas outlet pressure, in w.c.	X	
Barometric pressure, in Hg	X	
Fuel higher heating value, Btu/ft^3 (gas) or Btu/lb (oil)	X	
Oil pump pressure, psig (oil only)	X	
Air draft, ft/min	X	
Time, minutes/seconds		X
Heat exchanger outlet water temperature (T_{OHX}), °F		X
Ambient room temperature, °F		X
Test air temperature, °F		X
Water flow rate, gpm	X[b]	
Inlet water temperature (T_{IWT}), °F	X[b]	

Notes:

[a] These measurements are to be recorded at the start and end of the test, as well as every minute during the test.

[b] The water flow rate and supply water temperature and inlet water temperature (if a recirculating loop is used) must be measured during the steady-state verification period at 1-minute intervals. After the steady-state verification period ends, flow rate, supply water temperature, and inlet water temperature (if measured) are not required to be measured during the standby loss test, as there is no flow occurring during the standby loss test.

4. *Determination of Storage Volume*. Determine the storage volume by subtracting the tare weight, measured while the system is dry and empty, from the weight of the system when filled with water and dividing the resulting net weight of water by the density

of water at the measured water temperature. The volume of water contained in the water heater must be computed in gallons.

5. Fuel Input Rate

5.1. Determination of Fuel Input Rate. During the steady-state verification period and thermal efficiency test, as applicable, record the fuel consumption at 10-minute intervals. Calculate the fuel input rate for each 10-minute period using the equations in section 5.2 of this appendix. The measured fuel input rates for these 10-minute periods must not vary by more than ± 2 percent between any two readings. Determine the overall fuel input rate using the fuel consumption for the entire duration of the thermal efficiency test.

5.2. Fuel Input Rate Calculation. To calculate the fuel input rate, use the following equation:

$$Q = \frac{Q_s * C_s * H}{t}$$

Where:

Q = Fuel input rate, expressed in Btu/h

Q_s = Total fuel flow as metered, expressed in ft^3 for gas-fired equipment and lb for oil-fired equipment

C_s = Correction applied to the heating value of a gas H, when it is metered at temperature and/or pressure conditions other than the standard conditions for which the value of H is based. C_s=1 for oil-fired equipment.

H = Higher heating value of the fuel, expressed as Btu/ft^3 for gas-fired equipment and Btu/lb for oil-fired equipment.

t = Duration of measurement of fuel consumption

6. *Thermal Efficiency Test.* Before beginning the steady-state verification period, record the applicable parameters as specified in section 3.9.1 of this appendix. Begin drawing water from the unit by opening the main supply and outlet water valve, and adjust the water flow rate to achieve an outlet water temperature of 70 °F ± 2 °F above supply water temperature. The thermal efficiency test shall be deemed complete when there is a continuous, one-hour-long period where the steady-state conditions specified in section 6.1 of this appendix have been met, as confirmed by consecutive readings of the relevant parameters at 1-minute intervals (except for fuel input rate, which is determined at 10-minute intervals, as specified in section 5.1 of this appendix). During the one-hour-long period, the water heater must fire continuously at its full firing rate (*i.e.*, no modulation or cut-outs) and no settings can be changed on the unit being tested at any time. The first 30 minutes of the one-hour-period where the steady-state conditions in section 6.1 of this appendix are met is the steady-state verification period. The final 30 minutes of the one-hour-period where the steady-state conditions in section 6.1 of this appendix are met is the thermal efficiency test. The last reading of the steady-state verification period must be the first reading of the thermal efficiency test (*i.e.*, the thermal efficiency test starts immediately once the steady-state verification period ends).

6.1. *Steady-State Conditions.* The following conditions must be met at consecutive readings taken at 1-minute intervals (except for fuel input rate, for which measurements are taken at 10-minute intervals) to verify the water heater has achieved steady-state operation during the steady-state verification period and the thermal efficiency test.

6.1.1. The water flow rate must be maintained within ± 0.25 gallons per minute (gpm) of the initial reading at the start of the steady-state verification period.

6.1.2. Outlet water temperature must be maintained at 70 °F ± 2 °F above supply water temperature.

6.1.3. Fuel input rate must be maintained within ± 2 percent of the rated input certified by the manufacturer.

6.1.4. The supply water temperature (T_{SWT}) (or inlet water temperature (T_{IWT}) if a recirculating loop is used) must be maintained within ± 0.50 °F of the initial reading at the start of the steady-state verification period.

6.1.5. The rise between supply (or inlet if a recirculating loop is used) and outlet water temperatures must be maintained within ± 0.50 °F of its initial value taken at the start of the steady-state verification period for units with rated input less than 500,000 Btu/h, and maintained within ± 1.00 °F of its initial value for units with rated input greater than or equal to 500,000 Btu/h.

6.2. *Water Flow Measurement.* Measure the total weight of water heated during the 30-minute thermal efficiency test with either a scale or a water flow meter. With either method, the error of measurement of weight of water heated must not exceed 1 percent of the weight of the total draw.

6.3. *Thermal Efficiency Calculation.* Thermal efficiency must be calculated using data from the 30-minute thermal efficiency test.

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ER10NO16.022</GPH>

Calculate thermal efficiency, E_t, using the following equation:

$$E_t = \frac{K * W * (\theta_2 - \theta_1)}{(C_s * Q * H) + E_c}$$

Where:

K = 1.004 Btu/lb· °F, the nominal specific heat of water at 105 °F

W = Total weight of water heated, lb

θ_1 = Average supply water temperature, expressed in °F

θ_2 = Average outlet water temperature, expressed in °F

Q = Total fuel flow as metered, expressed in ft^3 (gas) or lb (oil)

C_s = Correction applied to the heating value of a gas H, when it is metered at temperature and/or pressure conditions other than the standard conditions for which the value of H is based. C_s=1 for oil-fired equipment.

H = Higher heating value of the fuel, expressed in Btu/ft^3 (gas) or Btu/lb (oil)

E_c = Electrical consumption of the water heater and, when used, the test set-up recirculating pump, expressed in Btu

7. *Standby Loss Test*. If the standby loss test is conducted immediately after a thermal efficiency test and no settings or conditions have been changed since the completion of the thermal efficiency test, then skip to section 7.2 or 7.3 of this appendix (as applicable). Otherwise, perform the steady-state verification in section 7.1 of this appendix. For thermostatically-activated instantaneous water heaters with an internal thermostat, use section 7.2 of this appendix to conduct the standby loss test, and for flow-activated and/or thermostatically-activated instantaneous water heaters with an external thermostat use section 7.3 of this appendix to conduct the standby loss test.

7.1. *Steady-State Verification Period*. For water heaters where the standby loss test is not conducted immediately following the thermal efficiency test, the steady-state verification period must be conducted before starting the standby loss test. Set the primary control in accordance with section 3.6 of this appendix, such that the primary control is always calling for heat and the water heater is firing continuously at the full firing rate (*i.e.*, no modulation or cut-outs). Begin drawing water from the unit by opening the main supply and the outlet water valve, and adjust the water flow rate to achieve an outlet water temperature of 70 °F ± 2 °F above supply water temperature. The steady-state verification period is complete when there is a continuous 30-minute period where the steady-state conditions specified in section 7.1.1 of this appendix are met, as confirmed by consecutive readings of the relevant parameters recorded at 1-minute intervals (except for fuel input rate, which is determined at 10-minute intervals, as specified in section 5.1 of this appendix).

7.1.1. *Steady-State Conditions*. The following conditions must be met at consecutive readings taken at 1-minute intervals (except for fuel input rate, for which measurements are taken at 10-minute intervals) to verify the water heater has achieved steady-state operation during the steady-state verification period prior to conducting the standby loss test.

7.1.1.1. The water flow rate must be maintained within ± 0.25 gallons per minute (gpm) of the initial reading at the start of the steady-state verification period;

7.1.1.2. Fuel input rate must be maintained within ± 2 percent of the rated input certified by the manufacturer;

7.1.1.3. The supply water temperature (T_{SWT}) (or inlet water temperature (T_{IWT}) if a recirculating loop is used) must be maintained within ± 0.50 °F of the initial reading at the start of the steady-state verification period; and

7.1.1.4. The rise between the supply (or inlet if a recirculating loop is used) and outlet water temperatures must be maintained within ± 0.50 °F of its initial value taken at the start of the steady-state verification period for units with rated input less than 500,000 Btu/h, and maintained within ± 1.00 °F of its initial value for units with rated input greater than or equal to 500,000 Btu/h.

7.2. *Thermostatically-Activated Instantaneous Water Heaters with an Internal Thermostat*. For water heaters that will experience cut-in based on a temperature-activated control that is internal to the water heater, use the following steps to conduct the standby loss test.

7.2.1. Immediately after the thermal efficiency test or the steady-state verification period (as applicable), turn off the outlet water valve(s) (installed as per the provisions in section 2.2 of this appendix), and the water pump (if applicable) simultaneously and ensure that there is no flow of water through the water heater.

7.2.2. After the first cut-out following the end of the thermal efficiency test or steady-state verification period (as applicable), allow the water heater to remain in standby mode. Do not change any settings on the water heater at any point until measurements for the standby loss test are finished. Begin recording the applicable parameters specified in section 3.9.2 of this appendix.

7.2.3. At the second cut-out, record the time and ambient room temperature, and begin measuring the fuel and electricity consumption. Record the initial heat exchanger outlet water temperature (T_{OHX}) and initial ambient room temperature. For the remainder of the test, continue recording the applicable parameters specified in section 3.9.2 of this appendix.

7.2.4. Stop the test after the first cut-out that occurs after 24 hours, or at 48 hours, whichever comes first.

7.2.5. Immediately after conclusion of the standby loss test, record the total fuel flow and electrical energy consumption, the final ambient room temperature, the duration of the standby loss test, and if the test ends at 48 hours without a cut-out, the final heat exchanger outlet temperature, or if the test ends after a cut-out, the maximum heat exchanger outlet temperature that occurs after the cut-out. Calculate the average of the recorded values of the heat exchanger outlet water temperature and the ambient room temperature taken at each measurement interval, including the initial and final values.

7.2.6. *Standby Loss Calculation.* To calculate the standby loss, follow the steps below:

7.2.6.1. The standby loss expressed as a percentage (per hour) of the heat content of the stored water above room temperature must be calculated using the following equation:

$$S = \frac{E_c + (C_s)(Q_s)(H) - \left(\frac{k(V_a)(\Delta T_4)}{E_t/100}\right)}{k(V_a)(\Delta T_3)(t)} \times 100$$

Where:

ΔT_3 = Average value of the heat exchanger outlet water temperature (T_{OHX}) minus the average value of the ambient room temperature, expressed in °F

ΔT_4 = Final heat exchanger outlet water temperature (T_{OHX}) measured at the end of the test minus the initial heat exchanger outlet water temperature (T_{OHX}) measured at the start of the test, expressed in °F

K = 8.25 Btu/gallon· °F, the nominal specific heat of water

V_a = Volume of water contained in the water heater in gallons measured in accordance with section 4 of this appendix

E_t = Thermal efficiency of the water heater determined in accordance with section 6 of this appendix, expressed in %

E_c = Electrical energy consumed by the water heater during the duration of the test in Btu

T = Total duration of the test in hours

C_s = Correction applied to the heating value of a gas H, when it is metered at temperature and/or pressure conditions other than the standard conditions for which the value of H is based. C_s=1 for oil-fired equipment.

Q_s = Total fuel flow as metered, expressed in ft^3 (gas) or lb (oil)

H = Higher heating value of gas or oil, expressed in Btu/ft^3 (gas) or Btu/lb (oil)

S = Standby loss, the average hourly energy required to maintain the stored water temperature expressed as a percentage of the initial heat content of the stored water above room temperature

7.2.6.2. The standby loss expressed in Btu per hour must be calculated as follows:

SL (Btu per hour) = S (% per hour) × 8.25 (Btu/gal- °F) × Measured Volume (gal) × 70 (°F).

Where, SL refers to the standby loss of the water heater, defined as the amount of energy required to maintain the stored water temperature expressed in Btu per hour.

7.3. *Flow-Activated and Thermostatically-Activated Instantaneous Water Heaters with an External Thermostat.* For water heaters that are either flow-activated or thermostatically-activated with an external thermostat, use the following steps to conduct the standby loss test.

7.3.1. Immediately after the thermal efficiency test or the steady-state verification period (as applicable), de-energize the primary control to end the call for heating. If the main burners do not cut out, then turn off the fuel supply.

7.3.1.1. If the unit does not have an integral pump purge functionality, then turn off the outlet water valve and water pump at this time.

7.3.1.2. If the unit has an integral pump purge functionality, allow the pump purge operation to continue. After the pump purge operation is complete, immediately turn off the outlet water valve and water pump and continue recording the required parameters for the remainder of the test.

7.3.2. Recording Data

7.3.2.1. For units with pump purge functionality, record the initial heat exchanger outlet water temperature (T_{OHX}), and ambient room temperature when the main burner(s) cut-out or the fuel supply is turned off. After the pump purge operation is complete, record the time as t = 0 and the initial electricity meter reading. Continue to monitor and record the heat exchanger outlet water temperature (T_{OHX}) and time elapsed from the start of the test, and the electricity consumption as per the requirements in section 3.9.2 of this appendix.

7.3.2.2. For unit*s* not equipped with pump purge functionality, begin recording the measurements as per the requirements of section 3.9.2 of this appendix when the main burner(s) cut-out or the fuel supply is turned off. Specifically, record the time as t = 0, and record the initial heat exchanger outlet water temperature (T_{OHX}), ambient room temperature, and electricity meter readings. Continue to monitor and record the heat exchanger outlet water temperature (T_{OHX}) and the time elapsed from the start of the test as per the requirements in section 3.9.2 of this appendix.

7.3.3. *Stopping Criteria.* Stop the test when one of the following occurs:

7.3.3.1. The heat exchanger outlet water temperature (T_{OHX}) decreases by 35 °F from its value recorded immediately after the main burner(s) has cut-out, and the pump purge operation (if applicable) is complete; or

7.3.3.2. 24 hours have elapsed from the start of the test.

7.3.4. At the end of the test, record the final heat exchanger outlet water temperature (T_{OHX}), fuel consumed, electricity consumed from time t=0, and the time elapsed from the start of the test.

7.3.5. Standby Loss Calculation

7.3.5.1. Once the test is complete, use the following equation to calculate the standby loss as a percentage (per hour) of the heat content of the stored water above room temperature:

$$S = \frac{\frac{k(V_a)(\Delta T_1)}{E_t/100} + E_c}{k(V_a)(\Delta T_2)(t)} \times 100$$

Where,

ΔT_1 = Heat exchanger outlet water temperature (T_{OHX}) measured after the pump purge operation is complete (if the unit is integrated with pump purge functionality); or after the main burner(s) cut-out (if the unit is not equipped with pump purge functionality) minus heat exchanger outlet water temperature (T_{OHX}) measured at the end of the test, expressed in °F

ΔT_2 = Heat exchanger outlet water temperature (T_{OHX}) minus the ambient temperature, both measured after the main burner(s) cut-out, at the start of the test, expressed in °F

K = 8.25 Btu/gallon· °F, the nominal specific heat of water

V_a = Volume of water contained in the water heater in gallons measured in accordance with section 4 of this appendix

E_t = Thermal efficiency of the water heater determined in accordance with section 6 of this appendix, expressed in %

E_c = Electrical energy consumed by the water heater during the duration of the test in Btu

t = Total duration of the test in hours

S = Standby loss, the average hourly energy required to maintain the stored water temperature expressed as a percentage of the initial heat content of the stored water above room temperature

7.3.5.2. The standby loss expressed in terms of Btu per hour must be calculated as follows:

SL (Btu per hour) = S (% per hour) × 8.25 (Btu/gal- °F) × Measured Volume (gal) × 70 (°F)

Where, SL refers to the standby loss of the water heater, defined as the amount of energy required to maintain the stored water temperature expressed in Btu per hour.

[81 FR 79332, Nov. 10, 2016]

Appendix D to Subpart G of Part 431—Uniform Test Method for the Measurement of Standby Loss of Electric Instantaneous Water Heaters (Other Than Storage-Type Instantaneous Water Heaters)

Note: Prior to November 6, 2017, manufacturers must make any representations with respect to the energy use or efficiency of the subject commercial water heating equipment in accordance with the results of testing pursuant to this appendix or the procedures in 10 CFR 431.106 that were in place on January

1, 2016. On and after November 6, 2017, manufacturers must make any representations with respect to energy use or efficiency of electric instantaneous water heaters (other than storage-type instantaneous water heaters) in accordance with the results of testing pursuant to this appendix to demonstrate compliance with the energy conservation standards at 10 CFR 431.110.

1. General

Determine the standby loss (as applicable) in accordance with the following sections of this appendix.

2. Test Set-Up

2.1. *Placement of Water Heater*. A water heater for installation on combustible floors must be placed on a ¾-inch plywood platform supported by three 2 × 4-inch runners. If the water heater is for installation on noncombustible floors, suitable noncombustible material must be placed on the platform. When the use of the platform for a large water heater is not practical, the water heater may be placed on any suitable flooring. A wall-mounted water heater must be mounted on a simulated wall section.

2.2. *Test Configuration*. If the instantaneous water heater is not required to be tested using a recirculating loop, then set up the unit in accordance with Figure 2.1, 2.2, or 2.3 of this appendix (as applicable). If the unit is required to be tested using a recirculating loop, then set up the unit as per Figure 2.4 of this appendix.

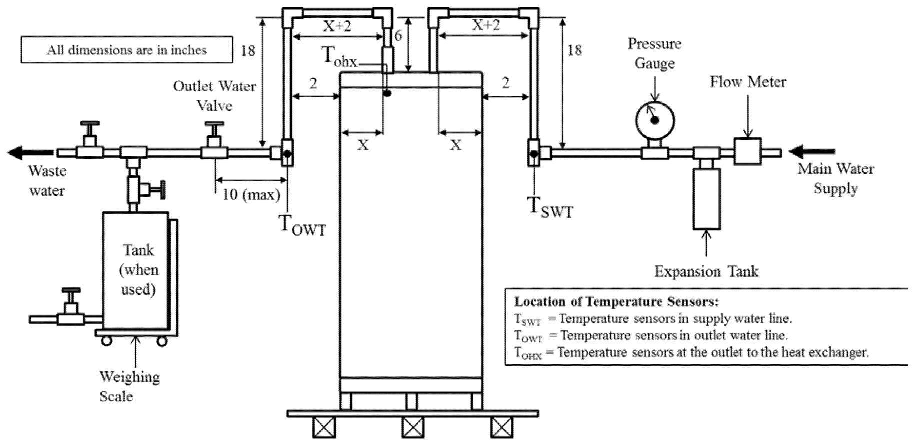

Figure 2.1. Set-up for standby loss test for electric instantaneous water heaters (other than storage-type instantaneous water heaters) equipped with vertical (top) connections not requiring a recirculating loop.

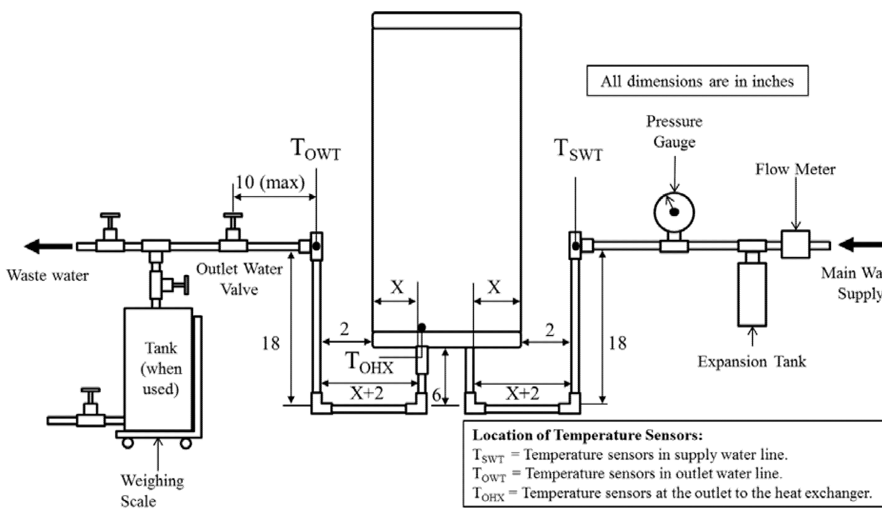

Figure 2.2. Set-up for standby loss test for electric instantaneous water heaters (other than storage-type instantaneous water heaters) equipped with vertical (bottom) connections not requiring a recirculating loop.

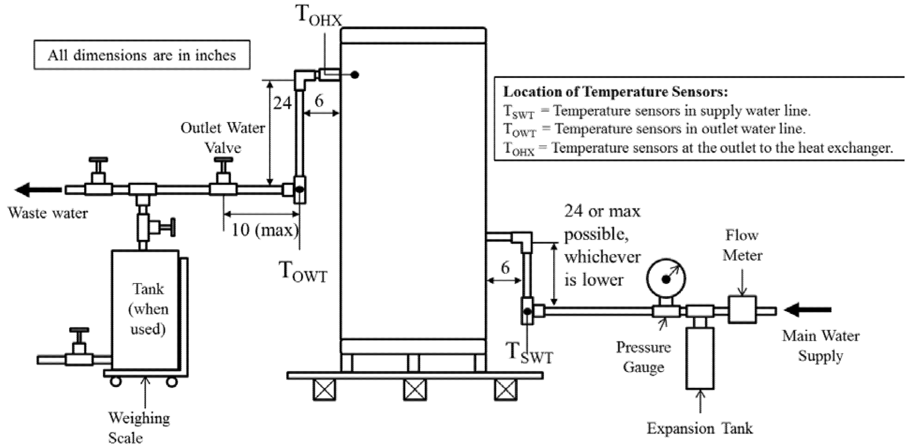

Figure 2.3. Set-up for standby loss test for electric instantaneous water heaters (other than storage-type instantaneous water heaters) equipped with horizontal connections not requiring a recirculating loop.

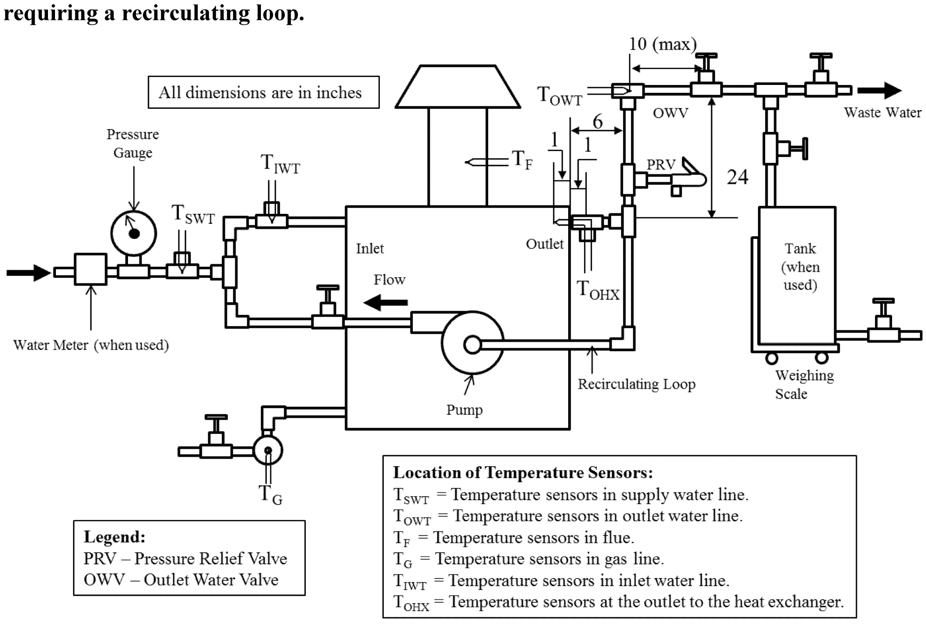

Figure 2.4. Set-up for standby loss test for electric instantaneous water heaters (other than storage-type instantaneous water heaters) requiring a recirculating loop for testing.

2.2.1. If the instantaneous water heater does not have any external piping, install an outlet water valve within 10 inches of the piping length of the water heater jacket or enclosure. If the instantaneous water heater includes external piping assembled at the manufacturer's premises prior to shipment, install water valves in the outlet piping within 5 inches of the end of the piping supplied with the unit.

2.2.2. If the water heater is not able to achieve an outlet water temperature of 70 °F ± 2 °F above the supply water temperature at a constant maximum electricity input rate, a recirculating loop with pump as shown in Figure 2.4 of this appendix must be used.

2.2.2.1. If a recirculating loop with a pump is used, then ensure that the inlet water temperature (labeled as T_{IWT} in Figure 2.4 of this appendix) is greater than or equal to 70 °F and less than or equal to 120 °F at all times during the steady-state verification period.

2.3. Installation of Temperature Sensors

2.3.1. Without Recirculating Loop

2.3.1.1. *Vertical Connections*. Use Figure 2.1 (for top connections) and 2.2 (for bottom connections) of this appendix.

2.3.1.2. *Horizontal Connections*. Use Figure 2.3 of this appendix.

2.3.2. *With Recirculating Loop*. Set up the recirculating loop as shown in Figure 2.4 of this appendix.

2.3.3. For water heaters with multiple outlet water connections leaving the water heater jacket that are required to be operated to achieve the rated input, temperature sensors must be installed for each outlet water connection leaving the water heater jacket or enclosure that is used during testing, in accordance with sections 2.3.1 and 2.3.2 of this appendix.

2.4. *Piping Insulation*. Insulate all the water piping external to the water heater jacket or enclosure, including piping that is installed by the manufacturer or shipped with the unit, for at least 4 ft of piping length from the connection at the appliance with material having an R-value not less than 4 °F·f ^{t2}·h/Btu. Ensure that the insulation does not contact any appliance surface except at the location where the pipe connections penetrate the appliance jacket or enclosure.

2.5. *Temperature and Pressure Relief Valve Insulation*. If the manufacturer has not provided a temperature and pressure relief valve, one shall be installed and insulated as specified in section 2.4 of this appendix. The temperature and pressure relief valve must be installed in the outlet water piping between the unit being tested and the outlet water valve.

2.6. *Energy Consumption*. Install equipment that determines, within ± 1 percent, the quantity of electricity consumed by factory-supplied water heater components, and of the test loop recirculating pump, if used.

3. Test Conditions

3.1. Water Supply

3.1.1. *Water Supply Pressure*. The pressure of the water supply must be maintained between 40 psi and the maximum pressure specified by the manufacturer of the unit being tested. The accuracy of the pressure-measuring devices must be ± 1.0 psi.

3.1.2. *Water Supply Temperature*. During the steady-state verification period, the temperature of the supply water (T_{SWT}) must be maintained at 70 °F ± 2 °F.

.2. *Electrical Supply*. Maintain the electrical supply voltage to within ± 5 percent of the voltage specified on the water heater nameplate. If a voltage range is specified on the nameplate, maintain the voltage to within ± 5 percent of the center of the voltage range specified on the nameplate.

3.3. *Ambient Room Temperature*. Maintain the ambient room temperature at 75 °F ± 10 °F at all times during the steady-state verification period and the standby loss test. Measure the ambient room temperature at 1-minute intervals during these periods. Measure the ambient room temperature at the vertical mid-point of the water heater and approximately 2 feet from the water heater jacket or enclosure. Shield the sensor against radiation. Calculate the average ambient room temperature for the standby loss test. During the standby loss test, the ambient room temperature must not vary more than ± 5.0 °F at any reading from the average ambient room temperature.

3.4. *Maximum Air Draft*. During the steady-state verification period and the standby loss test, the water heater must be located in an area protected from drafts of more than 50 ft/min. Prior to beginning steady-state verification before the standby loss test, measure the air draft within three feet of the jacket or enclosure of the water heater to ensure this condition is met. Ensure that no other changes that would increase the air draft are made to the test set-up or conditions during the conduct of the test.

3.5. Primary Control

3.5.1. *Thermostatically-Activated Water Heaters with an Internal Thermostat*. Before starting the steady-state verification prior to the standby loss test, the thermostat setting must be obtained. Set the thermostat to ensure:

3.5.1.1. With supply water temperature as per section 3.1.2 of this appendix (*i.e.*, 70 °F ± 2 °F) the water flow rate can be varied so that the outlet water temperature is constant at 70 °F ± 2 °F above the supply water temperature, while the heating element is operating at the rated input.

3.5.1.2. After the water supply is turned off and the thermostat reduces the electricity supply to the heating element to a minimum, the maximum heat exchanger outlet water temperature (T_{OHX}) is 140 °F ± 5 °F.

3.5.1.3. If the water heater includes a built-in safety mechanism that prevents it from achieving a heat exchanger outlet water temperature of 140 °F ± 5 °F, adjust the thermostat to its maximum setting.

3.5.2. *Flow-Activated Instantaneous Water Heaters and Thermostatically-Activated Instantaneous Water Heaters with an External Thermostat*. Before starting the steady-state verification prior to the standby loss test energize the primary control such that it is always calling for heating and the heating element is operating at the rated input. Maintain the supply water temperature as per section 3.1.2 of this appendix (*i.e.*, 70 °F ± 2 °F). Set the control so that the outlet water temperature (T_{OWT}) is 140 °F ± 5 °F. If the water heater includes a built-in safety mechanism that prevents it from achieving a heat exchanger outlet water temperature of 140 °F ± 5 °F, adjust the control to its maximum setting.

3.6. For Units With Multiple Outlet Water Connections

3.6.1. For each connection leaving the water heater that is required for the unit to achieve the rated input, the outlet water temperature must not differ from that of any other outlet water connection by more than 2 °F during the steady-state verification period prior to the standby loss test.

3.6.2. Determine the outlet water temperature representative for the entire unit at every required measurement interval by calculating the average of the outlet water temperatures measured at each connection leaving the water heater jacket or enclosure that is used during testing. Use the outlet water temperature representative for the entire unit in all calculations for the standby loss test.

3.7. *Data Collection Intervals*. During the standby loss test, follow the data recording intervals specified in Table 3.1 of this appendix. Also, the electricity consumption over the course of the entire test must be measured and used in calculation of standby loss.

3.7.1. *Steady-State Verification Period*. Follow the data recording intervals specified in Table 3.1 of this appendix.

TABLE 3.1—DATA TO BE RECORDED BEFORE AND DURING THE STEADY-STATE VERIFICATION PERIOD

Item recorded	Before steady-state verification period	Every 1 minute [a]	Every 10 minutes
Air draft, ft/min	X		
Time, minutes/seconds		X	
Electricity Consumed, Btu			X
Supply water temperature (T_{SWT}), °F		X	
Inlet water temperature (T_{IWT}), °F		X [b]	
Outlet water temperature (T_{OWT}), °F		X	
Ambient room temperature, °F		X	
Water flow rate, (gpm)		X	

Notes:
[a] These measurements are to be recorded at the start and end, as well as every minute of the steady-state verification period.
[b] Only measured when a recirculating loop is used.

3.7.2. *Standby Loss Test*. Follow the data recording intervals specified in Table 3.2 of this appendix. Additionally, the electricity consumption over the course of the entire test must be measured and used in calculation of standby loss.

TABLE 3.2—DATA TO BE RECORDED BEFORE AND DURING THE STANDBY LOSS TEST

Item recorded	Before test	Every 1 minute [a]
Air draft, ft/min	X	
Time, minutes/seconds.		X
Heat exchanger outlet water temperature, °F (T_{OHX}).		X
Ambient room temperature, °F.		X

Note:
[a] These measurements are to be recorded at the start and end of the test, as well as every minute during the test.

4. *Determination of Storage Volume*. Determine the storage volume by subtracting the tare weight—measured while the system is dry and empty—from the weight of the system when filled with water and dividing the resulting net weight of water by the density of water at the measured water temperature. The volume of water contained in the water heater must be computed in gallons.

5. *Standby Loss Test*. Perform the steady-state verification period in accordance with section 5.1 of this appendix. For thermostatically-activated instantaneous water heaters with an internal thermostat, use section 5.2 of this appendix to conduct the standby loss test, and for flow-activated and/or thermostatically-activated instantaneous water heaters with an external thermostat (including remote thermostatically activated and/or flow-activated instantaneous water heaters), use section 5.3 of this appendix to conduct the standby loss test.

Set the primary control in accordance with section 3.5 of this appendix, such that the primary control is always calling for heat and the water heater is operating at its full rated input. Begin drawing water from the unit by opening the main supply and the outlet water valve, and adjust the water flow rate to achieve an outlet water temperature of 70 °F ± 2 °F above supply water temperature. At this time, begin recording the parameters specified in section 3.7.1 of this appendix. The steady-state verification period is complete when there is a continuous 30-minute period where the steady-state conditions specified in section 5.1 of this appendix are met, as confirmed by consecutive readings of the relevant parameters recorded at 1-minute intervals (except for electric power input rate, which is determined at 10-minute intervals, as specified in section 3.7.1 of this appendix).

5.1. *Steady-State Conditions.* The following conditions must be met at consecutive readings taken at 1-minute intervals (except for electricity input rate, for which measurements are taken at 10-minute intervals) to verify the water heater has achieved steady-state operation prior to conducting the standby loss test.

5.1.1. The water flow rate must be maintained within ± 0.25 gallons per minute (gpm) of the initial reading at the start of the steady-state verification period;

5.1.2. Electric power input rate must be maintained within 2 percent of the rated input certified by the manufacturer.

5.1.3. The supply water temperature (or inlet water temperature if a recirculating loop is used) must be maintained within ± 0.50 °F of the initial reading at the start of the steady-state verification period; and

5.1.4. The rise between the supply (or inlet if a recirculating loop is used) and outlet water temperatures is maintained within ± 0.50 °F of its initial value taken at the start of the steady-state verification period for units with rated input less than 500,000 Btu/h, and maintained within ± 1.00 °F of its initial value for units with rated input greater than or equal to 500,000 Btu/h.

5.2. *Thermostatically-Activated Instantaneous Water Heaters with an Internal Thermostat.* For water heaters that will experience cut-in based on a temperature-activated control that is internal to the water heater, use the following steps to conduct the standby loss test.

5.2.1. Immediately after the steady-state verification period, turn off the outlet water valve(s) (installed as per the provisions in section 2.2 of this appendix), and the water pump (if applicable) simultaneously and ensure that there is no flow of water through the water heater.

5.2.2. After the first cut-out following the steady-state verification period, allow the water heater to remain in standby mode. Do not change any settings on the water heater at any point until measurements for the standby loss test are finished. Begin recording the applicable parameters specified in section 3.7.2 of this appendix.

5.2.3. At the second cut-out, record the time and ambient room temperature, and begin measuring the electricity consumption. Record the initial heat exchanger outlet water temperature (T_{OHX}) and initial ambient room temperature. For the remainder of the test, continue recording the applicable parameters specified in section 3.7.2 of this appendix.

5.2.4. Stop the test after the first cut-out that occurs after 24 hours, or at 48 hours, whichever comes first.

5.2.5. Immediately after conclusion of the standby loss test, record the total electrical energy consumption, the final ambient room temperature, the duration of the standby loss test, and if the test ends at 48 hours without a cut-out, the final heat exchanger outlet temperature, or if the test ends after a cut-out, the maximum heat exchanger outlet temperature that occurs after the cut-out. Calculate the average of the recorded values of the heat exchanger outlet water temperature and of the ambient air temperatures taken at each measurement interval, including the initial and final values.

5.2.6. *Standby Loss Calculation.* Calculate the standby loss, expressed as a percentage (per hour) of the heat content of the stored water above room temperature, using the following equation:

$$S = \frac{E_c - \left(\frac{k(V_a)(\Delta T_4)}{E_t/100}\right)}{k(V_a)(\Delta T_3)(t)} \times 100$$

Where,

ΔT_3 = Average value of the heat exchanger outlet water temperature (T_{OHX}) minus the average value of the ambient room temperature, expressed in °F

ΔT_4 = Final heat exchanger outlet water temperature (T_{OHX}) measured at the end of the test minus the initial heat exchanger outlet water temperature (T_{OHX})

measured at the start of the test, expressed in °F

k = 8.25 Btu/gallon· °F, the nominal specific heat of water

V_a = Volume of water contained in the water heater in gallons measured in accordance with section 4 of this appendix

E_t = Thermal efficiency = 98 percent for electric water heaters with immersed heating elements

E_c = Electrical energy consumed by the water heater during the duration of the test in Btu

t = Total duration of the test in hours

S = Standby loss, the average hourly energy required to maintain the stored water temperature expressed as a percentage of the initial heat content of the stored water above room temperature

5.3. *Flow-Activated and Thermostatically-Activated Instantaneous Water Heaters with an External Thermostat*. For water heaters that are either flow-activated or thermostatically-activated with an external thermostat, use the following steps to conduct the standby loss test:

5.3.1. Immediately after the steady-state verification period, de-energize the primary control to end the call for heating. If the heating elements do not cut out, then turn off the electricity supply to the heating elements. After the heating elements have cut-out, or the electricity supply to the heating elements is turned off, begin recording the measurements as per the requirements in section 3.7.2 of this appendix.

5.3.1.1. If the unit does not have an integral pump purge functionality, then turn off the outlet water valve and water pump immediately after the main burners cut-out.

5.3.1.2. If the unit has an integral pump purge functionality, allow the pump purge operation to continue. After the pump purge operation is complete, immediately turn off the outlet water valve and water pump and continue recording the required parameters for the remainder of the test.

5.3.2. Recording Data

5.3.2.1. For units with pump purge functionality, record the initial heat exchanger outlet water temperature (T_{OHX}), and ambient room temperature when the main heating element(s) cut-out or the electricity supply to the heating element(s) is turned off. After the pump purge operation is complete, record the time as t = 0 and the initial electricity meter reading. Continue to monitor and record the heat exchanger outlet water temperature (T_{OHX}) and time elapsed from the start of the test as per the requirements in section 3.7.2 of this appendix.

5.3.2.2. For units not equipped with pump purge functionality, begin recording the measurements as per the requirements of section 3.7.2 of this appendix when the main heating element(s) cut-out or the electricity supply to the heating element(s) is turned off. Specifically, record the time as t = 0, and record the initial heat exchanger outlet water temperature (T_{OHX}), ambient room temperature, and electricity meter readings. Continue to monitor and record the heat exchanger outlet water temperature (T_{OHX}) and the time elapsed from the start of the test as per the requirements in section 3.7.2 of this appendix.

5.3.3. *Stopping Criteria*. Stop the test when one of the following occurs:

5.3.3.1. The heat exchanger outlet water temperature (T_{OHX}) decreases by 35 °F from its value recorded after the main heating element(s) have cut-out, and the pump purge operation (if applicable) is complete; or

5.3.3.2. 24 hours have elapsed from the start of the test.

5.3.4. At the end of the test, record the final heat exchanger outlet water temperature (T_{OHX}), electricity consumed from time t = 0, and the time elapsed from the start of the test.

5.3.5. *Standby Loss Calculation*. Calculate the standby loss, expressed as a percentage (per hour) of the heat content of the stored water above room temperature, using the following equation:

$$S = \frac{\frac{k(V_a)(\Delta T_1)}{E_t/100} + E_c}{k(V_a)(\Delta T_2)(t)} \times 100$$

Where,

ΔT_1 = Heat exchanger outlet water temperature (T_{OHX}) measured after the pump purge operation is complete (if the unit is integrated with pump purge functionality); or after the main heating element(s) cut-out (if the unit is not equipped with pump purge functionality) minus heat exchanger outlet water temperature (T_{OHX}) measured at the end of the test, expressed in °F

ΔT_2 = Heat exchanger outlet water temperature (T_{OHX}) minus the ambient room temperature, both measured after the main heating element(s) cut-out at the start of the test, expressed in °F

k = 8.25 Btu/gallon· °F, the nominal specific heat of water

V_a = Volume of water contained in the water heater in gallons measured in accordance with section 4 of this appendix

E_t = Thermal efficiency = 98 percent for electric water heaters with immersed heating elements

E_c = Electrical energy consumed by the water heater during the duration of the test in Btu

t = Total duration of the test in hours

S = Standby loss, the average hourly energy required to maintain the stored water temperature expressed as a percentage of the initial heat content of the stored water above room temperature

[81 FR 79340, Nov. 10, 2016]

APPENDIX E TO SUBPART G OF PART 431—UNIFORM TEST METHOD FOR THE MEASUREMENT OF ENERGY EFFICIENCY OF COMMERCIAL HEAT PUMP WATER HEATERS

Note: On and after November 6, 2017, manufacturers must make any representations with respect to energy use or efficiency of commercial heat pump water heaters in accordance with the results of testing pursuant to this appendix.

1. General. Determine the COP_h for commercial heat pump water heaters (CHPWHs) using the test procedure set forth below. Certain sections below reference ANSI/ASHRAE 118.1–2012 (incorporated by reference; see §431.105). Where the instructions contained below differ from those contained in ANSI/ASHRAE 118.1–2012, the sections in this appendix control.

2. Definitions and Symbols. The definitions and symbols are as listed in section 3 of ANSI/ASHRAE 118.1–2012.

3. Instrumentation. The instruments required for the test are as described in section 6 of ANSI/ASHRAE 118.1–2012 (except sections 6.3, 6.4, and 6.6).

4. Test Set-Up. Follow the provisions described in this section to install the CHPWH for testing. Use the test set-up and installation instructions set forth for Type IV and Type V equipment (as applicable), defined in sections 4.4 and 4.5 of ANSI/ASHRAE 118.1–2012 and in accordance with the sections below:

4.1. Test set-up and installation instructions.

4.1.1. For air-source CHPWHs, set up the unit for testing as per section 7.1 and Figure 5a of ANSI/ASHRAE 118.1–2012 for CHPWHs without an integral storage tank, and as per Figure 6 in section 7.7.1 of ANSI/ASHRAE 118.1–2012 for CHPWHs with an integral storage tank.

4.1.2. For direct geo-exchange CHPWHs, set up the unit for testing as per section 7.1 and Figure 5b of ASNI/ASHRAE 118.1–2012 for CHPWHs without an integral storage tank, and as per Figure 7 in section 7.7.2 of ANSI/ASHRAE 118.1–2012 for CHPWHs with an integral storage tank.

4.1.3. For indoor water-source, ground-source closed-loop, and ground water-source CHPWHs, set up the unit for testing as per section 7.1 and Figure 5c of ANSI/ASHRAE 118.1–2012 for CHPWHs without an integral storage tank, and as per Figure 8 in section 7.7.3 of ANSI/ASHRAE 118.1–2012 for CHPWHs with an integral storage tank.

4.2. Use the water piping instructions described in section 7.2 of ANSI/ASHRAE 118.1–2012 and the special instructions described in section 7.7.6 of ANSI/ASHRAE 118.1–2012. Insulate all the pipes used for connections with material having a thermal resistance of not less than 4 h· °F·ft²/Btu for a total piping length of not less than 4 feet from the water heater connection ports.

4.3. Install the thermocouples, including the room thermocouples, as per the instructions in sections 7.3.1, 7.3.2, and 7.3.3 (as applicable) of ANSI/ASHRAE 118.1–2012.

4.4. Section 7.6 of ANSI/ASHRAE 118.1–2012 must be used if the manufacturer neither submits nor specifies a water pump applicable for the unit for laboratory testing.

4.5. Install the temperature sensors at the locations specified in Figure 5a, 5b, 5c, 6, 7, or 8 of ANSI/ASHRAE 118.1–2012, as applicable as per section 4.1 of this appendix. The sensor shall be installed in such a manner that the sensing portion of the device is positioned within the water flow and as close as possible to the center line of the pipe. Follow the instructions provided in sections 7.7.7.1 and 7.7.7.2 of ANSI/ASHRAE 118.1–2012 to install the temperature and flow-sensing instruments.

4.6. Use the following evaporator side rating conditions as applicable for each category of CHPWHs. These conditions are also mentioned in Table 5.1 of this appendix:

4.6.1. For air-source CHPWHs, maintain the evaporator air entering dry-bulb temperature at 80.6 °F ± 1 °F and wet-bulb temperature at 71.2 °F ± 1 °F throughout the conduct of the test.

4.6.2. For direct geo-exchange CHPWHs, maintain the evaporator refrigerant temperature at 32 °F ± 1 °F.

4.6.3. For indoor water-source CHPWHs, maintain the evaporator entering water temperature at 68 °F ± 1 °F.

4.6.4. For ground water-source CHPWHs, maintain the evaporator entering water temperature at50 °F ± 1 °F.

4.6.5. For ground-source closed-loop CHPWHs, maintain the evaporator entering water temperature at 32 °F ± 1 °F.

4.6.5.1. For ground-source closed-loop CHPWHs, the evaporator water must be mixed with 15-percent methanol by-weight to allow the solution to achieve the rating conditions required in section 4.6.5.

4.7. The CHPWH being tested must be installed as per the instructions specified in sections 4.1 to 4.6 (as applicable) of this appendix. For all other installation requirements, use section 7.7.4 of ANSI/ASHRAE 118.1–2012 to resolve any issues related to installation (other than what is specified in this test procedure) of the equipment for testing. Do not make any alterations to the equipment except as specified in this appendix for installation, testing, and the attachment of required test apparatus and instruments.

4.8. Use Table 3 of ANSI/ASHRAE 118.1–2012 for measurement tolerances of various parameters.

4.9. If the CHPWH is equipped with a thermostat that is used to control the throttling valve of the equipment, then use the provisions in section 7.7.7.3 of ANSI/ASHRAE 118.1–2012 to set up the thermostat.

4.10. For CHPWHs equipped with an integral storage tank, supplemental heat inputs such as electric resistance elements must be disabled as per section 7.7.8 of ANSI/ASHRAE 118.1–2012.

4.11. Install instruments to measure the electricity supply to the equipment as specified in section 7.5 of ANSI/ASHRAE 118.1–2012.

5. Test Procedure

Test all CHPWHs that are not equipped with an integral storage tank as per the provisions described in ANSI/ASHRAE 118.1–2012 for ‘‘Type IV’’ equipment as defined in section 4.4 of ANSI/ASHRAE 118.1–2012. Test all CHPWHs that are equipped with an integral storage tank as per the provisions described in ANSI/ASHRAE 118.1–2012 for ‘‘Type V’’ equipment as defined in section 4.5 of ANSI/ASHRAE 118.1–2012. Tests for all CHPWHs must follow the steps described below.

5.1. Supply the CHPWH unit with electricity at the voltage specified by the manufacturer. Follow the provisions in section 8.2.1 of ANSI/ASHRAE 118.1–2012 to maintain the electricity supply at the required level.

5.1.1. For models with multiple voltages specified by the manufacturer, use the minimum voltage specified by the manufacturer to conduct the test. Maintain the voltage as per the limits specified in section 8.2.1 of ANSI/ASHRAE 118.1–2012. The test may be repeated at other voltages at the manufacturer's discretion.

5.2. Set the condenser supply water temperature and outlet water temperature per the following provisions and as set forth in Table 5.1 of this section:

TABLE 5.1—EVAPORATOR AND CONDENSER SIDE RATING CONDITIONS

Category of CHPWH	Evaporator side rating conditions	Condenser side rating conditions
Air-source commercial heat pump water heater.	Evaporator entering air conditions:. Dry bulb: 80.6 °F ± 1 °F .... Wet bulb: 71.2 °F ± 1 °F	Entering water temperature: 70 °F ± 1 °F. Vary water flow rate (if needed) to achieve the outlet water temperature as specified in section 8.7.2 of ANSI/ASHRAE 118.1–2012. If the required outlet water temperature as specified in section 8.7.2 of ANSI/ASHRAE 118.1–2012 is not met even after varying the flow rate, then change the condenser entering water temperature to 110 °F ± 1 °F. Vary flow rate to achieve the conditions in section 8.7.2 of ANSI/ASHRAE 118.1–2012.
Direct geo-exchange commercial heat pump water heater.	Evaporator refrigerant temperature: 32 °F ± 1 °F.	Entering water temperature: 110 °F ± 1 °F.
Indoor water-source commercial heat pump water heater.	Evaporator entering water temperature: 68 °F ± 1 °F.	Entering water temperature: 110 °F ± 1 °F.
Ground water-source commercial heat pump water heater.	Evaporator entering water temperature: 50 °F ± 1 °F.	Entering water temperature: 110 °F ± 1 °F.
Ground-source closed-loop commercial heat pump water heater.	Evaporator entering water temperature: 32 °F ± 1 °F.	Entering water temperature: 110 °F ± 1 °F.

5.2.1. For air-source CHPWHs:

5.2.1.1. Set the supply water temperature to 70 °F ± 1 °F. The water pressure must not exceed the maximum working pressure rating for the equipment under test.

5.2.1.2. Use the provisions in section 8.7.1 of ANSI/ASHRAE 118.1–2012 to set the tank thermostat for CHPWHs equipped with an integral storage tank.

5.2.1.3. Initiate operation at the rated pump flow rate and measure the outlet water temperature. If the outlet water temperature is maintained at 120 °F ± 5 °F with no variation in excess of 2 °F over a three-minute period, as required by section 8.7.2 of ANSI/ASHRAE 118.1–2012, skip to section 5.3 of this appendix.

5.2.1.4. If the outlet water temperature condition as specified in section 8.7.2 of ANSI/ASHRAE 118.1–2012 is not achieved, adjust the water flow rate over the range of the pump's capacity. If, after varying the water flow rate, the outlet water temperature is maintained at 120 °F ± 5 °F with no variation in excess of 2 °F over a three-minute period, as required by section 8.7.2 of ANSI/ASHRAE 118.1–2012, skip to section 5.3 of this appendix.

5.2.1.5. If, after adjusting the water flow rate within the range that is achievable by the pump, the outlet water temperature condition as specified in section 8.7.2 of ANSI/ASHRAE 118.1–2012 is still not achieved, then change the supply water temperature to 110 °F ± 1 °F and repeat the instructions from sections 5.2.1.2 and 5.2.1.4 of this appendix.

5.2.1. 6. If the outlet water temperature condition cannot be met, then a test procedure waiver is necessary to specify an alternative set of test conditions.

5.2.2. For direct geo-exchange, indoor water-source, ground-source closed-loop, and ground water-source CHPWHs use the following steps:

5.2.2.1. Set the condenser supply water temperature to 110 °F ± 1 °F. The water pressure must not exceed the maximum working pressure rating for the equipment under test.

5.2.2.2. Use the provisions in section 8.7.1 of ANSI/ASHRAE 118.1–2012 to set the tank thermostat for CHPWHs equipped with an integral storage tank.

5.2.2.3. Follow the steps specified in section 8.7.2 of ANSI/ASHRAE 118.1–2012 to obtain an outlet water temperature of 120 °F ± 5 °F with no variation in excess of 2 °F over a three-minute period.

5.3. Conduct the test as per section 9.1.1, ''Full Input Rating,'' of ANSI/ASHRAE 118.1–2012. The flow rate, ''FR,'' referred to in section 9.1.1 of ANSI/ASHRAE 118.1–2012 is the flow rate of water through the CHPWH expressed in gallons per minute obtained after following the steps in section 5.2 of this appendix. Use the evaporator side rating conditions specified in section 4.6 of this appendix to conduct the test as per section 9.1.1 of ANSI/ASHRAE 118.1–2012.

5.4. Calculate the COP_h of the CHPWH according to section 10.3.1 of the ANSI/ASHRAE 118.1–2012 for the ''Full Capacity Test Method.'' For all calculations, time differences must be expressed in minutes.

[81 FR 79346, Nov. 10, 2016]

Subpart H—Automatic Commercial Ice Makers

SOURCE: 70 FR 60415, Oct. 18, 2005, unless otherwise noted.

§ 431.131 Purpose and scope.

This subpart contains energy conservation requirements for commercial ice makers, pursuant to Part C of Title III of the Energy Policy and Conservation Act, as amended, 42 U.S.C. 6311–6317.

§ 431.132 Definitions concerning automatic commercial ice makers.

Automatic commercial ice maker means a factory-made assembly (not necessarily shipped in 1 package) that—

(1) Consists of a condensing unit and ice-making section operating as an integrated unit, with means for making and harvesting ice; and

(2) May include means for storing ice, dispensing ice, or storing and dispensing ice.

Baffle means a partition (usually made of flat material like cardboard, plastic, or sheet metal) that reduces or prevents recirculation of warm air from an ice maker's air outlet to its air inlet—or, for remote condensers, from the condenser's air outlet to its inlet.

Basic model means all units of a given type of covered product (or class thereof) manufactured by one manufacturer, having the same primary energy source, and which have essentially identical electrical, physical, and functional (or hydraulic) characteristics that affect energy consumption, energy efficiency, water consumption, or water efficiency.

Batch type ice maker means an ice maker having alternate freezing and harvesting periods.

Condenser water use means the total amount of water used by the condensing unit (if water-cooled), stated in gallons per 100 pounds (gal/100 lb) of ice, in multiples of 1.

Continuous type ice maker means an ice maker that continually freezes and harvests ice at the same time.

Energy use means the total energy consumed, stated in kilowatt hours per one-hundred pounds (kWh/100 lb) of ice, in multiples of 0.01. For remote condensing (but not remote compressor) automatic commercial ice makers and remote condensing and remote compressor automatic commercial ice makers, total energy consumed shall include the energy use of the ice-making mechanism, the compressor, and the remote condenser or condensing unit.

Harvest rate means the amount of ice (at 32 degrees F) in pounds produced per 24 hours.

Ice hardness factor means the latent heat capacity of harvested ice, in British thermal units per pound of ice (Btu/lb), divided by 144 Btu/lb, expressed as a percent.

Ice-making head means automatic commercial ice makers that do not contain integral storage bins, but are generally designed to accommodate a variety of bin capacities. Storage bins entail additional energy use not included in the reported energy consumption figures for these units.

Portable automatic commercial ice maker means an automatic commercial ice maker that does not have a means to connect to a water supply line and has one or more reservoirs that are manually supplied with water.

Potable water use means the amount of potable water used in making ice, which is equal to the sum of the ice harvested, dump or purge water, and the harvest water, expressed in gal/100 lb, in multiples of 0.1, and excludes any condenser water use.

Refrigerated storage automatic commercial ice maker means an automatic commercial ice maker that has a refrigeration system that actively refrigerates the self-contained ice storage bin.

Remote compressor means a type of automatic commercial ice maker in which the ice-making mechanism and compressor are in separate sections.

Remote condensing means a type of automatic commercial ice maker in which the ice-making mechanism and condenser or condensing unit are in separate sections.

Self-contained means a type of automatic commercial ice maker in which the ice-making mechanism and storage compartment are in an integral cabinet.

[70 FR 60415, Oct. 18, 2005, as amended at 71 FR 71371, Dec. 8, 2006; 76 FR 12503, Mar. 7, 2011; 77 FR 1613, Jan. 11, 2012; 87 FR 65899, Nov. 1, 2022]

TEST PROCEDURES

§ 431.133 Materials incorporated by reference.

Certain material is incorporated by reference into this subpart with the approval of the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. To enforce any edition other than that specified in this section, the U.S. Department of Energy (DOE) must publish a document in the FEDERAL REGISTER and the material must be available to the public. All approved incorporation by reference (IBR) material is available for inspection at DOE and at the National Archives and Records Administration (NARA). Contact DOE at: the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Program, Sixth Floor, 950 L'Enfant Plaza SW, Washington, DC 20024, (202)-586–9127, *Buildings@ee.doe.gov*, *www.energy.gov/eere/buildings/building-technologies-office*. For information on the availability of this material at NARA, email: *fr.inspection@nara.gov*, or go to: *www.archives.gov/federal-register/cfr/ibr-locations.html*. The material may be obtained from the following sources:

(a) *AHRI*. Air-Conditioning, Heating, and Refrigeration Institute, 2111 Wilson Blvd., Suite 500, Arlington, VA 22201; (703) 524–8800; *ahri@ahrinet.org; www.ahrinet.org*.

(1) AHRI Standard 810 (I–P)–2016 with Addendum 1, *Performance Rating of Automatic Commercial Ice-Makers*, January 2018; IBR approved for § 431.134.

(2) [Reserved]

(b) *ASHRAE*. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 1791 Tullie Circle NE, Atlanta, GA 30329; (404) 636–8400; *ashrae@ashrae.org; www.ashrae.org*.

(1) ANSI/ASHRAE Standard 29–2015, *Method of Testing Automatic Ice Makers*, approved April 30, 2015; IBR approved for § 431.134.

(2) [Reserved]

[87 FR 65900, Nov. 1, 2022]

§ 431.134 Uniform test methods for the measurement of harvest rate, energy consumption, and water consumption of automatic commercial ice makers.

NOTE 1 TO § 431.134: On or after October 27, 2023, any representations, including certifications of compliance for automatic commercial ice makers, made with respect to the energy use or efficiency of automatic commercial ice makers must be made in accordance with the results of testing pursuant to this section. Prior to October 27, 2023, any representations with respect to energy use or efficiency of automatic commercial ice makers must be made either in accordance with the results of testing pursuant to this section or with the results of testing pursuant to this section as it appeared in 10 CFR 431.134 in the 10 CFR parts 200–499 edition revised as of January 1, 2022.

(a) *Scope*. This section provides the test procedures for measuring the harvest rate in pounds of ice per 24 hours (lb/24 h), energy use in kilowatt hours per 100 pounds of ice (kWh/100 lb), and the condenser water use in gallons per 100 pounds of ice (gal/100 lb) of automatic commercial ice makers with capacities up to 4,000 lb/24 h. This section also provides voluntary test procedures for measuring the potable water use in gallons per 100 pounds of ice (gal/100 lb).

(b) *Testing and calculations*. Measure the harvest rate, the energy use, the condenser water use, and, to the extent elected, the potable water use of each covered automatic commercial ice maker by conducting the test procedures set forth in AHRI Standard 810 (I–P)–2016 with Addendum 1, section 3, ''Definitions,'' section 4, ''Test Requirements,'' and section 5.2, ''Standard Ratings'' (incorporated by reference, *see* § 431.133), and according to the provisions of this section. Use ANSI/ASHRAE Standard 29–2015 (incorporated by reference, see § 431.133) referenced by AHRI Standard 810 (I–P)–2016 with Addendum 1 for all automatic commercial ice makers, except as noted in paragraphs (c) through (k) of this section. If any provision of the referenced test procedures conflicts with the requirements in this section or the definitions in § 431.132, the requirements in this section and the definitions in § 431.132 control.

(c) *Test setup and equipment configurations*—(1) *Baffles*. Conduct testing without baffles unless the baffle either is a part of the automatic commercial ice maker or shipped with the automatic commercial ice maker to be installed according to the manufacturer's installation instructions.

(2) *Clearances*. Install all automatic commercial ice makers for testing according to the manufacturer's specified minimum rear clearance requirements, or with 3 feet of clearance from the rear of the automatic commercial ice maker, whichever is less, from the chamber wall. All other sides of the automatic commercial ice maker and all sides of the remote condenser, if applicable, shall have clearances according to section 6.5 of ANSI/ASHRAE Standard 29–2015.

(3) *Purge settings*. Test automatic commercial ice makers equipped with automatic purge water control using a fixed purge water setting that is described in the manufacturer's written instructions shipped with the unit as being appropriate for water of normal, typical, or average hardness. Purge water settings described in the instructions as suitable for use only with water that has higher or lower than normal hardness (such as distilled water or reverse osmosis water) must not be used for testing.

(4) *Ambient conditions measurement*—(i) *Ambient temperature sensors*. Measure all ambient temperatures according to section 6.4 of ANSI/ASHRAE Standard 29–2015, except as provided in paragraph (c)(4)(iv) of this section, with unweighted temperature sensors.

(ii) *Ambient relative humidity measurement*. Except as provided in paragraph (c)(4)(iv) of this section, ambient relative humidity shall be measured at the same location(s) used to confirm ambient dry bulb temperature, or as close as the test setup permits. Ambient relative humidity shall be measured with an instrument accuracy of ±2.0 percent.

(iii) *Ambient conditions sensors shielding*. Ambient temperature and relative humidity sensors may be shielded if the ambient test conditions cannot be maintained within the specified tolerances because of warm discharge air from the condenser exhaust affecting the ambient measurements. If shields are used, the shields must not inhibit recirculation of the warm discharge air into the condenser or automatic commercial ice maker inlet.

(iv) *Alternate ambient conditions measurement location.* For automatic commercial ice makers in which warm air discharge from the condenser exhaust affects the ambient conditions as measured 1 foot in front of the air inlet, or automatic commercial ice makers in which the air inlet is located in the rear of the automatic commercial ice maker and the manufacturer's specified minimum rear clearance is less than or equal to 1 foot, the ambient temperature and relative humidity may instead be measured 1 foot from the cabinet, centered with respect to the sides of the cabinet, for any side of the automatic commercial ice maker cabinet with no warm air discharge or air inlet.

(5) *Collection container for batch type automatic commercial ice makers with harvest rates less than or equal to 50 lb/24 h.* Use an ice collection container as specified in section 5.5.2(a) of ANSI/ASHRAE Standard 29–2015, except that the water retention weight of the container is no more than 4.0 percent of that of the smallest batch of ice for which the container is used.

(d) *Test conditions*—(1) *Relative humidity.* Maintain an average minimum ambient relative humidity of 30.0 percent throughout testing.

(2) *Inlet water pressure.* Except for portable automatic commercial ice makers, the inlet water pressure when water is flowing into the automatic commercial ice maker shall be within the allowable range within 5 seconds of opening the water supply valve.

(e) *Stabilization*—(1) *Percent difference calculation.* Calculate the percent difference in the ice production rate between two cycles or samples using the following equation, where A and B are the harvest rates, in lb/24 h (for batch type ice makers) or lb/15 mins (for continuous type ice makers), of any cycles or samples used to determine stability:

$$Perent\ Difference = \frac{|A-B|}{\frac{A+B}{2}} x100\text{percent}$$

(2) *Automatic commercial ice makers with harvest rates greater than 50lb/24 h.* The three or more consecutive cycles or samples used to calculate harvest rate, energy use, condenser water use, and potable water use, must meet the stability criteria in section 7.1.1 of ANSI/ASHRAE Standard 29–2015.

(3) *Automatic commercial ice makers with harvest rates less than or equal to 50 lb/24 h.* The three or more consecutive cycles or samples used to calculate harvest rate, energy use, condenser water use, and potable water use, must meet the stability criteria in section 7.1.1 of ANSI/ASHRAE Standard 29–2015, except that the weights of the samples (for continuous type automatic commercial ice makers (ACIMs)) or 24-hour calculated ice production (for batch type ACIMs) must not vary by more than ±4 percent, and the 25 g (for continuous type ACIMs) and 1 kg (for batch type ACIMs) criteria do not apply.

(f) *Calculations.* The harvest rate, energy use, condenser water use, and potable water use must be calculated by averaging the values for the three calculated samples for each respective reported metric as specified in section 9 of ANSI/ASHRAE Standard 29–2015. All intermediate calculations prior to the reported value, as applicable, must be performed with unrounded values.

(g) *Rounding.* Round the reported values as follows: Harvest rate to the nearest 1 lb/24 h for harvest rates above 50 lb/24 h; harvest rate to the nearest 0.1 lb/24 h for harvest rates less than or equal to 50 lb/24 h; condenser water use to the nearest 1 gal/100 lb; and energy use to the nearest 0.01 kWh/100 lb. Round final potable water use value to the nearest 0.1 gal/100 lb.

(h) *Continuous type automatic commercial ice makers*—(1) *Ice hardness adjustment*—(i) *Calorimeter constant*. Determine the calorimeter constant according to the requirements in section A1 and A2 of Normative Annex A Method of Calorimetry in ANSI/ASHRAE Standard 29–2015, except that the trials shall be conducted at an ambient air temperature (room temperature) of 70 °F ± 1 °F, with an initial water temperature of 90 °F ± 1 °F. To verify the temperature of the block of pure ice as provided in section A2.e in ANSI/ASHRAE Standard 29–2015, a thermocouple shall be embedded at approximately the geometric center of the interior of the block. Any water that remains on the block of ice shall be wiped off the surface of the block before being placed into the calorimeter.

(ii) *Ice hardness factor*. Determine the ice hardness factor according to the requirements in section A1 and A3 of Normative Annex A Method of Calorimetry in ANSI/ASHRAE Standard 29–2015, except that the trials shall be conducted at an ambient air temperature (room temperature) of 70 °F ± 1 °F, with an initial water temperature of 90 °F ± 1 °F. The harvested ice used to determine the ice hardness factor shall be produced according to the test methods specified at §431.134. The ice hardness factor shall be calculated using the equation for ice hardness factor in section 5.2.2 of AHRI Standard 810 (I–P)–2016 with Addendum 1.

(iii) *Ice hardness adjustment calculation*. Determine the reported energy use and reported condenser water use by multiplying the measured energy use or measured condenser water use by the ice hardness adjustment factor, determined using the ice hardness adjustment factor equation in section 5.2.2 of AHRI Standard 810 (I–P)–2016 with Addendum 1.

(2) [Reserved]

(i) *Automatic commercial ice makers with automatic dispensers*. Allow for the continuous production and dispensing of ice throughout testing. If an automatic commercial ice maker with an automatic dispenser is not able to continuously produce and dispense ice because of certain mechanisms within the automatic commercial ice maker that prohibit the continuous production and dispensing of ice throughout testing, those mechanisms must be overridden to the minimum extent which allows for the continuous production and dispensing of ice. The automatic commercial ice maker shall have an empty internal storage bin at the beginning of the test period. Collect capacity samples according to the requirements of ANSI/ASHRAE Standard 29–2015, except that the samples shall be collected through continuous use of the dispenser rather than in the internal storage bin. The intercepted ice samples shall be obtained from a container in an external ice bin that is filled one-half full of ice and is connected to the outlet of the ice dispenser through the minimal length of conduit that can be used.

(j) *Portable automatic commercial ice makers*. Sections 5.4, 5.6, 6.2, and 6.3 of ANSI/ASHRAE Standard 29–2015 do not apply. Ensure that the ice storage bin is empty prior to the initial potable water reservoir fill. Fill an external container with water to be supplied to the portable automatic commercial ice maker water reservoir. Establish an initial water temperature of 70 °F ± 1.0 °F. Verify the initial water temperature by inserting a temperature sensor into approximately the geometric center of the water in the external container. Immediately after establishing the initial water temperature, fill the ice maker water reservoir to the maximum level of potable water as specified by the manufacturer. After the potable water reservoir is filled, operate the portable automatic commercial ice maker to produce ice into the ice storage bin until the bin is one-half full. One-half full for the purposes of testing portable automatic commercial ice makers means that half of the vertical dimension of the ice storage bin, based on the maximum ice fill level within the ice storage bin, is filled with ice. Once the ice storage bin is one-half full, conduct testing according to section 7 of ANSI/ASHRAE Standard 29–2015. The potable water use is equal to the sum of the weight of ice and any corresponding melt water collected for the capacity test as specified in section 7.2 of ANSI/ASHRAE Standard 29–2015.

(k) *Self-contained refrigerated storage automatic commercial ice makers.* For door openings, the door shall be in the fully open position, which means opening the ice storage compartment door to an angle of not less than 75 degrees from the closed position (or the maximum extent possible, if that is less than 75 degrees), for 10.0 ± 1.0 seconds to collect the sample. Conduct door openings only for ice sample collection and returning the empty ice collection container to the ice storage compartment (*i.e.*, conduct two separate door openings, one for removing the collection container to collect the ice and one for replacing the collection container after collecting the ice).

[87 FR 65900, Nov. 1, 2022]

ENERGY CONSERVATION STANDARDS

§ 431.136 Energy conservation standards and their effective dates.

(a) All basic models of commercial ice makers must be tested for performance using the applicable DOE test procedure in § 431.134, be compliant with the applicable standards set forth in paragraphs (b) through (d) of this section, and be certified to the Department of Energy under 10 CFR part 429 of this chapter.

(b) Each cube type automatic commercial ice maker with capacities between 50 and 2,500 pounds per 24-hour period manufactured on or after January 1, 2010 and before January 28, 2018, shall meet the following standard levels:

Equipment type	Type of cooling	Harvest rate lb ice/24 hours	Maximum energy use kWh/100 lb ice	Maximum condenser water use [1] gal/100 lb ice
Ice-Making Head	Water	<500	7.8–0.0055H [2]	200–0.022H.
Ice-Making Head	Water	≥500 and <1,436	5.58–0.0011H	200–0.022H.
Ice-Making Head	Water	≥1,436	4.0	200–0.022H.
Ice-Making Head	Air	<450	10.26–0.0086H	Not Applicable.
Ice-Making Head	Air	≥450	6.89–0.0011H	Not Applicable.
Remote Condensing (but not remote compressor)	Air	<1,000	8.85–0.0038H	Not Applicable.
Remote Condensing (but not remote compressor)	Air	≥1,000	5.1	Not Applicable.
Remote Condensing and Remote Compressor	Air	<934	8.85–0.0038H	Not Applicable.
Remote Condensing (but not remote compressor)	Air	≥934	5.3	Not Applicable.
Self-Contained	Water	<200	11.40–0.019H	191–0.0315H.
Self-Contained	Water	≥200	7.6	191–0.0315H.
Self-Contained	Air	<175	18.0–0.0469H	Not Applicable.
Self-Contained	Air	≥175	9.8	Not Applicable.

[1] Water use is for the condenser only and does not include potable water used to make ice.
[2] H = harvest rate in pounds per 24 hours, indicating the water or energy use for a given harvest rate.
Source: 42 U.S.C. 6313(d).

(c) Each batch type automatic commercial ice maker with capacities between 50 and 4,000 pounds per 24-hour period manufactured on or after January 28, 2018, shall meet the following standard levels:

Equipment type	Type of cooling	Harvest rate lb ice/24 hours	Maximum energy use kilowatt-hours (kWh)/100 lb ice [1]	Maximum condenser water use gal/100 lb ice [2]
Ice-Making Head	Water	< 300	6.88–0.0055H	200–0.022H.
Ice-Making Head	Water	≥300 and <850	5.80–0.00191H	200–0.022H.
Ice-Making Head	Water	≥850 and <1,500	4.42–0.00028H	200–0.022H.
Ice-Making Head	Water	≥1,500 and <2,500	4.0	200–0.022H.
Ice-Making Head	Water	≥2,500 and <4,000	4.0	145.
Ice-Making Head	Air	< 300	10–0.01233H	NA.
Ice-Making Head	Air	≥ 300 and < 800	7.05–0.0025H	NA.
Ice-Making Head	Air	≥ 800 and < 1,500	5.55–0.00063H	NA.
Ice-Making Head	Air	≥ 1500 and < 4,000	4.61	NA.
Remote Condensing (but not remote compressor)	Air	< 988	7.97–0.00342H	NA.
Remote Condensing (but not remote compressor)	Air	≥ 988 and < 4,000	4.59	NA.
Remote Condensing and Remote Compressor	Air	< 930	7.97–0.00342H	NA.
Remote Condensing and Remote Compressor	Air	≥ 930 and < 4,000	4.79	NA.
Self-Contained	Water	< 200	9.5–0.019H	191–0.0315H.
Self-Contained	Water	≥ 200 and < 2,500	5.7	191–0.0315H.

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Equipment type	Type of cooling	Harvest rate lb ice/24 hours	Maximum energy use kilowatt-hours (kWh)/100 lb ice [1]	Maximum condenser water use gal/100 lb ice [2]
Self-Contained	Water	≥ 2,500 and < 4,000	5.7	112.
Self-Contained	Air	< 110	14.79–0.0469H	NA.
Self-Contained	Air	≥ 110 and < 200	12.42–0.02533H	NA.
Self-Contained	Air	≥ 200 and < 4,000	7.35	NA.

[1] H = harvest rate in pounds per 24 hours, indicating the water or energy use for a given harvest rate. Source: 42 U.S.C. 6313(d).

[2] Water use is for the condenser only and does not include potable water used to make ice.

(d) Each continuous type automatic commercial ice maker with capacities between 50 and 4,000 pounds per 24-hour period manufactured on or after January 28, 2018, shall meet the following standard levels:

Equipment type	Type of cooling	Harvest rate lb ice/24 hours	Maximum energy use kWh/100 lb ice [1]	Maximum condenser water use gal/100 lb ice [2]
Ice-Making Head	Water	<801	6.48–0.00267H	180–0.0198H.
Ice-Making Head	Water	≥801 and <2,500	4.34	180–0.0198H.
Ice-Making Head	Water	≥2,500 and <4,000	4.34	130.5.
Ice-Making Head	Air	<310	9.19–0.00629H	NA.
Ice-Making Head	Air	≥310 and <820	8.23–0.0032H	NA.
Ice-Making Head	Air	≥820 and <4,000	5.61	NA.
Remote Condensing (but not remote compressor)	Air	<800	9.7–0.0058H	NA.
Remote Condensing (but not remote compressor)	Air	≥800 and <4,000	5.06	NA.
Remote Condensing and Remote Compressor	Air	<800	9.9–0.0058H	NA.
		≥800 and <4,000	5.26	NA.
Self-Contained	Water	<900	7.6–0.00302H	153–0.0252H.
Self-Contained	Water	≥900 and <2,500	4.88	153–0.0252H.
Self-Contained	Water	≥2,500 and <4,000	4.88	90.
Self-Contained	Air	<200	14.22–0.03H	NA.
Self-Contained	Air	≥200 and <700	9.47–0.00624H	NA.
Self-Contained	Air	≥700 and <4,000	5.1	NA.

[1] H = harvest rate in pounds per 24 hours, indicating the water or energy use for a given harvest rate. Source: 42 U.S.C. 6313(d).

[2] Water use is for the condenser only and does not include potable water used to make ice.

[80 FR 4754, Jan. 28, 2015]

Subpart I—Commercial Clothes Washers

SOURCE: 70 FR 60416, Oct. 18, 2005, unless otherwise noted.

§ 431.151 Purpose and scope.

This subpart contains energy conservation requirements for commercial clothes washers, pursuant to Part C of Title III of the Energy Policy and Conservation Act, as amended, 42 U.S.C. 6311–6317.

§ 431.152 Definitions concerning commercial clothes washers.

AEER means active-mode energy efficiency ratio, in pounds per kilowatt-hour per cycle (lbs/kWh/cycle), as determined in section 4.8 of appendix J to subpart B of part 430 (when using appendix J).

Basic model means all units of a given type of covered product (or class thereof) manufactured by one manufacturer, having the same primary energy source, and which have essentially identical electrical, physical, and functional (or hydraulic) characteristics that affect energy consumption, energy efficiency, water consumption, or water efficiency.

Commercial clothes washer means a soft-mounted front-loading or soft-mounted top-loading clothes washer that—

(1) Has a clothes container compartment that—

(i) For horizontal-axis clothes washers, is not more than 3.5 cubic feet; and

(ii) For vertical-axis clothes washers, is not more than 4.0 cubic feet; and

(2) Is designed for use in—

(i) Applications in which the occupants of more than one household will be using the clothes washer, such as multi-family housing common areas and coin laundries; or

(ii) Other commercial applications.

IWF means integrated water factor, in gallons per cubic feet per cycle (gal/cu ft/cycle), as determined in section 4.2.12 of appendix J2 to subpart B of part 430 (when using appendix J2).

MEF_{J2} means modified energy factor, in cu ft/kWh/cycle, as determined in section 4.5 of appendix J2 to subpart B of part 430 (when using appendix J2).

WER means water efficiency ratio, in pounds per gallon per cycle (lbs/gal/cycle), as determined in section 4.7 of appendix J to subpart B of part 430 (when using appendix J).

[87 FR 33405, June 1, 2022]

TEST PROCEDURES

§431.154 Test procedures.

The test procedures for clothes washers in appendix J2 to subpart B of part 430 must be used to determine compliance with the energy conservation standards at §431.156(b).

[87 FR 33405, June 1, 2022]

ENERGY CONSERVATION STANDARDS

§431.156 Energy and water conservation standards and effective dates.

(a) Each commercial clothes washer manufactured on or after January 8, 2013, and before January 1, 2018, shall have a modified energy factor no less than and a water factor no greater than:

Equipment class	Modified energy factor (MEF), *cu. ft./kWh/cycle*	Water factor (WF), *gal./cu. ft./cycle*
Top-Loading	1.60	8.5
Front-Loading	2.00	5.5

(b) Each commercial clothes washer manufactured on or after January 1, 2018 shall have a modified energy factor no less than and an integrated water factor no greater than:

Equipment class	Modified energy factor (MEF_{J2}), *cu. ft./kWh/cycle*	Integrated Water factor (IWF), *gal./cu. ft./cycle*
Top-Loading	1.35	8.8
Front-Loading	2.00	4.1

[76 FR 69123, Nov. 8, 2011, as amended at 79 FR 74541, Dec. 15, 2014; 81 FR 20529, Apr. 8, 2016]

Subpart J—Fans and Blowers

SOURCE: 86 FR 46590, Aug. 19, 2021, unless otherwise noted.

§431.171 Purpose and scope.

This subpart contains provisions regarding fans and blowers, pursuant to Part C of Title III of the Energy Policy and Conservation Act, as amended, 42 U.S.C. 6311–6317. This subpart does not cover ''ceiling fans'' as that term is defined and addressed in part 430 this chapter, nor does it cover ''furnace fans'' as that term is defined and addressed in part 430 of this chapter.

§431.172 Definition.

Fan or *blower* means a rotary bladed machine used to convert electrical or mechanical power to air power, with an energy output limited to 25 kilojoule (kJ)/kilogram (kg) of air. It consists of an impeller, a shaft and bearings and/or driver to support the impeller, as well as a structure or housing. A fan or blower may include a transmission, driver, and/or motor controller.

§§431.173–431.176 [Reserved]

Subpart K—Distribution Transformers

SOURCE: 70 FR 60416, Oct. 18, 2005, unless otherwise noted.

§431.191 Purpose and scope.

This subpart contains energy conservation requirements for distribution transformers, pursuant to Parts B and C of Title III of the Energy Policy and Conservation Act, as amended, 42 U.S.C. 6291–6317.

[71 FR 24995, Apr. 27, 2006]

§431.192 Definitions.

The following definitions apply for purposes of this subpart:

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Autotransformer means a transformer that:

(1) Has one physical winding that consists of a series winding part and a common winding part;

(2) Has no isolation between its primary and secondary circuits; and

(3) During step-down operation, has a primary voltage that is equal to the total of the series and common winding voltages, and a secondary voltage that is equal to the common winding voltage.

Auxiliary device means a localized component of a distribution transformer that is a circuit breaker, switch, fuse, or surge/lightning arrester.

Basic model means a group of models of distribution transformers manufactured by a single manufacturer, that have the same insulation type (*i.e.*, liquid-immersed or dry-type), have the same number of phases (*i.e.*, single or three), have the same standard kVA rating, and do not have any differentiating electrical, physical or functional features that affect energy consumption. Differences in voltage and differences in basic impulse insulation level (BIL) rating are examples of differentiating electrical features that affect energy consumption.

Distribution transformer means a transformer that—

(1) Has an input voltage of 34.5 kV or less;

(2) Has an output voltage of 600 V or less;

(3) Is rated for operation at a frequency of 60 Hz; and

(4) Has a capacity of 10 kVA to 2500 kVA for liquid-immersed units and 15 kVA to 2500 kVA for dry-type units; but

(5) The term ''distribution transformer'' does not include a transformer that is an—

(i) Autotransformer;

(ii) Drive (isolation) transformer;

(iii) Grounding transformer;

(iv) Machine-tool (control) transformer;

(v) Nonventilated transformer;

(vi) Rectifier transformer;

(vii) Regulating transformer;

(viii) Sealed transformer;

(ix) Special-impedance transformer;

(x) Testing transformer;

(xi) Transformer with tap range of 20 percent or more;

(xii) Uninterruptible power supply transformer; or

(xiii) Welding transformer.

Drive (isolation) transformer means a transformer that:

(1) Isolates an electric motor from the line;

(2) Accommodates the added loads of drive-created harmonics; and

(3) Is designed to withstand the additional mechanical stresses resulting from an alternating current adjustable frequency motor drive or a direct current motor drive.

Efficiency means the ratio of the useful power output to the total power input.

Excitation current or *no-load current* means the current that flows in any winding used to excite the transformer when all other windings are open-circuited.

Grounding transformer means a three-phase transformer intended primarily to provide a neutral point for system-grounding purposes, either by means of:

(1) A grounded wye primary winding and a delta secondary winding; or

(2) A transformer with its primary winding in a zig-zag winding arrangement, and with no secondary winding.

Liquid-immersed distribution transformer means a distribution transformer in which the core and coil assembly is immersed in an insulating liquid.

Load loss means, for a distribution transformer, those losses incident to a specified load carried by the transformer, including losses in the windings as well as stray losses in the conducting parts of the transformer.

Low-voltage dry-type distribution transformer means a distribution transformer that has an input voltage of 600 volts or less and has the core and coil assembly immersed in a gaseous or dry-compound insulating medium.

Machine-tool (control) transformer means a transformer that is equipped with a fuse or other over-current protection device, and is generally used for the operation of a solenoid, contactor, relay, portable tool, or localized lighting.

Medium-voltage dry-type distribution transformer means a distribution transformer in which the core and coil assembly is immersed in a gaseous or dry-compound insulating medium, and which has a rated primary voltage between 601 V and 34.5 kV.

Mining distribution transformer means a medium-voltage dry-type distribution transformer that is built only for installation in an underground mine or surface mine, inside equipment for use in an underground mine or surface mine, on-board equipment for use in an underground mine or surface mine, or for equipment used for digging, drilling, or tunneling underground or above ground, and that has a nameplate which identifies the transformer as being for this use only.

No-load loss means those losses that are incident to the excitation of the transformer.

Nonventilated transformer means a transformer constructed so as to prevent external air circulation through the coils of the transformer while operating at zero gauge pressure.

Per-unit load means the fraction of rated load.

Phase angle means the angle between two phasors, where the two phasors represent progressions of periodic waves of either:

(1) Two voltages;

(2) Two currents; or

(3) A voltage and a current of an alternating current circuit.

Phase angle correction means the adjustment (correction) of measurement data to negate the effects of phase angle error.

Phase angle error means incorrect displacement of the phase angle, introduced by the components of the test equipment.

Rectifier transformer means a transformer that operates at the fundamental frequency of an alternating-current system and that is designed to have one or more output windings connected to a rectifier.

Reference temperature means the temperature at which the transformer losses are determined, and to which such losses are corrected if testing is done at a different point. (Reference temperature values are specified in the test method in appendix A to this subpart.)

Regulating transformer means a transformer that varies the voltage, the phase angle, or both voltage and phase angle, of an output circuit and compensates for fluctuation of load and input voltage, phase angle or both voltage and phase angle.

Sealed transformer means a transformer designed to remain hermetically sealed under specified conditions of temperature and pressure.

Special-impedance transformer means any transformer built to operate at an impedance outside of the normal impedance range for that transformer's kVA rating. The normal impedance range for each kVA rating for liquid-immersed and dry-type transformers is shown in Tables 1 and 2, respectively.

TABLE 1—NORMAL IMPEDANCE RANGES FOR LIQUID-IMMERSED TRANSFORMERS

Single-phase transformers		Three-phase transformers	
kVA	Impedance (%)	kVA	Impedance (%)
10	1.0–4.5	15	1.0–4.5
15	1.0–4.5	30	1.0–4.5
25	1.0–4.5	45	1.0–4.5
37.5	1.0–4.5	75	1.0–5.0
50	1.5–4.5	112.5	1.2–6.0
75	1.5–4.5	150	1.2–6.0
100	1.5–4.5	225	1.2–6.0
167	1.5–4.5	300	1.2–6.0
250	1.5–6.0	500	1.5–7.0
333	1.5–6.0	750	5.0–7.5
500	1.5–7.0	1000	5.0–7.5
667	5.0–7.5	1500	5.0–7.5
833	5.0–7.5	2000	5.0–7.5
....		2500	5.0–7.5

TABLE 2—NORMAL IMPEDANCE RANGES FOR DRY-TYPE TRANSFORMERS

Single-phase transformers		Three-phase transformers	
kVA	Impedance (%)	kVA	Impedance (%)
15	1.5–6.0	15	1.5–6.0
25	1.5–6.0	30	1.5–6.0
37.5	1.5–6.0	45	1.5–6.0
50	1.5–6.0	75	1.5–6.0
75	2.0–7.0	112.5	1.5–6.0
100	2.0–7.0	150	1.5–6.0
167	2.5–8.0	225	3.0–7.0
250	3.5–8.0	300	3.0–7.0
333	3.5–8.0	500	4.5–8.0
500	3.5–8.0	750	5.0–8.0
667	5.0–8.0	1000	5.0–8.0
833	5.0–8.0	1500	5.0–8.0
....		2000	5.0–8.0
....		2500	5.0–8.0

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Temperature correction means the mathematical correction(s) of measurement data, obtained when a transformer is tested at a temperature that is different from the reference temperature, to the value(s) that would have been obtained if the transformer had been tested at the reference temperature.

Terminal means a conducting element of a distribution transformer providing electrical connection to an external conductor that is not part of the transformer.

Test current means the current of the electrical power supplied to the transformer under test.

Test frequency means the frequency of the electrical power supplied to the transformer under test.

Test voltage means the voltage of the electrical power supplied to the transformer under test.

Testing transformer means a transformer used in a circuit to produce a specific voltage or current for the purpose of testing electrical equipment.

Total loss means the sum of the no-load loss and the load loss for a transformer.

Transformer means a device consisting of 2 or more coils of insulated wire that transfers alternating current by electromagnetic induction from 1 coil to another to change the original voltage or current value.

Transformer with tap range of 20 percent or more means a transformer with multiple voltage taps, the highest of which equals at least 20 percent more than the lowest, computed based on the sum of the deviations of the voltages of these taps from the transformer's nominal voltage.

Uninterruptible power supply transformer means a transformer that is used within an uninterruptible power system, which in turn supplies power to loads that are sensitive to power failure, power sags, over voltage, switching transients, line noise, and other power quality factors.

Waveform correction means the adjustment(s) (mathematical correction(s)) of measurement data obtained with a test voltage that is non-sinusoidal, to a value(s) that would have been obtained with a sinusoidal voltage.

Welding transformer means a transformer designed for use in arc welding equipment or resistance welding equipment.

[70 FR 60416, Oct. 18, 2005, as amended at 71 FR 24995, Apr. 27, 2006; 71 FR 60662, Oct. 16, 2006; 72 FR 58239, Oct. 12, 2007; 78 FR 23433, Apr. 18, 2013; 86 FR 51252, Sept. 14, 2021]

TEST PROCEDURES

§ 431.193 Test procedure for measuring energy consumption of distribution transformers.

The test procedure for measuring the energy efficiency of distribution transformers for purposes of EPCA is specified in appendix A to this subpart. The test procedure specified in appendix A to this subpart applies only to distribution transformers subject to energy conservation standards at § 431.196.

[86 FR 51252, Sept. 14, 2021]

ENERGY CONSERVATION STANDARDS

§ 431.196 Energy conservation standards and their effective dates.

(a) *Low-Voltage Dry-Type Distribution Transformers*. (1) The efficiency of a low-voltage, dry-type distribution transformer manufactured on or after January 1, 2007, but before January 1, 2016, shall be no less than that required for the applicable kVA rating in the table below. Low-voltage dry-type distribution transformers with kVA ratings not appearing in the table shall have their minimum efficiency level determined by linear interpolation of the kVA and efficiency values immediately above and below that kVA rating.

Single-phase		Three-phase	
kVA	%	kVA	%
15	97.7	15	97.0
25	98.0	30	97.5
37.5	98.2	45	97.7
50	98.3	75	98.0
75	98.5	112.5	98.2
100	98.6	150	98.3
167	98.7	225	98.5
250	98.8	300	98.6
333	98.9	500	98.7
		750	98.8
		1000	98.9

NOTE 1 TO PARAGRAPH (a)(1): All efficiency values are at 35 percent per-unit load.

(2) The efficiency of a low-voltage dry-type distribution transformer manufactured on or after January 1, 2016, shall be no less than that required for their kVA rating in the table below. Low-voltage dry-type distribution transformers with kVA ratings not appearing in the table shall have their minimum efficiency level determined by linear interpolation of the kVA and efficiency values immediately above and below that kVA rating.

Single-phase		Three-phase	
kVA	Efficiency (%)	kVA	Efficiency (%)
15	97.70	15	97.89
25	98.00	30	98.23
37.5	98.20	45	98.40
50	98.30	75	98.60
75	98.50	112.5	98.74
100	98.60	150	98.83
167	98.70	225	98.94
250	98.80	300	99.02
333	98.90	500	99.14
		750	99.23
		1000	99.28

NOTE 2 TO PARAGRAPH (a)(2): All efficiency values are at 35 percent per-unit load.

(b) *Liquid-Immersed Distribution Transformers.* (1) The efficiency of a liquid-immersed distribution transformer manufactured on or after January 1, 2010, but before January 1, 2016, shall be no less than that required for their kVA rating in the table below. Liquid-immersed distribution transformers with kVA ratings not appearing in the table shall have their minimum efficiency level determined by linear interpolation of the kVA and efficiency values immediately above and below that kVA rating.

Single-phase		Three-phase	
kVA	Efficiency (%)	kVA	Efficiency (%)
10	98.62	15	98.36
15	98.76	30	98.62
25	98.91	45	98.76
37.5	99.01	75	98.91
50	99.08	112.5	99.01
75	99.17	150	99.08
100	99.23	225	99.17
167	99.25	300	99.23
250	99.32	500	99.25
333	99.36	750	99.32
500	99.42	1000	99.36
667	99.46	1500	99.42
833	99.49	2000	99.46
		2500	99.49

NOTE 3 TO PARAGRAPH (b)(1): All efficiency values are at 50 percent per-unit load.

(2) The efficiency of a liquid-immersed distribution transformer manufactured on or after January 1, 2016, shall be no less than that required for their kVA rating in the table below. Liquid-immersed distribution transformers with kVA ratings not appearing in the table shall have their minimum efficiency level determined by linear interpolation of the kVA and efficiency values immediately above and below that kVA rating.

Single-phase		Three-phase	
kVA	Efficiency (%)	kVA	Efficiency (%)
10	98.70	15	98.65
15	98.82	30	98.83
25	98.95	45	98.92
37.5	99.05	75	99.03
50	99.11	112.5	99.11
75	99.19	150	99.16
100	99.25	225	99.23
167	99.33	300	99.27
250	99.39	500	99.35
333	99.43	750	99.40
500	99.49	1000	99.43
667	99.52	1500	99.48
833	99.55	2000	99.51
		2500	99.53

NOTE 4 TO PARAGRAPH (b)(2): All efficiency values are at 50 percent per-unit load.

(c) *Medium-Voltage Dry-Type Distribution Transformers.* (1) The efficiency of a medium-voltage dry-type distribution transformer manufactured on or after January 1, 2010, but before January 1, 2016, shall be no less than that required for their kVA and BIL rating in the table below. Medium-voltage dry-type distribution transformers with kVA ratings not appearing in the table shall have their minimum efficiency level determined by linear interpolation of the kVA and efficiency values immediately above and below that kVA rating.

Single-phase				Three-phase			
kVA	BIL*			kVA	BIL		
	20–45 kV	46–95 kV	≥96 kV		20–45 kV	46–95 kV	≥96 kV
	Efficiency (%)	Efficiency (%)	Efficiency (%)		Efficiency (%)	Efficiency (%)	Efficiency (%)
15	98.10	97.86		15	97.50	97.18	
25	98.33	98.12		30	97.90	97.63	
37.5	98.49	98.30		45	98.10	97.86	
50	98.60	98.42		75	98.33	98.12	
75	98.73	98.57	98.53	112.5	98.49	98.30	
100	98.82	98.67	98.63	150	98.60	98.42	
167	98.96	98.83	98.80	225	98.73	98.57	98.53
250	99.07	98.95	98.91	300	98.82	98.67	98.63
333	99.14	99.03	98.99	500	98.96	98.83	98.80
500	99.22	99.12	99.09	750	99.07	98.95	98.91
667	99.27	99.18	99.15	1000	99.14	99.03	98.99
833	99.31	99.23	99.20	1500	99.22	99.12	99.09
				2000	99.27	99.18	99.15
				2500	99.31	99.23	99.20

* BIL means basic impulse insulation level.

NOTE 5 TO PARAGRAPH (c)(1): All efficiency values are at 50 percent per-unit load.

(2) The efficiency of a medium- voltage dry-type distribution transformer manufactured on or after January 1, 2016, shall be no less than that required for their kVA and BIL rating in the table below. Medium-voltage dry-type distribution transformers with kVA ratings not appearing in the table shall have their minimum efficiency level determined by linear interpolation of the kVA and efficiency values immediately above and below that kVA rating.

Single-phase				Three-phase			
kVA	BIL*			kVA	BIL		
	20–45 kV	46–95 kV	≥96 kV		20–45 kV	46–95 kV	≥96 kV
	Efficiency (%)	Efficiency (%)	Efficiency (%)		Efficiency (%)	Efficiency (%)	Efficiency (%)
15	98.10	97.86		15	97.50	97.18	
25	98.33	98.12		30	97.90	97.63	
37.5	98.49	98.30		45	98.10	97.86	
50	98.60	98.42		75	98.33	98.13	
75	98.73	98.57	98.53	112.5	98.52	98.36	
100	98.82	98.67	98.63	150	98.65	98.51	
167	98.96	98.83	98.80	225	98.82	98.69	98.57
250	99.07	98.95	98.91	300	98.93	98.81	98.69
333	99.14	99.03	98.99	500	99.09	98.99	98.89
500	99.22	99.12	99.09	750	99.21	99.12	99.02
667	99.27	99.18	99.15	1000	99.28	99.20	99.11
833	99.31	99.23	99.20	1500	99.37	99.30	99.21
				2000	99.43	99.36	99.28
				2500	99.47	99.41	99.33

* BIL means basic impulse insulation level.

NOTE 6 TO PARAGRAPH (c)(2): All efficiency values are at 50 percent per-unit load.

(d) *Mining Distribution Transformers.* [Reserved]

[78 FR 23433, Apr. 18, 2013, as amended at 86 FR 51252, Sept. 14, 2021]

COMPLIANCE AND ENFORCEMENT

SOURCE: 71 FR 24997, Apr. 27, 2006, unless otherwise noted.

APPENDIX A TO SUBPART K OF PART 431—UNIFORM TEST METHOD FOR MEASURING THE ENERGY CONSUMPTION OF DISTRIBUTION TRANSFORMERS

1.0 DEFINITIONS.

The definitions contained in §§431.2 and 431.192 are applicable to this appendix A.

2.0 PER-UNIT LOAD, REFERENCE TEMPERATURE, AND ACCURACY REQUIREMENTS.

2.1 *Per-Unit Load*

In conducting the test procedure in this appendix for the purpose of:

(a) Certification to an energy conservation standard, the applicable per-unit load in Table 2.1 must be used; or

(b) Making voluntary representations as provided in section 7.0 at an additional per-unit load, select the per-unit load of interest.

TABLE 2.1—PER-UNIT LOAD FOR CERTIFICATION TO ENERGY CONSERVATION STANDARDS

Distribution transformer category	Per-unit load (percent)
Liquid-immersed	50
Medium-voltage dry-type	50
Low-voltage dry-type	35

2.2 *Reference Temperature*

In conducting the test procedure in this appendix for the purpose of:

(a) Certification to an energy conservation standard, the applicable reference temperature in Table 2.2 must be used; or

(b) Making voluntary representations as provided in section 7.0 at an additional reference temperature, select the reference temperature of interest.

TABLE 2.2—REFERENCE TEMPERATURE FOR CERTIFICATION TO ENERGY CONSERVATION STANDARDS

Distribution transformer category	Reference temperature
Liquid-immersed	20 °C for no-load loss. 55 °C for load loss.
Medium-voltage dry-type	20 °C for no-load loss. 75 °C for load loss.
Low-voltage dry-type	20 °C for no-load loss. 75 °C for load loss.

2.3 *Accuracy Requirements*

(a) Equipment and methods for loss measurement must be sufficiently accurate that measurement error will be limited to the values shown in Table 2.3.

TABLE 2.3—TEST SYSTEM ACCURACY REQUIREMENTS FOR EACH MEASURED QUANTITY

Measured quantity	Test system accuracy
Power Losses	±3.0%.
Voltage	±0.5%.
Current	±0.5%.
Resistance	±0.5%.
Temperature	±1.5 °C for liquid-immersed distribution transformers, and ±2.0 °C for low-voltage dry-type and medium-voltage dry-type distribution transformers.

(b) Only instrument transformers meeting the 0.3 metering accuracy class, or better, may be used under this test method.

3.0 RESISTANCE MEASUREMENTS

3.1 *General Considerations*

(a) Measure or establish the winding temperature at the time of the winding resistance measurement.

(b) Measure the direct current resistance (R_{dc}) of transformer windings by one of the methods outlined in section 3.3. The methods of section 3.5 must be used to correct load losses to the applicable reference temperature from the temperature at which they are measured. Observe precautions while taking measurements, such as those in section 3.4, in order to maintain measurement uncertainty limits specified in Table 2.1.

(c) Measure the direct current resistance (R_{dc}) of transformer windings by one of the methods outlined in section 3.3. The methods of section 3.5 must be used to correct load losses to the applicable reference temperature from the temperature at which they are measured. Observe precautions while taking measurements, such as those in section 3.4, in order to maintain measurement uncertainty limits specified in Table 2.3 of this appendix.

3.2 *Temperature Determination of Windings and Pre-conditions for Resistance Measurement.*

Make temperature measurements in protected areas where the air temperature is stable and there are no drafts. Determine the winding temperature (T_{dc}) for liquid-immersed and dry-type distribution transformers by the methods described in sections 3.2.1 and 3.2.2, respectively.

3.2.1 *Liquid-Immersed Distribution Transformers.*

3.2.1.1 *Methods*

Record the winding temperature (T_{dc}) of liquid-immersed transformers as the average of either of the following:

(a) The measurements from two temperature sensing devices (for example, thermocouples) applied to the outside of the transformer tank and thermally insulated

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from the surrounding environment, with one located at the level of the insulating liquid and the other located near the tank bottom or at the lower radiator header if applicable; or

(b) The measurements from two temperature sensing devices immersed in the insulating liquid, with one located directly above the winding and other located directly below the winding.

3.2.1.2 *Conditions*

Make this determination under either of the following conditions:

(a) The windings have been under insulating liquid with no excitation and no current in the windings for four hours before the dc resistance is measured; or

(b) The temperature of the insulating liquid has stabilized, and the difference between the top and bottom temperature does not exceed 5 °C. The temperature of the insulating liquid is considered stable if the top liquid temperature does not vary more than 2 °C in a 1-h period.

3.2.2 *Dry-Type Distribution Transformers.*

Record the winding temperature (T_{dc}) of dry-type transformers as one of the following:

(a) For ventilated dry-type units, use the average of readings of four or more thermometers, thermocouples, or other suitable temperature sensors inserted within the coils. Place the sensing points of the measuring devices as close as possible to the winding conductors; or

(b) For sealed units, such as epoxy-coated or epoxy-encapsulated units, use the average of four or more temperature sensors located on the enclosure and/or cover, as close to different parts of the winding assemblies as possible; or

(c) For ventilated units or sealed units, use the ambient temperature of the test area, only if the following conditions are met:

(1) All internal temperatures measured by the internal temperature sensors must not differ from the test area ambient temperature by more than 2 °C. Enclosure surface temperatures for sealed units must not differ from the test area ambient temperature by more than 2 °C.

(2) Test area ambient temperature must not have changed by more than 3 °C for 3 hours before the test.

(3) Neither voltage nor current has been applied to the unit under test for 24 hours. In addition, increase this initial 24-hour period by any added amount of time necessary for the temperature of the transformer windings to stabilize at the level of the ambient temperature. However, this additional amount of time need not exceed 24 hours (*i.e.*, after 48 hours, the transformer windings can be assumed to have stabilized at the level of the ambient temperature. Any stabilization time beyond 48 hours is optional).

3.3 *Resistance Measurement Methods.*

Make resistance measurements using either the resistance bridge method (section 3.3.1), the voltmeter-ammeter method (section 3.3.2) or resistance meters (section 3.3.3). In each instance when this appendix is used to test more than one unit of a basic model to determine the efficiency of that basic model, the resistance of the units being tested may be determined from making resistance measurements on only one of the units.

3.3.1 *Resistance Bridge Methods.*

If the resistance bridge method is selected, use either the Wheatstone or Kelvin bridge circuit (or the equivalent of either).

3.3.1.1 *Wheatstone Bridge*

(a) This bridge is best suited for measuring resistances larger than ten ohms. A schematic diagram of a Wheatstone bridge with a representative transformer under test is shown in Figure 3.1.

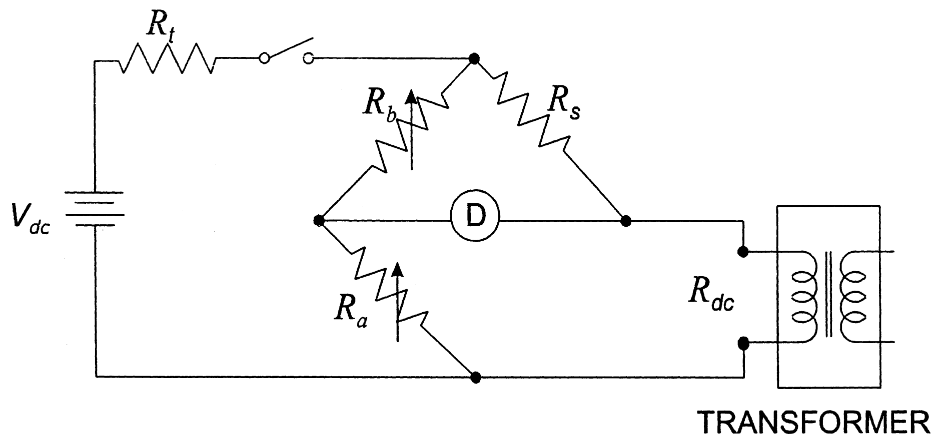

Figure 3.1 Wheatstone Bridge

Where:

R_{dc} is the resistance of the transformer winding being measured,

R_s is a standard resistor having the resistance R_s,

R_a, R_b are two precision resistors with resistance values R_a and R_b, respectively; at least one resistor must have a provision for resistance adjustment,

R_t is a resistor for reducing the time constant of the circuit,

D is a null detector, which may be either a micro ammeter or microvoltmeter or equivalent instrument for observing that no signal is present when the bridge is balanced, and

V_{dc} is a source of dc voltage for supplying the power to the Wheatstone Bridge.

(b) In the measurement process, turn on the source (V_{dc}), and adjust the resistance ratio (R_a/R_b) to produce zero signal at the detector (D). Determine the winding resistance by using equation 3–1 as follows:

$$R_{dc} = R_s \left(R_a/R_b\right) \qquad (3\text{-}1)$$

3.3.1.2 *Kelvin Bridge*

(a) This bridge separates the resistance of the connecting conductors to the transformer winding being measured from the resistance of the winding, and therefore is best suited for measuring resistances of ten ohms and smaller. A schematic diagram of a Kelvin bridge with a representative transformer under test is shown in Figure 3.2.

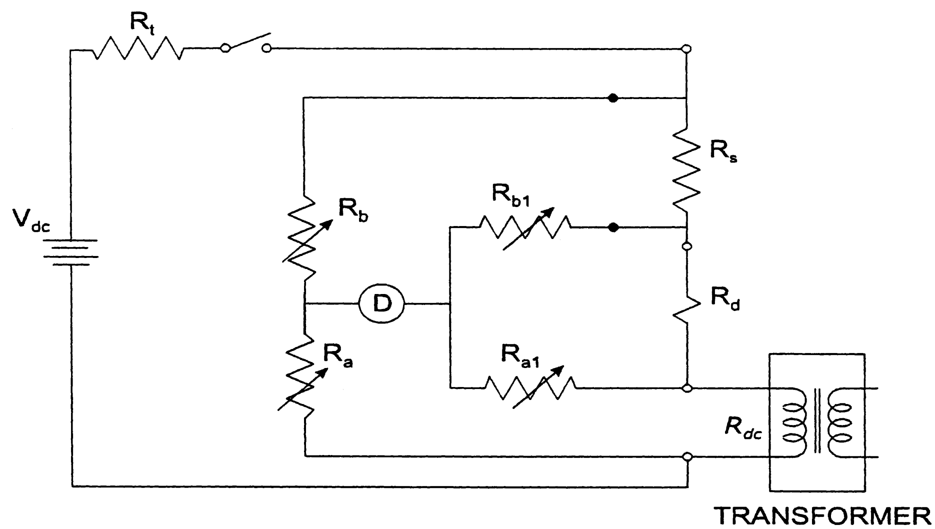

Figure 3.2 Kelvin Bridge

(b) The Kelvin Bridge has seven of the same type of components as in the Wheatstone Bridge. It has two more resistors than the Wheatstone bridge, R_{a1} and R_{b1}. At least one of these resistors must have adjustable resistance. In the measurement process, the source is turned on, two resistance ratios (R_a/R_b) and (R_{a1}/R_{b1}) are adjusted to be equal, and then the two ratios are adjusted together to balance the bridge producing zero signal at the detector. Determine the winding resistance by using equation 3–2 as follows:

$$R_{dc} = R_s \left(R_a/R_b\right) \qquad (3\text{-}2),$$

as with the Wheatstone bridge, with an additional condition that:

$$\left(R_a/R_b\right) = \left(R_{a1}/R_{b1}\right) \qquad (3\text{-}3)$$

(c) The Kelvin bridge provides two sets of leads, current-carrying and voltage-sensing, to the transformer terminals and the standard resistor, thus eliminating voltage drops from the measurement in the current-carrying leads as represented by R_d.

3.3.2 *Voltmeter-Ammeter Method.*

(a) Employ the voltmeter-ammeter method only if the test current is limited to 15 percent of the winding current. Connect the transformer winding under test to the circuit shown in Figure 3.3 of this appendix.

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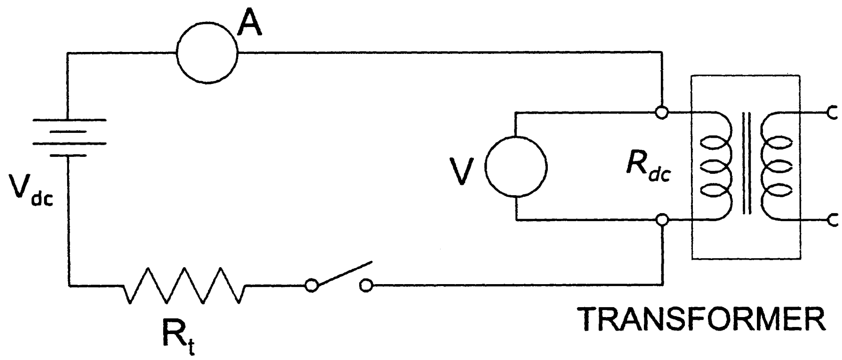

Figure 3.3 Voltmeter-Ammeter Method

Where:

A is an ammeter or a voltmeter-shunt combination for measuring the current (I_{mdc}) in the transformer winding,

V is a voltmeter with sensitivity in the millivolt range for measuring the voltage (V_{mdc}) applied to the transformer winding,

R_{dc} is the resistance of the transformer winding being measured,

R_t is a resistor for reducing the time constant of the circuit, and

V_{dc} is a source of dc voltage for supplying power to the measuring circuit.

(b) To perform the measurement, turn on the source to produce current no larger than 15 percent of the rated current for the winding. Wait until the current and voltage readings have stabilized and then take a minimum of four readings of voltage and current. Voltage and current readings must be taken simultaneously for each of the readings. Calculate the average voltage and average current using the readings. Determine the winding resistance R_{dc} by using equation 3–4 as follows:

$$R_{dc} = (V_{mdc}/I_{mdc}) \quad (3\text{-}4)$$

Where:

V_{mdc} is the average voltage measured by the voltmeter V; and

I_{mdc} is the average current measured by the ammeter (A).

(c) As shown in Figure 3.3, separate current and voltage leads must be brought to the transformer terminals. (This eliminates the errors due to lead and contact resistance.)

3.3.3 *Resistance Meters.*

Resistance meters may be based on voltmeter-ammeter, or resistance bridge, or some other operating principle. Any meter used to measure a transformer's winding resistance must have specifications for resistance range, current range, and ability to measure highly inductive resistors that cover the characteristics of the transformer being tested. Also, the meter's specifications for accuracy must meet the applicable criteria of Table 2.3 in section 2.3 of this appendix.

3.4 *Precautions in Measuring Winding Resistance.*

3.4.1 *Required actions.*

The following requirements must be observed when making resistance measurements:

(a) Use separate current and voltage leads when measuring small (<10 ohms) resistance.

(b) Use null detectors in bridge circuits, and measuring instruments in voltmeter-ammeter circuits, that have sensitivity and resolution sufficient to enable observation of at least 0.1 percent change in the measured resistance.

(c) Maintain the dc test current at or below 15 percent of the rated winding current.

(d) Inclusion of a stabilizing resistor R_t (see section 3.4.2) will require higher source voltage.

(e) Disconnect the null detector (if a bridge circuit is used) and voltmeter from the circuit before the current is switched off, and switch off current by a suitable insulated switch.

(f) Keep the polarity of the core magnetization constant during all resistance measurements.

(g) For single-phase windings, measure the resistance from terminal to terminal. The total winding resistance is the terminal-to-terminal measurement. For series-parallel windings, the total winding resistance is the sum of the series terminal-to-terminal section measurements.

(h) For wye windings, measure the resistance from terminal to terminal or from terminal to neutral. For the total winding resistance, the resistance of the lead from the neutral connection to the neutral bushing may be excluded. For terminal-to-terminal measurements, the total resistance reported is the sum of the three measurements divided by two.

(i) For delta windings, measure resistance from terminal to terminal with the delta closed or from terminal to terminal with the delta open to obtain the individual phase readings. The total winding resistance is the sum of the three-phase readings if the delta is open. If the delta is closed, the total winding resistance is the sum of the three phase-to-phase readings times 1.5.

3.4.2 *Guideline for Time Constant.*

(a) The following guideline is suggested for the tester as a means to facilitate the measurement of resistance in accordance with the accuracy requirements of section 2.3:

(b) The accurate reading of resistance R_{dc} may be facilitated by shortening the time constant. This is done by introducing a resistor R_t in series with the winding under test in both the bridge and voltmeter-ammeter circuits as shown in Figures 3.1 to 3.3. The relationship for the time constant is:

$$T_c = \left(L_{tc}/R_{tc}\right) \qquad (3\text{-}5)$$

Where:

T_c is the time constant in seconds,

L_{tc} is the total magnetizing and leakage inductance of the winding under test, in henries, and

R_{tc} is the total resistance in ohms, consisting of R_t in series with the winding resistance R_{dc} and the resistance R_s of the standard resistor in the bridge circuit.

(c) Because R_{tc} is in the denominator of the expression for the time constant, increasing the resistance R_{tc} will decrease the time constant. If the time constant in a given test circuit is too long for the resistance readings to be stable, then a higher resistance can be substituted for the existing R_{tc}, and successive replacements can be made until adequate stability is reached.

3.5 *Conversion of Resistance Measurements.*

(a) Resistance measurements must be corrected from the temperature at which the winding resistance measurements were made, to the reference temperature.

(b) Correct the measured resistance to the resistance at the reference temperature using equation 3–6 as follows:

$$R_{ts} = R_{dc}\left[\left(T_s + T_k\right)/\left(T_{dc} + T_k\right)\right] \qquad (3\text{-}6)$$

Where:

R_{ts} is the resistance at the reference temperature, T_s,

R_{dc} is the measured resistance at temperature, T_{dc},

T_s is the reference temperature in °C,

T_{dc} is the temperature at which resistance was measured in °C, and

T_k is 234.5 °C for copper or 225 °C for aluminum.

4.0 Loss Measurement

4.1 *General Considerations.*

The efficiency of a transformer is computed from the total transformer losses, which are determined from the measured value of the no-load loss and load loss power components. Each of these two power loss components is measured separately using test sets that are identical, except that shorting straps are added for the load-loss test. The measured quantities need correction for instrumentation losses and may need corrections for known phase angle errors in measuring equipment and for the waveform distortion in the test voltage. Any power loss not measured at the applicable reference temperature must be adjusted to that reference temperature. The measured load loss must also be adjusted to a specified output loading level if not measured at the specified output loading level. Test all distribution transformers using a sinusoidal waveform (k = 1). Measure losses with the transformer energized by a 60 Hz supply.

4.2 *Measurement of Power Losses.*

4.2.1 *No-Load Loss.*

Measure the no-load loss and apply corrections as described in section 4.4, using the appropriate test set as described in section 4.3.

4.2.2 *Load Loss.*

Measure the load loss and apply corrections as described in section 4.5, using the appropriate test set as described in section 4.3.

4.3 *Test Sets.*

(a) The same test set may be used for both the no-load loss and load loss measurements provided the range of the test set encompasses the test requirements of both tests. Calibrate the test set to national standards to meet the tolerances in Table 2.3 in section 2.3 of this appendix. In addition, the wattmeter, current measuring system and

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voltage measuring system must be calibrated separately if the overall test set calibration is outside the tolerance as specified in section 2.3 or the individual phase angle error exceeds the values specified in section 4.5.3.

(b) A test set based on the wattmeter-voltmeter-ammeter principle may be used to measure the power loss and the applied voltage and current of a transformer where the transformer's test current and voltage are within the measurement capability of the measuring instruments. Current and voltage transformers, known collectively as instrument transformers, or other scaling devices such as resistive or capacitive dividers for voltage, may be used in the above circumstance, and must be used together with instruments to measure current, voltage, or power where the current or voltage of the transformer under test exceeds the measurement capability of such instruments. Thus, a test set may include a combination of measuring instruments and instrument transformers (or other scaling devices), so long as the current or voltage of the transformer under test does not exceed the measurement capability of any of the instruments.

(c) Both load loss and no-load loss measurements must be made from terminal to terminal.

4.3.1 *Single-Phase Test Sets.*

Use these for testing single-phase distribution transformers.

4.3.1.1 *Without Instrument Transformers.*

(a) A single-phase test set without an instrument transformer is shown in Figure 4.1.

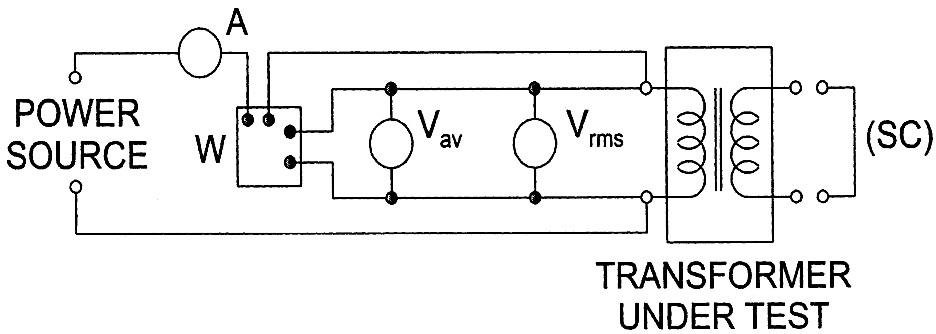

Figure 4.1 Single-Phase Test Set Without Instrument Transformers

Where:

W is a wattmeter used to measure P_{nm} and P_{lm}, the no-load and load loss power, respectively,

V_{rms} is a true root-mean-square (rms) voltmeter used to measure $V_{r(nm)}$ and V_{lm}, the rms test voltages in no-load and load loss measurements, respectively,

V_{av} is an average sensing voltmeter, calibrated to indicate rms voltage for sinusoidal waveforms and used to measure $V_{a(nm)}$, the average voltage in no-load loss measurements,

A is an rms ammeter used to measure test current, especially I_{lm}, the load loss current, and

(SC) is a conductor for providing a short-circuit across the output windings for the load loss measurements.

(b) Either the primary or the secondary winding can be connected to the test set. However, more compatible voltage and current levels for the measuring instruments are available if for no-load loss measurements the secondary (low voltage) winding is connected to the test set, and for load loss measurements the primary winding is connected to the test set. Use the average-sensing voltmeter, V_{av}, only in no-load loss measurements.

4.3.1.2 *With Instrument Transformers.*

A single-phase test set with instrument transformers is shown in Figure 4.2. This circuit has the same four measuring instruments as that in Figure 4.1. The current and voltage transformers, designated as (CT) and (VT), respectively, are added.

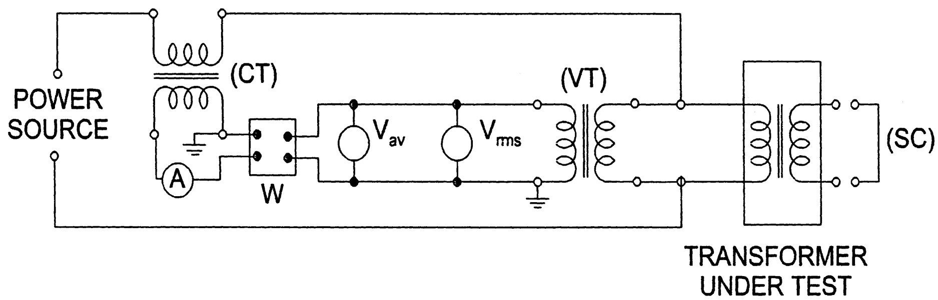

Figure 4.2 Single-Phase Test Set With Instrument Transformers

4.3.2 *Three-Phase Test Sets.*

Use these for testing three-phase distribution transformers. Use in a four-wire, three-wattmeter test circuit.

4.3.2.1 *Without Instrument Transformers.*

(a) A three-phase test set without instrument transformers is shown in Figure 4.3. This test set is essentially the same circuit shown in Figure 4.1 repeated three times, and the instruments are individual devices as shown. As an alternative, the entire instrumentation system of a three-phase test set without transformers may consist of a multi-function analyzer.

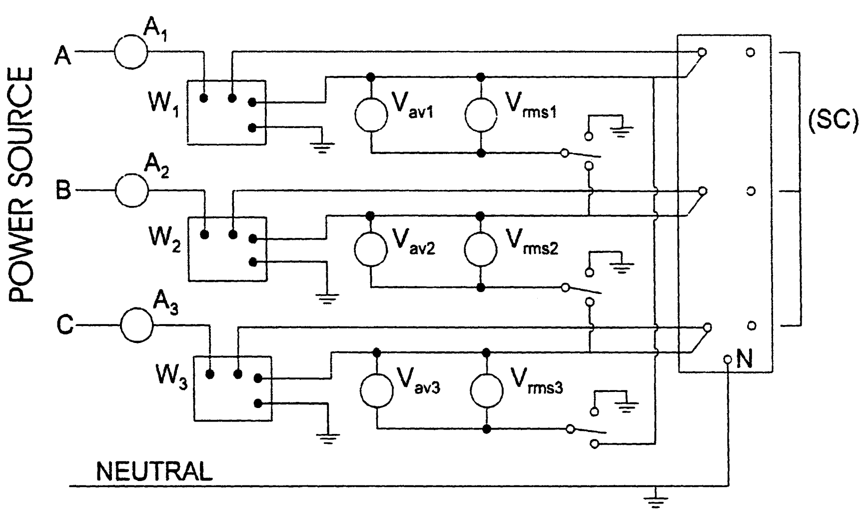

Figure 4.3 Three-Phase Test Set Without Instrument Transformers

(b) Either group of windings, the primary or the secondary, can be connected in wye or delta configuration. If both groups of windings are connected in the wye configuration for the no-load test, the neutral of the winding connected to the test set must be connected to the neutral of the source to provide a return path for the neutral current.

(c) In the no-load loss measurement, the voltage on the winding must be measured. Therefore a provision must be made to switch the voltmeters for line-to-neutral measurements for wye-connected windings

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and for line-to-line measurements for delta-connected windings.

4.3.2.2 *With Instrument Transformers.*

A three-phase test set with instrument transformers is shown in Figure 4.4. This test set is essentially the same circuit shown in Figure 4.2 repeated three times. Provision must be made to switch the voltmeters for line-to-neutral and line-to-line measurements as in section 4.3.2.1. The voltage sensors (''coils'') of the wattmeters must always be connected in the line-to-neutral configuration.

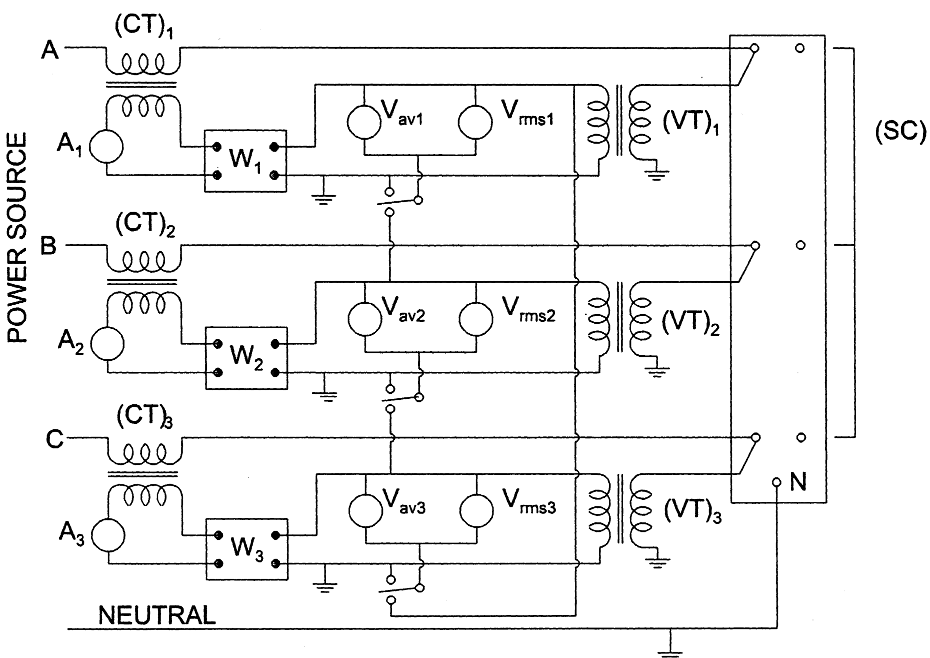

Figure 4.4 Three-Phase Test Set with Instrument Transformers

4.3.2.3 *Test Set Neutrals.*

If the power source in the test circuit is wye-connected, ground the neutral. If the power source in the test circuit is delta-connected, use a grounding transformer to obtain neutral and ground for the test.

4.4 *No-Load Losses: Measurement and Calculations.*

4.4.1 *General Considerations.*

Measurement corrections are permitted but not required for instrumentation losses and for losses from auxiliary devices. Measurement corrections are required:

(a) When the waveform of the applied voltage is non-sinusoidal; and

(b) When the core temperature or liquid temperature is outside the 20 °C ±10 °C range.

4.4.2 *No-Load Loss Test.*

(a) The purpose of the no-load loss test is to measure no-load losses at a specified excitation voltage and a specified frequency. The no-load loss determination must be based on a sine-wave voltage corrected to the reference temperature. Connect either of the transformer windings, primary or secondary, to the appropriate test set of Figures 4.1 to 4.4, giving consideration to section 4.4.2(a)(2). Leave the unconnected winding(s) open circuited. Apply the rated voltage at rated frequency, as measured by the average-sensing voltmeter, to the transformer. Take the readings of the wattmeter(s) and the average-sensing and true rms voltmeters. Observe the following precautions:

(1) Voltmeter connections. When correcting to a sine-wave basis using the average-voltmeter method, the voltmeter connections must be such that the waveform applied to the voltmeters is the same as the waveform across the energized windings.

(2) Energized windings. Energize either the high voltage or the low voltage winding of the transformer under test.

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ER27AP06.014</GPH>

(3) Voltage and frequency. The no-load loss test must be conducted with rated voltage impressed across the transformer terminals using a voltage source at a frequency equal to the rated frequency of the transformer under test.

(b) Adjust the voltage to the specified value as indicated by the average-sensing voltmeter. Record the values of rms voltage, rms current, electrical power, and average voltage as close to simultaneously as possible. For a three-phase transformer, take all of the readings on one phase before proceeding to the next, and record the average of the three rms voltmeter readings as the rms voltage value.

NOTE: When the tester uses a power supply that is not synchronized with an electric utility grid, such as a dc/ac motor-generator set, check the frequency and maintain it within ±0.5 percent of the rated frequency of the transformer under test. A power source that is directly connected to, or synchronized with, an electric utility grid need not be monitored for frequency.

4.4.3 *Corrections.*

4.4.3.1 *Correction for Instrumentation Losses.*

Measured losses attributable to the voltmeters and wattmeter voltage circuit, and to voltage transformers if they are used, may be deducted from the total no-load losses measured during testing.

4.4.3.2 *Correction for Non-Sinusoidal Applied Voltage.*

(a) The measured value of no-load loss must be corrected to a sinusoidal voltage, except when waveform distortion in the test voltage causes the magnitude of the correction to be less than 1 percent. In such a case, no correction is required.

(b) To make a correction where the distortion requires a correction of 5 percent or less, use equation 4–1. If the distortion requires a correction to be greater than 5 percent, improve the test voltage and re-test. Repeat until the distortion requires a correction of 5 percent or less.

(c) Determine the no-load losses of the transformer corrected for sine-wave basis from the measured value by using equation 4–1 as follows:

$$P_{ncl} = \frac{P_{nm}}{P_1 + kP_2} \qquad (4\text{-}1)$$

Where:

P_{ncl} is the no-load loss corrected to a sine-wave basis at the temperature (T_{nm}) at which no-load loss is measured,

P_{nm} is the measured no-load loss at temperature T_{nm},

P_1 is the per unit hysteresis loss,

P_2 is the per unit eddy-current loss,

$P_1 + P_2 = 1$,

$$k = \left(\frac{V_{r(nm)}}{V_{a(nm)}}\right)^2,$$

$V_{r(nm)}$ is the test voltage measured by rms voltmeter, and

$V_{a(nm)}$ is the test voltage measured by average-voltage voltmeter.

(d) The two loss components (P_1 and P_2) are assumed equal in value, each assigned a value of 0.5 per unit, unless the actual measurement-based values of hysteresis and eddy-current losses are available (in per unit form), in which case the actual measurements apply.

4.4.3.3 *Correction of No-Load Loss to Reference Temperature.*

After correcting the measured no-load loss for waveform distortion, correct the loss to the reference temperature. For both certification to energy conservation standards and voluntary representations, if the correction to reference temperature is applied, then the core temperature of the transformer during no-load loss measurement (T_{nm}) must be determined within ±10 °C of the true average core temperature. For certification to energy conservation standards only, if the no-load loss measurements were made between 10 °C and 30 °C, this correction is not required. Correct the no-load loss to the reference temperature by using equation 4–2 as follows:

$$P_{nc} = P_{nc1}[1 + 0.00065(T_{nm} - T_{nr})] \qquad (4\text{-}2)$$

Where:

P_{nc} is the no-load losses corrected for waveform distortion and then to the reference temperature;

P_{nc1} is the no-load losses, corrected for waveform distortion, at temperature T_{nm};

T_{nm} is the core temperature during the measurement of no-load losses; and

T_{nr} is the reference temperature.

4.5 *Load Losses: Measurement and Calculations.*

4.5.1 *General Considerations.*

(a) The load losses of a transformer are those losses incident to a specified load carried by the transformer. Load losses consist of ohmic loss in the windings due to the load current and stray losses due to the eddy currents induced by the leakage flux in the windings, core clamps, magnetic shields, tank walls, and other conducting parts. The ohmic loss of a transformer varies directly with temperature, whereas the stray losses vary inversely with temperature.

(b) For a transformer with a tap changer, conduct the test at the rated current and rated-voltage tap position. For a transformer that has a configuration of windings which allows for more than one nominal rated voltage, determine its load losses either in the winding configuration in which the highest losses occur or in each winding configuration in which the transformer can operate.

4.5.2 *Tests for Measuring Load Losses.*

(a) Connect the transformer with either the high-voltage or low-voltage windings to the appropriate test set. Then short-circuit the winding that was not connected to the test set. Apply a voltage at the rated frequency (of the transformer under test) to the connected windings to produce the rated current in the transformer. Take the readings of the wattmeter(s), the ammeters(s), and rms voltmeter(s).

(b) Regardless of the test set selected, the following preparatory requirements must be satisfied for accurate test results:

(1) Determine the temperature of the windings using the applicable method in section 3.2.1 or section 3.2.2.

(2) The conductors used to short-circuit the windings must have a cross-sectional area equal to, or greater than, the corresponding transformer leads, or, if the tester uses a different method to short-circuit the windings, the losses in the short-circuiting conductor assembly must be less than 10 percent of the transformer's load losses.

(3) When the tester uses a power supply that is not synchronized with an electric utility grid, such as a dc/ac motor-generator set, follow the provisions of the ''Note'' in section 4.4.2.

4.5.3 *Corrections.*

4.5.3.1 *Correction for Losses from Instrumentation and Auxiliary Devices.*

4.5.3.1.1 *Instrumentation Losses.*

Measured losses attributable to the voltmeters, wattmeter voltage circuit and short-circuiting conductor (SC), and to the voltage transformers if they are used, may be deducted from the total load losses measured during testing.

4.5.3.1.2 *Losses from Auxiliary Devices.*

Measured losses attributable to auxiliary devices (e.g., circuit breakers, fuses, switches) installed in the transformer, if any, that are not part of the winding and core assembly, may be excluded from load losses measured during testing. To exclude these losses, either (1) measure transformer losses without the auxiliary devices by removing or bypassing them, or (2) measure transformer losses with the auxiliary devices connected, determine the losses associated with the auxiliary devices, and deduct these losses from the load losses measured during testing.

4.5.3.2 *Correction for Phase Angle Errors.*

(a) Corrections for phase angle errors are not required if the instrumentation is calibrated over the entire range of power factors and phase angle errors. Otherwise, determine whether to correct for phase angle errors from the magnitude of the normalized per unit correction, β_n, obtained by using equation 4–3 as follows:

$$\beta_n = \frac{V_{lm} I_{lm} (\beta_w - \beta_v + \beta_c) \sin \phi}{p_{lm}} \qquad (4\text{-}3)$$

(b) The correction must be applied if β_n is outside the limits of ±0.01. If β_n is within the limits of ±0.01, the correction is permitted but not required.

(c) If the correction for phase angle errors is to be applied, first examine the total system phase angle ($\beta_w - \beta_v + \beta_c$). Where the total system phase angle is equal to or less than ±12 milliradians (±41 minutes), use either equation 4–4 or 4–5 to correct the measured load loss power for phase angle errors, and where the total system phase angle exceeds ±12 milliradians (±41 minutes) use equation 4–5, as follows:

$$P_{lc1} = P_{lm} - V_{lm} I_{lm} (\beta_w - \beta_v + \beta_c) \sin \varphi \qquad (4\text{-}4)$$

$$P_{lc1} = V_{lm} I_{lm} \cos(\varphi + \beta_w - \beta_v + \beta_c) \qquad (4\text{-}5)$$

(d) The symbols in this section (4.5.3.2) have the following meanings:

P_{lc1} is the corrected wattmeter reading for phase angle errors,

P_{lm} is the actual wattmeter reading,

V_{lm} is the measured voltage at the transformer winding,

I_{lm} is the measured rms current in the transformer winding,

$$\phi = \cos^{-1}\frac{P_{lm}}{V_{lm}I_{lm}}$$

is the measured phase angle between V_{lm} and I_{lm},

β_w is the phase angle error (in radians) of the wattmeter; the error is positive if the phase angle between the voltage and current phasors as sensed by the wattmeter is smaller than the true phase angle, thus effectively increasing the measured power,

β_v is the phase angle error (in radians) of the voltage transformer; the error is positive if the secondary voltage leads the primary voltage, and

β_c is the phase angle error (in radians) of the current transformer; the error is positive if the secondary current leads the primary current.

(e) The instrumentation phase angle errors used in the correction equations must be specific for the test conditions involved.

4.5.3.3 *Temperature Correction of Load Loss.*

(a) When the measurement of load loss is made at a temperature T_{lm} that is different from the reference temperature, use the procedure summarized in the equations 4–6 to 4–10 to correct the measured load loss to the reference temperature. The symbols used in these equations are defined at the end of this section.

(b) Calculate the ohmic loss (P_e) by using equation 4–6 as follows:

$$\begin{aligned} P_e &= P_{e(p)} + P_{e(s)} \\ &= I^2_{lm(p)} R_{dc(p)} \frac{T_{k(p)} + T_{lm}}{T_{k(p)} + T_{dc}} + I^2_{lm(s)} R_{dc(s)} \frac{T_{k(s)} + T_{lm}}{T_{k(s)} + T_{dc}} \\ &= I^2_{lm(p)} \left[R_{dc(p)} \frac{T_{k(p)} + T_{lm}}{T_{k(p)} + T_{dc}} + \left[\frac{N_1}{N_2}\right]^2 R_{dc(s)} \frac{T_{k(s)} + T_{lm}}{T_{k(s)} + T_{dc}} \right] \qquad (4\text{-}6) \end{aligned}$$

(c) Obtain the stray loss by subtracting the calculated ohmic loss from the measured load loss, by using equation 4–7 as follows:

$$P_s = P_{lc1} - P_e \qquad (4\text{-}7)$$

(d) Correct the ohmic and stray losses to the reference temperature for the load loss by using equations 4–8 and 4–9, respectively, as follows:

$$P_{er} = P_{e(p)} \frac{T_{k(p)} + T_{lr}}{T_{k(p)} + T_{lm}} + P_{e(s)} \frac{T_{k(s)} + T_{lr}}{T_{k(s)} + T_{lm}}$$

$$= I^2_{lm(p)} \left[R_{dc(p)} \frac{T_{k(p)} + T_{lr}}{T_{k(p)} + T_{dc}} + \left[\frac{N_1}{N_2}\right]^2 R_{dc(s)} \frac{T_{k(s)} + T_{lr}}{T_{k(s)} + T_{dc}} \right] \qquad (4\text{-}8)$$

$$P_{sr} = \left(P_{lc1} - P_e\right) \frac{T_k + T_{lm}}{T_k + T_{lr}} \qquad (4\text{-}9)$$

(e) Add the ohmic and stray losses, corrected to the reference temperature, to give the load loss, P_{lc2}, at the reference temperature, by using equation 4–10 as follows:

$$P_{lc2} = P_{er} + P_{sr}$$

$$= I_{lm(p)}^2 \left[R_{dc(p)} \frac{T_{k(p)} + T_{lr}}{T_{k(p)} + T_{dc}} + \left[\frac{N_1}{N_2}\right]^2 R_{dc(s)} \frac{T_{k(s)} + T_{lr}}{T_{k(s)} + T_{dc}} \right]$$

$$+ \left[P_{lc1} - I_{lm(p)}^2 \left[R_{dc(p)} \frac{T_{k(p)} + T_{lm}}{T_{k(p)} + T_{dc}} + \left[\frac{N_1}{N_2}\right]^2 R_{dc(s)} \frac{T_{k(s)} + T_{lm}}{T_{k(s)} + T_{dc}} \right]\right] \frac{T_k + T_{lm}}{T_k + T_{lr}} \qquad (4\text{-}10)$$

(f) The symbols in this section (4.5.3.3) have the following meanings:

$I_{lm(p)}$ is the primary current in amperes,

$I_{lm(s)}$ is the secondary current in amperes,

P_e is the ohmic loss in the transformer in watts at the temperature T_{lm},

$P_{e(p)}$ is the ohmic loss in watts in the primary winding at the temperature T_{lm},

$P_{e(s)}$ is the ohmic loss in watts in the secondary winding at the temperature T_{lm},

P_{er} is the ohmic loss in watts corrected to the reference temperature,

P_{lc1} is the measured load loss in watts, corrected for phase angle error, at the temperature T_{lm},

P_{lc2} is the load loss at the reference temperature,

P_s is the stray loss in watts at the temperature T_{lm},

P_{sr} is the stray loss in watts corrected to the reference temperature,

$R_{dc(p)}$ is the measured dc primary winding resistance in ohms,

$R_{dc(s)}$ is the measured dc secondary winding resistance in ohms,

T_k is the critical temperature in degrees Celsius for the material of the transformer windings. Where copper is used in both primary and secondary windings, T_k is 234.5 °C; where aluminum is used in both primary and secondary windings, T_k is 225 °C; where both copper and aluminum are used in the same transformer, the value of 229 °C is used for T_k,

$T_{k(p)}$ is the critical temperature in degrees Celsius for the material of the primary winding: 234.5 °C if copper and 225 °C if aluminum,

$T_{k(s)}$ is the critical temperature in degrees Celsius for the material of the secondary winding: 234.5 °C if copper and 225 °C if aluminum,

T_{lm} is the temperature in degrees Celsius at which the load loss is measured,

T_{lr} is the reference temperature for the load loss in degrees Celsius,

T_{dc} is the temperature in degrees Celsius at which the resistance values are measured, and

N_1/N_2 is the ratio of the number of turns in the primary winding (N_1) to the number of turns in the secondary winding (N_2); for a primary winding with taps, N_1 is the number of turns used when the voltage applied to the primary winding is the rated primary voltage.

5.0 DETERMINING THE EFFICIENCY VALUE OF THE TRANSFORMER

This section presents the equations to use in determining the efficiency value of the transformer at the required reference conditions and at the specified loading level. The details of measurements are described in sections 3.0 and 4.0. For a transformer that has a configuration of windings which allows for more than one nominal rated voltage, determine its efficiency either at the voltage at which the highest losses occur or at each voltage at which the transformer is rated to operate.

5.1 *Output Loading Level Adjustment.*

If the per-unit load selected in section 2.1 is different from the per-unit load at which the load loss power measurements were made, then adjust the corrected load loss power, P_{lc2}, by using equation 5–1 as follows:

$$P_{lc} = P_{lc2} \left[\frac{P_{os}}{P_{or}}\right]^2 = P_{lc2} L^2 \qquad (5\text{-}1)$$

Where:

P_{lc} is the adjusted load loss power to the per-unit load;

P_{lc2} is as calculated in section 4.5.3.3;

P_{or} is the rated transformer apparent power (name plate);

P_{os} is the adjusted rated transformer apparent power, where $P_{os} = P_{or}L$; and

L is the per-unit load, *e.g.*, if the per-unit load is 50 percent then ''L'' is 0.5.

5.2 *Total Loss Power Calculation.*

Calculate the corrected total loss power by using equation 5–2 as follows:

$$P_{ts} = P_{nc} + P_{lc} \qquad (5\text{-}2)$$

Where:

P_{ts} is the corrected total loss power adjusted for the transformer output loading specified by the standard,

P_{nc} is as calculated in section 4.4.3.3, and

P_{lc} is as calculated in section 5.1.

5.3 *Energy Efficiency Calculation.*

Calculate efficiency (η) in percent at specified energy efficiency load level, P_{os}, by using equation 5–3 as follows:

$$\eta = 100\left(\frac{P_{os}}{P_{os} + P_{ts}}\right) \qquad (5\text{-}3)$$

Where:

P_{os} is as described and calculated in section 5.1, and

P_{ts} is as described and calculated in section 5.2.

5.4 *Significant Figures in Power Loss and Efficiency Data.*

In measured and calculated data, retain enough significant figures to provide at least 1 percent resolution in power loss data and 0.01 percent resolution in efficiency data.

6.0 *Test Equipment Calibration and Certification.*

Maintain and calibrate test equipment and measuring instruments, maintain calibration records, and perform other test and measurement quality assurance procedures according to the following sections. The calibration of the test set must confirm the accuracy of the test set to that specified in section 2.3, Table 2.3 of this appendix.

6.1 *Test Equipment.*

The party performing the tests must control, calibrate, and maintain measuring and test equipment, whether or not it owns the equipment, has the equipment on loan, or the equipment is provided by another party. Equipment must be used in a manner which assures that measurement uncertainty is known and is consistent with the required measurement capability.

6.2 *Calibration and Certification.*

The party performing the tests must:

(a) Identify the measurements to be made, the accuracy required (section 2.3) and select the appropriate measurement and test equipment;

(b) At prescribed intervals, or prior to use, identify, check and calibrate, if needed, all measuring and test equipment systems or devices that affect test accuracy, against certified equipment having a known valid relationship to nationally recognized standards; where no such standards exist, the basis used for calibration must be documented;

(c) Establish, document and maintain calibration procedures, including details of equipment type, identification number, location, frequency of checks, check method, acceptance criteria and action to be taken when results are unsatisfactory;

(d) Ensure that the measuring and test equipment is capable of the accuracy and precision necessary, taking into account the voltage, current and power factor of the transformer under test;

(e) Identify measuring and test equipment with a suitable indicator or approved identification record to show the calibration status;

(f) Maintain calibration records for measuring and test equipment;

(g) Assess and document the validity of previous test results when measuring and test equipment is found to be out of calibration;

(h) Ensure that the environmental conditions are suitable for the calibrations, measurements and tests being carried out;

(i) Ensure that the handling, preservation and storage of measuring and test equipment is such that the accuracy and fitness for use is maintained; and

(j) Safeguard measuring and test facilities, including both test hardware and test software, from adjustments which would invalidate the calibration setting.

7.0 TEST PROCEDURE FOR VOLUNTARY REPRESENTATIONS

Follow sections 1.0 through 6.0 of this appendix using the per-unit load and/or reference temperature of interest for voluntary representations of efficiency, and corresponding values of load loss and no-load loss at additional per-unit load and/or reference temperature. Representations made at a per-unit load and/or reference temperature other than those required to comply with the energy conservation standards at §431.196 must be in addition to, and not in place of, a representation at the required DOE settings for per-unit load and reference temperature. As a best practice, the additional settings of per-unit load and reference temperature should be provided with the voluntary representations.

[71 FR 24999, Apr. 27, 2006; 71 FR 60662, Oct. 16, 2006; 86 FR 51252, Sept. 14, 2021]

EFFECTIVE DATE NOTE: At 71 FR 24999, Apr. 27, 2006, appendix A to subpart K of part 431 was added. Section 6.2(f) contains information collection requirements and will not become effective until approval has been given by the Office of Management and Budget.

Subpart L—Illuminated Exit Signs

SOURCE: 70 FR 60417, Oct. 18, 2005, unless otherwise noted.

§431.201 Purpose and scope.

This subpart contains energy conservation requirements for illuminated exit signs, pursuant to Part B of Title III of the Energy Policy and Conservation Act, as amended, 42 U.S.C. 6291–6309.

§431.202 Definitions concerning illuminated exit signs.

Basic model means all units of a given type of covered product (or class thereof) manufactured by one manufacturer, having the same primary energy source, and which have essentially identical electrical, physical, and functional (or hydraulic) characteristics that affect energy consumption, energy efficiency, water consumption, or water efficiency.

Face means an illuminated side of an illuminated exit sign.

Illuminated exit sign means a sign that—

(1) Is designed to be permanently fixed in place to identify an exit; and

(2) Consists of an electrically powered integral light source that—

(i) Illuminates the legend "EXIT" and any directional indicators; and

(ii) Provides contrast between the legend, any directional indicators, and the background.

Input power demand means the amount of power required to continuously illuminate an exit sign model, measured in watts (W). For exit sign models with rechargeable batteries, input power demand shall be measured with batteries at full charge.

[70 FR 60417, Oct. 18, 2005, as amended at 71 FR 71372, Dec. 8, 2006; 76 FR 12504, Mar. 7, 2011]

TEST PROCEDURES

§431.203 Materials incorporated by reference.

(a) *General.* The Department incorporates by reference the following test procedures into subpart L of part 431. The Director of the Federal Register has approved the material listed in paragraph (b) of this section for incorporation by reference in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. Any subsequent amendment to this material by the standard-setting organization will not affect the DOE test procedures unless and until DOE amends its test procedures. The Department incorporates the material as it exists on the date of the approval by the Federal Register and a notice of any change in the material will be published in the FEDERAL REGISTER.

(b) *Test procedure incorporated by reference.* Environmental Protection Agency "ENERGY STAR Program Requirements for Exit Signs," Version 2.0 issued January 1, 1999.

(c) *Availability of reference*—(1) *Inspection of test procedure.* The test procedure incorporated by reference are available for inspection at:

(i) National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call (202) 741–6030, or go to: *http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html.*

(ii) U.S. Department of Energy, Forrestal Building, Room 1J–018 (Resource Room of the Building Technologies Program), 1000 Independence Avenue, SW., Washington, DC 20585–0121, (202) 586–9127, between 9 a.m. and 4 p.m., Monday through Friday, except Federal holidays.

(2) *Obtaining copies of the standard.* Copies of the Environmental Protection Agency "ENERGY STAR Program Requirements for Exit Signs," Version 2.0, may be obtained from the Environmental Protection Agency, Ariel Rios Building, 1200 Pennsylvania Avenue, NW., Washington, DC 20460, (202) 272–0167 or at*http://www.epa.gov.*

[71 FR 71373, Dec. 8, 2006]

§ 431.204 Uniform test method for the measurement of energy consumption of illuminated exit signs.

(a) *Scope*. This section provides the test procedure for measuring, pursuant to EPCA, the input power demand of illuminated exit signs. For purposes of this part 431 and EPCA, the test procedure for measuring the input power demand of illuminated exit signs shall be the test procedure specified in § 431.203(b).

(b) *Testing and Calculations*. Determine the energy efficiency of each covered product by conducting the test procedure, set forth in the Environmental Protection Agency's ''ENERGY STAR Program Requirements for Exit Signs,'' Version 2.0, section 4 (Test Criteria), ''Conditions for testing'' and ''Input power measurement.'' (Incorporated by reference, see § 431.203)

[71 FR 71373, Dec. 8, 2006]

ENERGY CONSERVATION STANDARDS

§ 431.206 Energy conservation standards and their effective dates.

An illuminated exit sign manufactured on or after January 1, 2006, shall have an input power demand of 5 watts or less per face.

Subpart M—Traffic Signal Modules and Pedestrian Modules

SOURCE: 70 FR 60417, Oct. 18, 2005, unless otherwise noted.

§ 431.221 Purpose and scope.

This subpart contains energy conservation requirements for traffic signal modules and pedestrian modules, pursuant to Part B of Title III of the Energy Policy and Conservation Act, as amended, 42 U.S.C. 6291–6309.

§ 431.222 Definitions concerning traffic signal modules and pedestrian modules.

Basic model means all units of a given type of covered product (or class thereof) manufactured by one manufacturer, having the same primary energy source, and which have essentially identical electrical, physical, and functional (or hydraulic) characteristics that affect energy consumption, energy efficiency, water consumption, or water efficiency.

Maximum wattage means the power consumed by the module after being operated for 60 minutes while mounted in a temperature testing chamber so that the lensed portion of the module is outside the chamber, all portions of the module behind the lens are within the chamber at a temperature of 74 °C and the air temperature in front of the lens is maintained at a minimum of 49 °C.

Nominal wattage means the power consumed by the module when it is operated within a chamber at a temperature of 25 °C after the signal has been operated for 60 minutes.

Pedestrian module means a light signal used to convey movement information to pedestrians.

Traffic signal module means a standard 8-inch (200 mm) or 12-inch (300 mm) traffic signal indication that—

(1) Consists of a light source, a lens, and all other parts necessary for operation; and

(2) Communicates movement messages to drivers through red, amber, and green colors.

[70 FR 60417, Oct. 18, 2005, as amended at 71 FR 71373, Dec. 8, 2006; 76 FR 12504, Mar. 7, 2011]

TEST PROCEDURES

§ 431.223 Materials incorporated by reference.

(a) *General*. The Department incorporates by reference the following test procedures into subpart M of part 431. The Director of the Federal Register has approved the material listed in paragraph (b) of this section for incorporation by reference in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. Any subsequent amendment to this material by the standard-setting organization will not affect the DOE test procedures unless and until DOE amends its test procedures. The Department incorporates the material as it exists on the date of the approval by the Federal Register and a notice of any change in the material will be published in the FEDERAL REGISTER.

(b) *List of test procedures incorporated by reference.* (1) Environmental Protection Agency, ''ENERGY STAR Program Requirements for Traffic Signals,'' Version 1.1 issued February 4, 2003.

(2) Institute of Transportation Engineers (ITE), ''Vehicle Traffic Control Signal Heads: Light Emitting Diode (LED) Circular Signal Supplement,'' June 27, 2005.

(c) *Availability of references*—(1) *Inspection of test procedures.* The test procedures incorporated by reference are available for inspection at:

(i) National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call (202) 741–6030, or go to: *http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html.*

(ii) U.S. Department of Energy, Forrestal Building, Room 1J–018 (Resource Room of the Building Technologies Program), 1000 Independence Avenue, SW., Washington, DC 20585–0121, (202) 586–9127, between 9 a.m. and 4 p.m., Monday through Friday, except Federal holidays.

(2) *Obtaining copies of standards.* Standards incorporated by reference may be obtained from the following sources:

(i) Copies of the Environmental Protection Agency ''ENERGY STAR Program Requirements for Traffic Signals,'' Version 1.1, may be obtained from the Environmental Protection Agency, Ariel Rios Building, 1200 Pennsylvania Avenue, NW., Washington, DC 20460, (202) 272–0167 or at *http://www.epa.gov.*

(ii) Institute of Transportation Engineers, 1099 14th Street, NW., Suite 300 West, Washington, DC 20005–3438, (202) 289–0222, or *ite_staff@ite.org.*

[71 FR 71373, Dec. 8, 2006]

§ 431.224 Uniform test method for the measurement of energy consumption for traffic signal modules and pedestrian modules.

(a) *Scope.* This section provides the test procedures for measuring, pursuant to EPCA, the maximum wattage and nominal wattage of traffic signal modules and pedestrian modules. For purposes of 10 CFR part 431 and EPCA, the test procedures for measuring the maximum wattage and nominal wattage of traffic signal modules and pedestrian modules shall be the test procedures specified in § 431.223(b).

(b) *Testing and Calculations.* Determine the nominal wattage and maximum wattage of each covered traffic signal module or pedestrian module by conducting the test procedure set forth in Environmental Protection Agency, ''ENERGY STAR Program Requirements for Traffic Signals,'' Version 1.1, section 1, ''Definitions,'' and section 4, ''Test Criteria.'' (Incorporated by reference, see § 431.223) Use a wattmeter having an accuracy of ±1% to measure the nominal wattage and maximum wattage of a red and green traffic signal module, and a pedestrian module when conducting the photometric and colormetric tests as specified by the testing procedures in VTCSH 2005.

[71 FR 71373, Dec. 8, 2006]

ENERGY CONSERVATION STANDARDS

§ 431.226 Energy conservation standards and their effective dates.

Any traffic signal module or pedestrian module manufactured on or after January 1, 2006, shall meet both of the following requirements:

(a) Have a nominal wattage and maximum wattage no greater than:

	Maximum wattage (at 74 °C)	Nominal wattage (at 25 °C)
Traffic Signal Module Type:		
12″ Red Ball	17	11
8″ Red Ball	13	8
12″ Red Arrow	12	9
12″ Green Ball	15	15
8″ Green Ball	12	12
12″ Green Arrow	11	11
Pedestrian Module Type:		
Combination Walking Man/Hand	16	13
Walking Man	12	9
Orange Hand	16	13

(b) Be installed with compatible, electrically connected signal control interface devices and conflict monitoring systems.

[70 FR 60417, Oct. 18, 2005, as amended at 71 FR 71374, Dec. 8, 2006]

Subpart N—Unit Heaters

SOURCE: 70 FR 60418, Oct. 18, 2005, unless otherwise noted.

§ 431.241 Purpose and scope.

This subpart contains energy conservation requirements for unit heaters, pursuant to Part B of Title III of the Energy Policy and Conservation Act, as amended, 42 U.S.C. 6291–6309.

§ 431.242 Definitions concerning unit heaters.

Automatic flue damper means a device installed in the flue outlet or in the inlet of or upstream of the draft control device of an individual, automatically operated, fossil fuel-fired appliance that is designed to automatically open the flue outlet during appliance operation and to automatically close the flue outlet when the appliance is in a standby condition.

Automatic vent damper means a device intended for installation in the venting system of an individual, automatically operated, fossil fuel-fired appliance either in the outlet or downstream of the appliance draft control device, which is designed to automatically open the venting system when the appliance is in operation and to automatically close off the venting system when the appliance is in a standby or shutdown condition.

Basic model means all units of a given type of covered product (or class thereof) manufactured by one manufacturer, having the same primary energy source, and which have essentially identical electrical, physical, and functional (or hydraulic) characteristics that affect energy consumption, energy efficiency, water consumption, or water efficiency.

Intermittent ignition device means an ignition device in which the ignition source is automatically shut off when the appliance is in an off or standby condition.

Power venting means a venting system that uses a separate fan, either integral to the appliance or attached to the vent pipe, to convey products of combustion and excess or dilution air through the vent pipe.

Unit heater means a self-contained fan-type heater designed to be installed within the heated space; however, the term does not include a warm air furnace.

Warm air furnace means commercial warm air furnace as defined in § 431.72.

[70 FR 60418, Oct. 18, 2005, as amended at 71 FR 71374, Dec. 8, 2006; 76 FR 12504, Mar. 7, 2011]

TEST PROCEDURES [RESERVED]

ENERGY CONSERVATION STANDARDS

§ 431.246 Energy conservation standards and their effective dates.

A unit heater manufactured on or after August 8, 2008, shall:

(a) Be equipped with an intermittent ignition device; and

(b) Have power venting or an automatic flue damper. An automatic vent damper is an acceptable alternative to an automatic flue damper for those unit heaters where combustion air is drawn from the conditioned space.

[70 FR 60418, Oct. 18, 2005, as amended at 71 FR 71374, Dec. 8, 2006]

Subpart O—Commercial Prerinse Spray Valves

SOURCE: 70 FR 60418, Oct. 18, 2005, unless otherwise noted.

§ 431.261 Purpose and scope.

This subpart contains energy conservation requirements for commercial prerinse spray valves, pursuant to section 135 of the Energy Policy Act of 2005, Pub. L. 109–58.

§ 431.262 Definitions.

As used in this subpart:

Basic model means all spray settings of a given class manufactured by one manufacturer, which have essentially identical physical and functional (or hydraulic) characteristics that affect water consumption or water efficiency.

Commercial prerinse spray valve means a handheld device that has a release-to-close valve and is suitable for removing food residue from food service items before cleaning them in commercial dishwashing or ware washing equipment. DOE may determine that a device is suitable for removing food residue from food service items before cleaning them in commercial dishwashing or ware washing equipment based on any or all of the following:

(1) Equipment design and representations (for example, whether equipment is represented as being capable of rinsing dishes as compared to equipment that is represented exclusively for washing walls and floors or animal washing);

(2) Channels of marketing and sales (for example, whether equipment is marketed or sold through outlets that market or sell to food service entities);

(3) Actual sales (including whether the end-users are restaurants or commercial or institutional kitchens, even if those sales are indirectly through an entity such as a distributor).

Spray force means the amount of force exerted onto the spray disc, measured in ounce-force (ozf).

[80 FR 81453, Dec. 30, 2015, as amended at 87 FR 13909, Mar. 11, 2022]

§ 431.263 Materials incorporated by reference.

(a) Certain material is incorporated by reference into this subpart with the approval of the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. To enforce any edition other than that specified in this section, the U.S. Department of Energy (DOE) must publish a document in the FEDERAL REGISTER and the material must be available to the public. All approved material is available for inspection at the DOE and at the National Archives and Records Administration (NARA). Contact DOE at: The U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Program, 6th Floor, 950 L'Enfant Plaza SW, Washington, DC 20024, (202) 586–9127, or *Buildings@ee.doe.gov, https://www.energy.gov/eere/buildings/building-technologies-office*. For information on the availability of this material at NARA, email: *fr.inspection@nara.gov*, or go to: *www.archives.gov/federal-register/cfr/ibr-locations.html*. The material may be obtained from the source(s) in the following paragraph(s) of this section.

(b) *ASTM*. ASTM, International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428–2959, (610) 832–9585, or go to *www.astm.org*.

(1) ASTM F2324–13 (R2019) (''ASTM F2324''),''Standard Test Method for Prerinse Spray Valves'', Approved May 1, 2019; IBR approved for § 431.264.

(2) [Reserved]

[87 FR 13910, Mar. 11, 2022]

TEST PROCEDURES

§ 431.264 Uniform test method to measure flow rate and spray force of commercial prerinse spray valves.

(a) *Scope*. This section provides the test procedure to measure the flow rate and spray force of a commercial prerinse spray valve.

(b) *Testing and calculations for a unit with a single spray setting*—(1) *Flow rate*. (i) Test each unit in accordance with the requirements of Sections 6.1 through 6.9 (Apparatus) (except 6.4 and 6.7), 9.1 through 9.4 (Preparation of Apparatus), and 10.1 through 10.2.5 (Procedure) of ASTM F2324, (incorporated by reference, see § 431.263). Precatory language in ASTM F2324 is to be treated as mandatory for the purpose of testing. In Section 9.1 of ASTM F2324, the second instance of ''prerinse spray valve'' refers to the spring-style deck-mounted prerinse unit defined in Section 6.8. In lieu of using manufacturer installation instructions or packaging, always connect the commercial prerinse spray valve to the flex tubing for testing. Normalize the weight of the water to calculate flow rate using Equation 1 to this paragraph, where W_{water} is the weight normalized to a 1 minute time period, W_1 is the weight of the water in the carboy at the conclusion of the flow rate test, and t_1 is the total recorded time of the flow rate test.

$$W_{water} = W_1 \, x \, \frac{60\,s}{t_1} \qquad \text{(Eq. 1 to paragraph (b)(1)(i))}$$

(ii) Perform calculations in accordance with Section 11.3.1 (Calculation and Report) of ASTM F2324. Record the water temperature (°F) and dynamic water pressure (psi) once at the start for each run of the test. Record the time (min), the normalized weight of water in the carboy (lb) and the resulting flow rate (gpm) once at the end of each run of the test. Record flow rate measurements of time (min) and weight (lb) at the resolutions of the test instrumentation. Perform three runs on each unit, as specified in Section 10.2.5 of ASTM F2324, but disregard any references to Annex A1. Then, for each unit, calculate the mean of the three flow rate values determined from each run. Round the final value for flow rate to two decimal places and record that value.

(2) *Spray force*. Test each unit in accordance with the test requirements specified in Sections 6.2 and 6.4 through 6.9 (Apparatus), 9.1 through 9.5.3.2 (Preparation of Apparatus), and 10.3.1 through 10.3.8 (Procedure) of ASTM F2324. In Section 9.1 of ASTM F2324, the second instance of ''prerinse spray valve'' refers to the spring-style deck-mounted prerinse unit defined in Section 6.8. In lieu of using manufacturer installation instructions or packaging, always connect the commercial prerinse spray valve to the flex tubing for testing. Record the water temperature (°F) and dynamic water pressure (psi) once at the start for each run of the test. In order to calculate the mean spray force value for the unit under test, there are two measurements per run and there are three runs per test. For each run of the test, record a minimum of two spray force measurements and calculate the mean of the measurements over the 15-second time period of stabilized flow during spray force testing. Record the time (min) once at the end of each run of the test. Record spray force measurements at the resolution of the test instrumentation. Conduct three runs on each unit, as specified in Section 10.3.8 of ASTM F2324, but disregard any references to Annex A1. Ensure the unit has been stabilized separately during each run. Then for each unit, calculate and record the mean of the spray force values determined from each run. Round the final value for spray force to one decimal place.

(c) *Testing and calculations for a unit with multiple spray settings*. If a unit has multiple user-selectable spray settings, or includes multiple spray faces that can be installed, for each possible spray setting or spray face:

(1) Measure both the flow rate and spray force according to paragraphs (b)(1) and (2) of this section (including calculating the mean flow rate and mean spray force) for each spray setting; and

(2) Record the mean flow rate for each spray setting, rounded to two decimal places. Record the mean spray force for each spray setting, rounded to one decimal place.

(d) *Test procedure for voluntary representations*. Follow paragraph (b)(1) or (2) or (c) of this section, as applicable, using test water pressure(s) of interest for voluntary representations of flow rate. Representations made at a water pressure other than the required test water pressure cannot replace a representation at the required test water pressure specified in Section 9.1 of ASTM F2324. Any voluntary representation of flow rate made pursuant to this paragraph shall specify the water pressure associated with the represented flow rate.

[80 FR 81453, Dec. 30, 2015, as amended at 87 FR 13910, Mar. 11, 2022]

ENERGY CONSERVATION STANDARDS

§ 431.266 Energy conservation standards and their effective dates.

(a) Commercial prerinse spray valves manufactured on or after January 1, 2006 and before January 28, 2019, shall have a flow rate of not more than 1.6 gallons per minute. For the purposes of this standard, a *commercial prerinse spray valve* is a handheld device designed and marketed for use with commercial dishwashing and ware washing equipment that sprays water on dishes, flatware, and other food service items for the purpose of removing food residue before cleaning the items.

(b) Commercial prerinse spray valves manufactured on or after January 28, 2019 shall have a flow rate that does not exceed the following:

Product class (spray force in ounce-force, ozf)	Flow rate (gallons per minute, gpm)
Product Class 1 (≤5.0 ozf)	1.00
Product Class 2 (>5.0 ozf and ≤8.0 ozf)	1.20
Product Class 3 (>8.0 ozf)	1.28

(1) For the purposes of this standard, the definition of *commercial prerinse spray valve* in §431.262 applies.

(2) [Reserved]

[81 FR 4801, Jan. 27, 2016]

Subpart P—Mercury Vapor Lamp Ballasts

SOURCE: 70 FR 60418, Oct. 18, 2005, unless otherwise noted.

§431.281 Purpose and scope.

This subpart contains energy conservation requirements for mercury vapor lamp ballasts, pursuant to section 135 of the Energy Policy Act of 2005, Pub. L. 109–58.

§431.282 Definitions concerning mercury vapor lamp ballasts.

Ballast means a device used with an electric discharge lamp to obtain necessary circuit conditions (voltage, current, and waveform) for starting and operating.

High intensity discharge lamp means an electric-discharge lamp in which—

(1) The light-producing arc is stabilized by the arc tube wall temperature; and

(2) The arc tube wall loading is in excess of 3 Watts/cm^2, including such lamps that are mercury vapor, metal halide, and high-pressure sodium lamps.

Mercury vapor lamp means a high intensity discharge lamp, including clear, phosphor-coated, and self-ballasted screw base lamps, in which the major portion of the light is produced by radiation from mercury typically operating at a partial vapor pressure in excess of 100,000 Pa (approximately 1 atm).

Mercury vapor lamp ballast means a device that is designed and marketed to start and operate mercury vapor lamps intended for general illumination by providing the necessary voltage and current.

Specialty application mercury vapor lamp ballast means a mercury vapor lamp ballast that—

(1) Is designed and marketed for operation of mercury vapor lamps used in quality inspection, industrial processing, or scientific use, including fluorescent microscopy and ultraviolet curing; and

(2) In the case of a specialty application mercury vapor lamp ballast, the label of which—

(i) Provides that the specialty application mercury vapor lamp ballast is 'For specialty applications only, not for general illumination'; and

(ii) Specifies the specific applications for which the ballast is designed.

[74 FR 12074, Mar. 23, 2009]

TEST PROCEDURES [RESERVED]

ENERGY CONSERVATION STANDARDS

§431.286 Energy conservation standards and their effective dates.

Mercury vapor lamp ballasts, other than specialty application mercury vapor lamp ballasts, shall not be manufactured or imported after January 1, 2008.

[74 FR 12074, Mar. 23, 2009]

Subpart Q—Refrigerated Bottled or Canned Beverage Vending Machines

SOURCE: 71 FR 71375, Dec. 8, 2006, unless otherwise noted.

§431.291 Scope.

This subpart specifies test procedures and energy conservation standards for certain commercial refrigerated bottled or canned beverage vending machines, pursuant to part A of Title III of the Energy Policy and Conservation Act, as amended, 42 U.S.C. 6291–6309. The regulatory provisions of §§430.33 and 430.34 and subparts D and E of part 430 of this chapter are applicable to refrigerated bottled or canned beverage vending machines.

[80 FR 45792, July 31, 2015]

§ 431.292 Definitions concerning refrigerated bottled or canned beverage vending machines.

Basic model means all units of a given type of covered product (or class thereof) manufactured by one manufacturer, having the same primary energy source, and which have essentially identical electrical, physical, and functional (or hydraulic) characteristics that affect energy consumption, energy efficiency, water consumption, or water efficiency.

Bottled or canned beverage means a beverage in a sealed container.

Class A means a refrigerated bottled or canned beverage vending machine that is not a combination vending machine and in which 25 percent or more of the surface area on the front side of the beverage vending machine is transparent.

Class B means a refrigerated bottled or canned beverage vending machine that is not considered to be Class A and is not a combination vending machine.

Combination A means a combination vending machine where 25 percent or more of the surface area on the front side of the beverage vending machine is transparent.

Combination B means a combination vending machine that is not considered to be Combination A.

Combination vending machine means a bottled or canned beverage vending machine containing two or more compartments separated by a solid partition, that may or may not share a product delivery chute, in which at least one compartment is designed to be refrigerated, as demonstrated by the presence of temperature controls, and at least one compartment is not.

Refrigerated bottled or canned beverage vending machine means a commercial refrigerator (as defined at § 431.62) that cools bottled or canned beverages and dispenses the bottled or canned beverages on payment.

Transparent means greater than or equal to 45 percent light transmittance, as determined in accordance with ASTM E 1084–86 (Reapproved 2009), (incorporated by reference, see § 431.293) at normal incidence and in the intended direction of viewing.

V means the refrigerated volume (ft^3) of the refrigerated bottled or canned beverage vending machine, as measured by Appendix C of ANSI/ASHRAE 32.1 (incorporated by reference, see § 431.293).

[71 FR 71375, Dec. 8, 2006, as amended at 74 FR 44967, Aug. 31, 2009; 76 FR 12504, Mar. 7, 2011; 80 FR 45792, July 31, 2015; 81 FR 1112, Jan. 8, 2016]

TEST PROCEDURES

§ 431.293 Materials incorporated by reference.

(a) *General*. DOE incorporates by reference the following standards into subpart Q of part 431. The material listed has been approved for incorporation by reference by the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. Any subsequent amendment to a standard by the standard-setting organization will not affect the DOE regulations unless and until amended by DOE. Material is incorporated as it exists on the date of the approval and a notice of any change in the material will be published in the FEDERAL REGISTER. All approved material is available for inspection at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call (202) 741–6030 or visit *http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html*. This material is also available for inspection at U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Program, 6th Floor, 950 L'Enfant Plaza, SW., Washington, DC 20024, 202–586–2945, or visit *http://www1.eere.energy.gov/buildings/appliance_standards*. Standards can be obtained from the sources listed below.

(b) *ASHRAE*. American Society of Heating, Refrigerating and Air-Conditioning Engineers, 1791 Tullie Circle, NE. Atlanta, GA 30329, 404–636–8400, or *www.ashrae.org*.

(1) ANSI/ASHRAE Standard 32.1–2010, (''ANSI/ASHRAE 32.1''), ''Methods of Testing for Rating Vending Machines for Sealed Beverages,'' approved July 23, 2010, IBR approved for § 431.292 and appendices A and B to subpart Q of this part.

(2) [Reserved]

(c) *ASTM*. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428–2959, (877) 909–2786, or go to *www.astm.org*.

(1) ASTM E 1084–86 (Reapproved 2009), ‘‘Standard Test Method for Solar Transmittance (Terrestrial) of Sheet Materials Using Sunlight,’’ approved April 1, 2009, IBR approved for §431.292.

(2) [Reserved]

[74 FR 44967, Aug. 31, 2009, as amended at 80 FR 45792, July 31, 2015; 81 FR 1113, Jan. 8, 2016]

§431.294 Uniform test method for the measurement of energy consumption of refrigerated bottled or canned beverage vending machines.

(a) *Scope*. This section provides test procedures for measuring, pursuant to EPCA, the energy consumption of refrigerated bottled or canned beverage vending machines.

(b) *Testing and Calculations*. Determine the daily energy consumption of each covered refrigerated bottled or canned beverage vending machine by conducting the appropriate test procedure set forth in appendix A or B to this subpart.

[71 FR 71375, Dec. 8, 2006, as amended at 80 FR 45793, July 31, 2015]

ENERGY CONSERVATION STANDARDS

§431.296 Energy conservation standards and their effective dates.

(a) Each refrigerated bottled or canned beverage vending machine manufactured on or after August 31, 2012 and before January 8, 2019, shall have a daily energy consumption (in kilowatt hours per day), when measured in accordance with the DOE test procedure at §431.294, that does not exceed the following:

Equipment class	Maximum daily energy consumption (kilowatt hours per day)
Class A	0.055 × V† + 2.56.
Class B	0.073 × V† + 3.16.
Combination Vending Machines.	[Reserved].

†“V” is the representative value of refrigerated volume (ft^3) of the BVM model, as calculated pursuant to 10 CFR 429.52(a)(3).

(b) Each refrigerated bottled or canned beverage vending machine manufactured on or after January 8, 2019, shall have a daily energy consumption (in kilowatt hours per day), when measured in accordance with the DOE test procedure at §431.294, that does not exceed the following:

Equipment class	Maximum daily energy consumption (kilowatt hours per day)
Class A	0.052 × V† + 2.43.
Class B	0.052 × V† + 2.20.
Combination A	0.086 × V† + 2.66.
Combination B	0.111 × V† + 2.04.

†“V” is the representative value of refrigerated volume (ft^3) of the BVM model, as calculated pursuant to 10 CFR 429.52(a)(3).

[81 FR 1113, Jan. 8, 2016]

APPENDIX A TO SUBPART Q OF PART 431—UNIFORM TEST METHOD FOR THE MEASUREMENT OF ENERGY CONSUMPTION OF REFRIGERATED BOTTLED OR CANNED BEVERAGE VENDING MACHINES

NOTE: Prior to January 27, 2016, manufacturers must make any representations with respect to the energy use or efficiency of refrigerated bottled or canned beverage vending machines in accordance with the results of testing pursuant to this Appendix A or the procedures in 10 CFR 431.294 as it appeared in the edition of 10 CFR parts 200 to 499 revised as of January 1, 2015. Any representations made with respect to the energy use or efficiency of such refrigerated beverage vending machines must be in accordance with whichever version is selected. On or after January 27, 2016, manufacturers must make any representations with respect to energy use or efficiency in accordance with the results of testing pursuant to this Appendix A to demonstrate compliance with the energy conservation standards at 10 CFR 431.296, for which compliance was required as of August 31, 2012.

1. *General*. Section 3, ‘‘Definitions’’; section 4, ‘‘Instruments’’; section 5, ‘‘Vendible Capacity’’; section 6, ‘‘Test Conditions’’; section 7.1, ‘‘Test Procedures—General Requirements’’; and section 7.2, ‘‘Energy Consumption Test’’ of ANSI/ASHRAE 32.1 (incorporated by reference; see §431.293) apply to this appendix except as noted throughout this appendix. In cases where there is a conflict, the language of the test procedure in this appendix takes precedence over ANSI/ASHRAE 32.1.

1.1. *Instruments*. In addition to the instrument accuracy requirements in section 4, ‘‘Instruments,’’ of ANSI/ASHRAE 32.1 (incorporated by reference, see §431.293), humidity shall be measured with a calibrated instrument accurate to ±2 percent RH at the specified ambient relative humidity condition specified in section 2.1.2 of this appendix.

1.2. *Definitions.* In addition to the definitions specified in section 3, ''Definitions,'' of ANSI/ASHRAE 32.1 (incorporated by reference, see § 431.293), the following definition is also applicable to this appendix.

External accessory standby mode means the mode of operation in which any external, integral customer display signs, lighting, or digital screens:

(1) Are connected to mains power;

(2) Do not produce the intended illumination, display, or interaction functionality; and

(3) Can be switched into another mode automatically with only a remote user-generated or an internal signal.

Instantaneous average next-to-vend beverage temperature means the spatial average of all standard test packages in the next-to-vend beverages positions at a given time.

Integrated average temperature means the average temperature of all standard test package measurements in the next-to-vend beverage positions taken over the duration of the test, expressed in degrees Fahrenheit (°F).

Lowest application product temperature means the lowest integrated average temperature a given basic model is capable of maintaining so as to comply with the temperature stabilization requirements specified in section 7.2.2.2 of ANSI/ASHRAE 32.1 (incorporated by reference, see § 431.293).

2. *Test Procedure.*

2.1. *Test Conditions.* The test conditions specified in section 6, ''Test Conditions,'' of ANSI/ASHRAE 32.1 (incorporated by reference, see § 431.293) apply to this appendix except that in section 6.1, ''Voltage and Frequency,'' of ANSI/ASHRAE 32.1, the voltage and frequency tolerances specified in section 6.1.a of ANSI/ASHRAE 32.1 also apply equivalently to section 6.1.b of ANSI/ASHRAE 32.1 for equipment with dual nameplate voltages.

2.1.1. *Average Beverage Temperature.* The integrated average temperature measured during the test must be within ±1 °F of the value specified in Table A.1 of this appendix or the lowest application product temperature for models tested in accordance with paragraph 2.1.3 of this appendix. The measurement of integrated average temperature must begin after temperature stabilization has been achieved and continue for the following 24 consecutive hours. All references to ''Table 1'' in ANSI/ASHRAE 32.1 (incorporated by reference, see § 431.293) shall instead be interpreted as references to Table A.1 of this appendix and all references to ''average beverage temperature'' in ANSI/ASHRAE 32.1 shall instead be interpreted as references to the integrated average temperature as defined in section 1.2 of this appendix of this subpart, except as noted in section 2.1.1.1 of this appendix.

2.1.1.1. *Temperature Stabilization.* Temperature stabilization shall be determined in accordance with section 7.2.2.2 of ANSI/ASHRAE 32.1 (incorporated by reference § 431.293), except that the reference to ''average beverage temperature'' shall instead refer to the ''instantaneous average next-to-vend beverage temperature,'' as defined in section 1.2 of this appendix, and the reference to ''Table 1'' shall instead refer to Table A.1 of this appendix. That is, temperature stabilization is considered to be achieved 24 hours after the instantaneous average next-to-vend beverage temperature reaches the specified value (see Table A.1) and energy consumption for two successive 6 hour periods are within 2 percent of each other.

2.1.2. *Ambient Test Conditions.* The refrigerated bottled or canned beverage vending machine must be tested at the test conditions and tolerances specified in the following Table A.1 of this appendix. The specified ambient temperature and humidity conditions shall be maintained within the ranges specified for each recorded measurement. All references to ''Table 1'' in ANSI/ASHRAE 32.1 (incorporated by reference, see § 431.293) shall instead be interpreted as references to Table A.1 of this appendix. In contrast to the requirements of section 6.1 and Table 1 of ANSI/ASHRAE 32.1, conduct testing only one time at the conditions referenced in Table A.1 of this appendix. Testing at alternate ambient conditions is not required or permitted.

TABLE A.1—AMBIENT TEMPERATURE AND RELATIVE HUMIDITY SPECIFIED VALUE AND TOLERANCE

Test and pretest condition	Value	Tolerance	Acceptable range (based on value and tolerance)
Instantaneous Average Next-to-Vend Temperature.	36 °F	±1 °F	35–37 °F.
Integrated Average Temperature	36 °F	±1 °F	N/A (value is averaged throughout test).
Ambient Temperature	75 °F	±2 °F	73–77 °F.
Relative Humidity	45 percent RH	±5 percent RH	40–50 percent RH.

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2.1.3. *Lowest Application Product Temperature*. If a refrigerated bottled or canned beverage vending machine is not capable of maintaining an integrated average temperature of 36 °F (±1 °F) during the 24 hour test period, the unit must be tested at the lowest application product temperature, as defined in section 1.2 of this appendix. For refrigerated bottled or canned beverage vending machines equipped with a thermostat, the lowest application product temperature is the integrated average temperature achieved at the lowest thermostat setting.

2.2. *Equipment Installation and Test Set Up*. Except as provided in this appendix, the test procedure for energy consumption of refrigerated bottled or canned beverage vending machines shall be conducted in accordance with the methods specified in sections 7.1 through 7.2.2.3 under "Test Procedures" of ANSI/ASHRAE 32.1 (incorporated by reference, see § 431.293).

2.2.1. *Equipment Loading*. Configure refrigerated bottled or canned beverage vending machines to hold the maximum number of standard products in the refrigerated compartment(s) and place standard test packages as specified in section 2.2.1.1 or 2.2.1.2 of this appendix.

2.2.1.1. *Placement of Standard Test Packages for Equipment with Products Arranged Horizontally*. For refrigerated bottled or canned beverage vending machines with products arranged horizontally (*e.g.*, on shelves or in product spirals), place standard test packages in the refrigerated compartment(s) in the following locations, as shown in Figure A.1:

(a) For odd-number shelves, when counting starting from the bottom shelf, standard test packages shall be placed at:

(1) The left-most next-to-vend product location,

(2) The right-most next-to-vend product location, and

(3) For equipment with greater than or equal to five next-to-vend product locations on each shelf, either:

(A) The next-to-vend product location in the center of the shelf (*i.e.*, equidistant from the left-most and right-most next-to-vend product locations) if there are an odd number of next-to-vend products on the shelf or

(B) The next-to-vend product location immediately to the right and the left of the center position if there are an even number of next-to-vend products on the shelf.

(b) For even-numbered shelves, when counting from the bottom shelf, standard test packages shall be places at either:

(1) For equipment with less than or equal to six next-to-vend product locations on each shelf, the next-to-vend product location(s):

(A) One location towards the center from the left-most next-to-vend product location; and

(B) One location towards to the center from the right-most next-to-vend product location, or

(2) For equipment with greater than six next-to-vend product locations on each shelf, the next-to-vend product locations

(A) Two locations towards the center from the left-most next-to-vend product location; and

(B) Two locations towards to the center from the right-most next-to-vend product location.

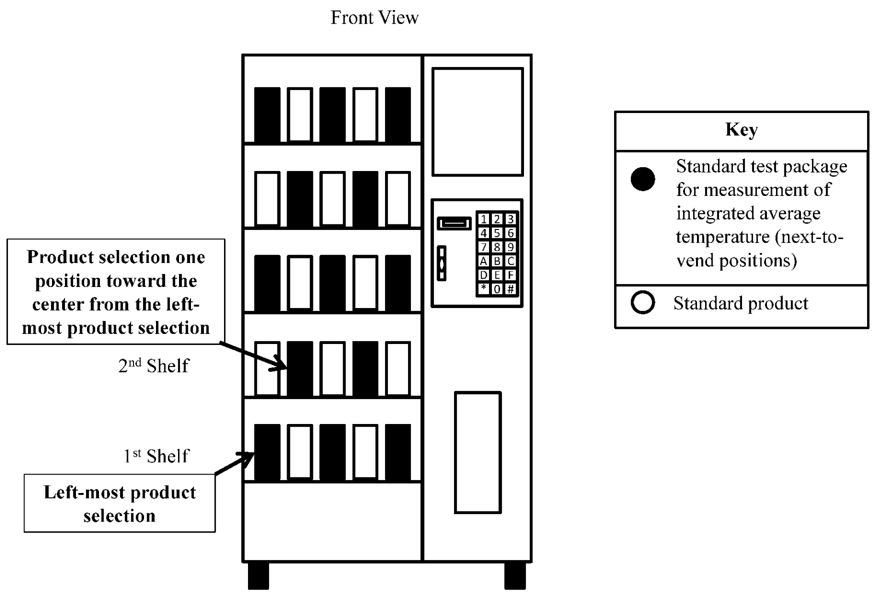

Figure A.1. Location of Standard Test Packages for Refrigerated Bottled or Canned Beverage Vending Machines with Products Arranged Horizontally and Five Next-to-Vend Product Locations on Each Shelf.

2.2.1.2. *Placement of Standard Test Packages for Equipment with Products Arranged Vertically*. For refrigerated bottled or canned beverage vending machines with products arranged vertically (*e.g.*, in stacks), place standard test packages in the refrigerated compartment(s) in each next-to-vend product location.

2.2.1.3. *Loading of Combination Vending Machines*. For combination vending machines, the non-refrigerated compartment(s) must not be loaded with any standard products, test packages, or other vendible merchandise.

2.2.1.4. *Standard Products*. The standard product shall be standard 12-ounce aluminum beverage cans filled with a liquid with a density of 1.0 grams per milliliter (g/mL) ± 0.1 g/mL at 36 °F. For product storage racks that are not capable of vending 12-ounce cans, but are capable of vending 20-ounce bottles, the standard product shall be 20-ounce plastic bottles filled with a liquid with a density of 1.0 g/mL ± 0.1 g/mL at 36 °F. For product storage racks that are not capable of vending 12-ounce cans or 20-ounce bottles, the standard product shall be the packaging and contents specified by the manufacturer in product literature as the standard product (*i.e.*, the specific merchandise the refrigerated bottled or canned beverage vending machine is designed to vend).

2.2.1.5. *Standard Test Packages*. A standard test package is a standard product, as specified in 2.2.1.4 of this appendix, altered to include a temperature-measuring instrument at its center of mass.

2.2.2. *Sensor Placement*. The integrated average temperature of next-to-vend beverages shall be measured in standard test packages in the next-to-vend product locations specified in section 2.2.1.1 of this appendix. Do not run the thermocouple wire and other measurement apparatus through the dispensing door; the thermocouple wire and other measurement apparatus must be configured and sealed so as to minimize air flow between the interior refrigerated volume and the ambient room air. If a manufacturer chooses to employ a method other than routing thermocouple and sensor wires through the door gasket and ensuring the gasket is compressed around the wire to ensure a good seal, then it must maintain a record of the method used in the data underlying that basic model's certification pursuant to 10 CFR 429.71.

2.2.3. *Accessories*. (a) All standard components that would be used during normal operation of the model in the field and are necessary to provide sufficient functionality for cooling and vending products in field installations (*i.e.*, product inventory, temperature management, product merchandising (including, *e.g.*, lighting or signage), product selection, and product transport and delivery) shall be in place during testing and shall be set to the maximum energy-consuming setting if manually adjustable, except that the specific components and accessories listed in the subsequent sections shall be operated as stated. Components not necessary for the inventory, temperature management, product merchandising (*e.g.*, lighting or signage), product selection, and or product transport and delivery shall be de-energized. If systems not required for the primary functionality of the machine as stated in this section cannot be de-energized without preventing the operation of the machine, then they shall be placed in the lowest energy consuming state.

(b) Instead of testing pursuant to section 7.2.2.4 of ANSI/ASHRAE 32.1 (incorporated by reference, see §431.293), provide, if necessary, any physical stimuli or other input to the machine needed to prevent automatic activation of energy management systems that can be adjusted by the machine operator during the test period. Automatic energy management systems that cannot be adjusted by the machine operator may be enabled, as specified by section 7.2.1 of ANSI/ASHRAE 32.1.

2.2.3.1. *Payment Mechanisms*. Refrigerated bottled or canned beverage vending machines shall be tested with no payment mechanism in place, the payment mechanism in place but de-energized, or the payment mechanism in place but set to the lowest energy consuming state, if it cannot be de-energized. A default payment mechanism energy consumption value of 0.20 kWh/day shall be added to the primary rated energy consumption per day, as required in section 2.3 of this appendix.

2.2.3.2. *Internal Lighting*. All lighting that is contained within or is part of the internal physical boundary of the refrigerated bottled or canned beverage vending machine, as established by the top, bottom, and side panels of the equipment, shall be placed in its maximum energy consuming state.

2.2.3.3. *External Customer Display Signs, Lights, and Digital Screens*. All external customer display signs, lights, and digital screens that are independent from the refrigeration or vending performance of the refrigerated bottled or canned beverage vending machine must be disconnected, disabled, or otherwise de-energized for the duration of testing. Customer display signs, lighting, and digital screens that are integrated into the beverage vending machine cabinet or controls such that they cannot be de-energized without disabling the refrigeration or vending functions of the refrigerated bottled or canned beverage vending machine or modifying the circuitry must be placed in external accessory standby mode, if available, or their lowest energy-consuming state. Digital displays that also serve a vending or money processing function must be placed in the lowest energy-consuming state that still allows the money processing feature to function.

2.2.3.4. *Anti-sweat and Other Electric Resistance Heaters*. Anti-sweat and other electric resistance heaters must be operational during the entirety of the test procedure. Units with a user-selectable setting must have the heaters energized and set to the most energy-consumptive position. Units featuring an automatic, non-user-adjustable controller that turns on or off based on environmental conditions must be operating in the automatic state. Units that are not shipped with a controller from the point of manufacture, but are intended to be used with a controller, must be equipped with an appropriate controller when tested.

2.2.3.5. *Condensate Pan Heaters and Pumps*. All electric resistance condensate heaters and condensate pumps must be installed and operational during the test. Prior to the start of the test, including the 24 hour period used to determine temperature stabilization, as described in ANSI/ASHRAE 32.1 section 7.2.2.2 (incorporated by reference, see §431.293), the condensate pan must be dry. For the duration of the test, including the 24 hour time period necessary for temperature stabilization, allow any condensate moisture generated to accumulate in the pan. Do not manually add or remove water from the condensate pan at any time during the test.

2.2.3.6. *Illuminated Temperature Displays*. All illuminated temperature displays must be energized and operated during the test the same way they would be energized and operated during normal field operation, as recommended in manufacturer product literature, including manuals.

2.2.3.7. *Condenser Filters*. Remove any non-permanent filters provided to prevent particulates from blocking a model's condenser coil.

2.2.3.8. *Security Covers*. Remove any devices used to secure the model from theft or tampering.

2.2.3.9. *General Purpose Outlets*. During the test, do not connect any external load to any general purpose outlets available on a unit.

2.2.3.10. *Crankcase Heaters and Other Electric Resistance Heaters for Cold Weather*. Crankcase heaters and other electric resistance heaters for cold weather must be operational during the test. If a control system, such as a thermostat or electronic controller, is used to modulate the operation of the heater, it must be activated during the test and operated in accordance with the manufacturer's instructions.

2.2.4. *Sampling and Recording of Data*. Record the data listed in section 7.2.2.3 of

ANSI/ASHRAE 32.1 (incorporated by reference, see §431.293) at least every 1 minute. For the purpose of this subsection, "average beverage temperature," listed in section 7.2.2.3 of ANSI/ASHRAE 32.1, means "instantaneous average next-to-vend beverage temperature."

2.3. *Determination of Daily Energy Consumption.* Determine the daily energy consumption of each tested refrigerated bottled or canned beverage vending machine as the sum of:

(a) The default payment mechanism energy consumption value from section 2.2.3.1 of this appendix and

(b) The primary rated energy consumption per day (E_D), in kWh, and determined in accordance with the calculation procedure in section 7.2.3.1, "Calculation of Daily Energy Consumption," of ANSI/ASHRAE 32.1 (incorporated by reference, see §431.293).

2.3.1. *Calculations and Rounding.* In all cases, the primary rated energy consumption per day (E_D) must be calculated with raw measured values and rounded to units of 0.01 kWh/day.

3. *Determination of Refrigerated Volume, Vendible Capacity, and Surface Area.*

3.1. *Refrigerated Volume.* Determine the "refrigerated volume" of refrigerated bottled or canned beverage vending machines in accordance with appendix C, "Measurement of Volume," of ANSI/ASHRAE 32.1 (incorporated by reference, see §431.293). For combination vending machines, the "refrigerated volume" does not include any non-refrigerated compartments.

3.2. *Vendible Capacity.* Determine the "vendible capacity" of refrigerated bottled or canned beverage vending machines in accordance with the first paragraph of section 5, "Vending Machine Capacity," of ANSI/ASHRAE 32.1, (incorporated by reference, see §431.293). For combination vending machines, the "vendible capacity" includes only the capacity of any portion of the refrigerated bottled or canned beverage vending machine that is refrigerated and does not include the capacity of the non-refrigerated compartment(s).

[80 FR 45793, July 31, 2015]

APPENDIX B TO SUBPART Q OF PART 431—UNIFORM TEST METHOD FOR THE MEASUREMENT OF ENERGY CONSUMPTION OF REFRIGERATED BOTTLED OR CANNED BEVERAGE VENDING MACHINES

NOTE: After January 27, 2016, manufacturers must make any representations with respect to energy use or efficiency in accordance with the results of testing pursuant to appendix A of this subpart to demonstrate compliance with the energy conservation standards at 10 CFR 431.296, for which compliance was required as of August 31, 2012. Alternatively, manufacturers may make representations based on testing in accordance with this appendix prior to the compliance date of any amended energy conservation standards, provided that such representations demonstrate compliance with such amended energy conservation standards. Any representations made on or after the compliance date of any amended energy conservation standards, must be made in accordance with the results of testing pursuant to this appendix. Any representations made with respect to the energy use or efficiency of such refrigerated beverage vending machines must be in accordance with whichever version is selected.

1. *General.* Section 3, "Definitions"; section 4, "Instruments"; section 5, "Vendible Capacity"; section 6, "Test Conditions"; section 7.1, "Test Procedures—General Requirements"; and section 7.2, "Energy Consumption Test" of ANSI/ASHRAE 32.1 (incorporated by reference; see §431.293) apply to this appendix except as noted throughout this appendix. In cases where there is a conflict, the language of the test procedure in this appendix takes precedence over ANSI/ASHRAE 32.1.

1.1. *Instruments.* In addition to the instrument accuracy requirements in section 3, "Instruments," of ANSI/ASHRAE 32.1 (incorporated by reference, see §431.293), humidity shall be measured with a calibrated instrument accurate to ±2 percent RH at the specified ambient relative humidity condition specified in section 2.1.3 of this appendix.

1.2. *Definitions.* In addition to the definitions specified in section 3, "Definitions," of ANSI/ASHRAE 32.1 (incorporated by reference, see §431.293) the following definitions are also applicable to this appendix.

Accessory low power mode means a state in which a beverage vending machine's lighting and/or other energy-using systems are in low power mode, but that is not a refrigeration low power mode. Functions that may constitute an accessory low power mode may include, for example, dimming or turning off lights, but does not include adjustment of the refrigeration system to elevate the temperature of the refrigerated compartment(s).

External accessory standby mode means the mode of operation in which any external, integral customer display signs, lighting, or digital screens are connected to mains power; do not produce the intended illumination, display, or interaction functionality; and can be switched into another mode automatically with only a remote user-generated or an internal signal.

Instantaneous average next-to-vend beverage temperature means the spatial average of all standard test packages in the next-to-vend beverages positions at a given time.

Integrated average temperature means the average temperature of all standard test package measurements in the next-to-vend beverage positions taken over the duration of the test, expressed in degrees Fahrenheit (°F).

Low power mode means a state in which a beverage vending machine's lighting, refrigeration, and/or other energy-using systems are automatically adjusted (without user intervention) such that they consume less energy than they consume in an active vending environment.

Lowest application product temperature means the lowest integrated average temperature a given basic model is capable of maintaining so as to comply with the temperature stabilization requirements specified in section 7.2.2.2 of ANSI/ASHRAE 32.1 (incorporated by reference, see §431.293).

Refrigeration low power mode means a state in which a beverage vending machine's refrigeration system is in low power mode because of elevation of the temperature of the refrigerated compartment(s). To qualify as low power mode, the unit must satisfy the requirements described in section 2.3.2.1 of this appendix.

2. *Test Procedure.*

2.1. *Test Conditions.* The test conditions specified in section 6, ''Test Conditions'' of ANSI/ASHRAE 32.1 (incorporated by reference, see §431.293) apply to this appendix except that in section 6.1, ''Voltage and Frequency,'' of ANSI/ASHRAE 32.1, the voltage and frequency tolerances specified in section 6.1.a of ANSI/ASHRAE 32.1 also apply equivalently to section 6.1.b of ANSI/ASHRAE 32.1 for equipment with dual nameplate voltages.

2.1.1. *Average Beverage Temperature.* The integrated average temperature measured during the test must be within ±1 °F of the value specified in Table B.1 of this appendix or the lowest application product temperature for models tested in accordance with paragraph 2.1.3 of this appendix. The measurement of integrated average temperature must begin after temperature stabilization has been achieve and continue for the following 24 consecutive hours. All references to ''Table 1'' in ANSI/ASHRAE 32.1 (incorporated by reference, see §431.293) shall instead be interpreted as references to Table B.1 of this appendix and all references to ''average beverage temperature'' in ANSI/ASHRAE 32.1 shall instead be interpreted as references to the integrated average temperature as defined in section 1.2 of this appendix, except as noted in section 2.1.1.1 of this appendix.

2.1.1.1. *Temperature Stabilization.* Temperature stabilization shall be determined in accordance with section 7.2.2.2 of ANSI/ASHRAE 32.1 (incorporated by reference §431.293), except that the reference to ''average beverage temperature'' shall instead refer to the ''instantaneous average next-to-vend beverage temperature,'' as defined in section 1.2 of this appendix, and the reference to ''Table 1'' shall instead refer to Table A.1 of this appendix. That is, temperature stabilization is considered to be achieved 24 hours after the instantaneous average next-to-vend beverage temperature reaches the specified value (see Table A.1) and energy consumption for two successive 6 hour periods are within 2 percent of each other.

2.1.2. *Ambient Test Conditions.* The refrigerated bottled or canned beverage vending machine must be tested at the test conditions and tolerances specified in the following Table B.1 of this appendix. The specified ambient temperature and humidity conditions shall be maintained within the ranges specified for each recorded measurement. All references to ''Table 1'' in ANSI/ASHRAE 32.1 (incorporated by reference, see §431.293) shall instead be interpreted as references to Table B.1 of this appendix. In contrast to the requirements of section 6.1 and Table 1 of ANSI/ASHRAE 32.1, conduct testing only one time at the conditions referenced in Table B.1 of this appendix. Testing at alternate ambient conditions is not required or permitted.

TABLE B.1—AMBIENT TEMPERATURE AND RELATIVE HUMIDITY SPECIFIED VALUE AND TOLERANCE

Test and pretest condition	Value	Tolerance	Acceptable range (based on value and tolerance)
Instantaneous Average Next-to-Vend Temperature.	36 °F	±1 °F	35–37 °F.
Integrated Average Temperature	36 °F	±1 °F	N/A (value is averaged throughout test).
Ambient Temperature	75 °F	±2 °F	73–77 °F.
Relative Humidity	45 percent RH	±5 percent RH	40–50 percent RH.

2.1.3. *Lowest Application Product Temperature.* If a refrigerated bottled or canned beverage vending machine is not capable of maintaining an integrated average temperature of 36 °F (±1 °F) during the 24 hour test period, the unit must be tested at the lowest application product temperature, as defined in section 1.2 of this appendix. For refrigerated bottled or canned beverage vending machines equipped with a thermostat, the lowest application product temperature is the integrated average temperature achieved at the lowest thermostat setting.

2.2. *Equipment Installation and Test Set Up*. Except as provided in this section 2.2 of appendix, the test procedure for energy consumption of refrigerated bottled or canned beverage vending machines shall be conducted in accordance with the methods specified in sections 7.1 through 7.2.2.3 under ''Test Procedures'' of ANSI/ASHRAE 32.1 (incorporated by reference, see § 431.293).

2.2.1. *Equipment Loading*. Configure refrigerated bottled or canned beverage vending machines to hold the maximum number of standard products, and place standard test packages in the refrigerated compartment(s) as specified in section 2.2.1.1 or 2.2.1.2 of this appendix.

2.2.1.1. *Placement of Standard Test Packages for Equipment with Products Arranged Horizontally*. For refrigerated bottled or canned beverage vending machines with products arranged horizontally (*e.g.*, on shelves or in product spirals), place standard test packages in the refrigerated compartment(s) in the following locations, as shown in Figure B.1:

(a) For odd-number shelves, when counting starting from the bottom shelf, standard test packages shall be placed at:

(1) The left-most next-to-vend product location;

(2) The right-most next-to-vend product location; and

(3) For equipment with greater than or equal to five product locations on each shelf, either:

(i) The next-to-vend product location in the center of the shelf (*i.e.*, equidistant from the left-most and right-most next-to-vend product locations) if there are an odd number of next-to-vend products on the shelf or,

(ii) The next-to-vend product location immediately to the right and the left of the center position if there are an even number of next-to-vend products on the shelf.

(b) For even-numbered shelves, when counting from the bottom shelf, standard test packages shall be places at either:

(1) For equipment with less than or equal to six next-to-vend product locations on each shelf, the next-to-vend product location(s);

(i) One position towards the center from the left-most next-to-vend product location; and

(ii) One location towards to the center from the right-most next-to-vend product location; or

(2) For equipment with greater than six next-to-vend product locations on each shelf, the next-to-vend product locations:

(i) Two selections towards the center from the left-most next-to-vend product location; and

(ii) Two locations towards to the center from the right-most next-to-vend product location.

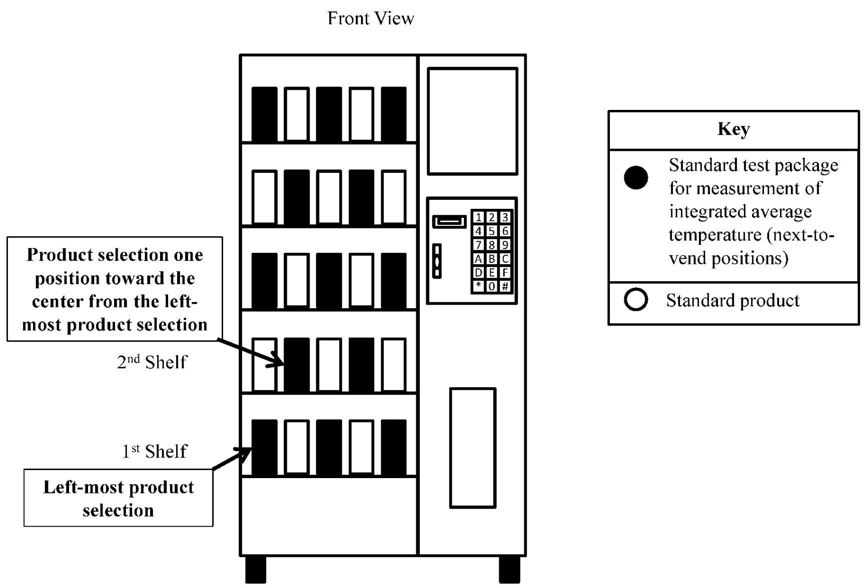

Figure B.1. Location of Standard Test Packages for Refrigerated Bottled or Canned Beverage Vending Machines with Products Arranged Horizontally and Five Next-to-Vend Product Locations on Each Shelf.

2.2.1.2. *Placement of Standard Test Packages for Equipment with Products Arranged Vertically*. For refrigerated bottled or canned beverage vending machines with products arranged vertically (*e.g.*, in stacks), place standard test packages in the refrigerated compartment(s) in each next-to-vend product location.

2.2.1.3. *Loading of Combination Vending Machines*. For combination vending machines, the non-refrigerated compartment(s) must not be loaded with any standard products, test packages, or other vendible merchandise.

2.2.1.4. *Standard Products*. The standard product shall be standard 12-ounce aluminum beverage cans filled with a liquid with a density of 1.0 grams per milliliter (g/mL) ±0.1 g/mL at 36 °F. For product storage racks that are not capable of vending 12-ounce cans, but are capable of vending 20-ounce bottles, the standard product shall be 20-ounce plastic bottles filled with a liquid with a density of 1.0 g/mL ±0.1 g/mL at 36 °F. For product storage racks that are not capable of vending 12-ounce cans or 20-ounce bottles, the standard product shall be the packaging and contents specified by the manufacturer in product literature as the standard product (*i.e.*, the specific merchandise the refrigerated bottled or canned beverage vending machine is designed to vend).

2.2.1.5. *Standard Test Packages*. A standard test package is a standard product, as specified in 2.2.1.4 of this appendix, altered to include a temperature-measuring instrument at its center of mass.

2.2.2. *Sensor Placement*. The integrated average temperature of next-to-vend beverages shall be measured in standard test packages in the next-to-vend product locations specified in section 2.2.1.1 of this appendix. Do not run the thermocouple wire and other measurement apparatus through the dispensing door; the thermocouple wire and other measurement apparatus must be configured and sealed so as to minimize air flow between the interior refrigerated volume and the ambient room air. If a manufacturer chooses to employ a method other than routing thermocouple and sensor wires through the door gasket and ensuring the gasket is compressed around the wire to ensure a good seal, then it must maintain a record of the method used in the data underlying that basic model's certification pursuant to 10 CFR 429.71.

2.2.3. *Vending Mode Test Period*. The vending mode test period begins after temperature stabilization has been achieved, as described in ANSI/ASHRAE 32.1 section 7.2.2.2 (incorporated by reference, see §431.293) and continues for 18 hours for equipment with an accessory low power mode or for 24 hours for equipment without an accessory low power mode. For the vending mode test period, equipment that has energy-saving features that cannot be disabled shall have those features set to the most energy-consuming settings, except for as specified in section 2.2.4 of this appendix. In addition, all energy management systems shall be disabled. Instead of testing pursuant to sections 7.1.1(d) and 7.2.2.4 of ANSI/ASHRAE 32.1, provide, if necessary, any physical stimuli or other input to the machine needed to prevent automatic activation of low power modes during the vending mode test period.

2.2.4. *Accessory Low Power Mode Test Period.* For equipment with an accessory low power mode, the accessory low power mode may be engaged for 6 hours, beginning 18 hours after the temperature stabilization requirements established in section 7.2.2.2 of ANSI/ASHRAE 32.1 (incorporated by reference, see §431.293) have been achieved, and continuing until the end of the 24-hour test period. During the accessory low power mode test, operate the refrigerated bottled or canned beverage vending machine with the lowest energy-consuming lighting and control settings that constitute an accessory low power mode. The specification and tolerances for integrated average temperature in Table B.1 of this appendix still apply, and any refrigeration low power mode must not be engaged. Instead of testing pursuant to sections 7.1.1(d) and 7.2.2.4 of ANSI/ASHRAE 32.1, provide, if necessary, any physical stimuli or other input to the machine needed to prevent automatic activation of refrigeration low power modes during the accessory low power mode test period.

2.2.5. *Accessories.* Unless specified otherwise in this appendix, all standard components that would be used during normal operation of the basic model in the field and are necessary to provide sufficient functionality for cooling and vending products in field installations (*i.e.*, product inventory, temperature management, product merchandising(including, *e.g.*, lighting or signage), product selection, and product transport and delivery) shall be in place during testing and shall be set to the maximum energy-consuming setting if manually adjustable. Components not necessary for the inventory, temperature management, product merchandising (*e.g.*, lighting or signage), product selection, or product transport and delivery shall be de-energized. If systems not required for the primary functionality of the machine as stated in this section cannot be de-energized without preventing the operation of the machine, then they shall be placed in the lowest energy consuming state Components with controls that are permanently operational and cannot be adjusted by the machine operator shall be operated in their normal setting and consistent with the requirements of 2.2.3 and 2.2.4 of this appendix. The specific components and accessories listed in the subsequent sections shall be operated as stated during the test, except when controlled as part of a low power mode during the low power mode test period.

2.2.5.1 *Payment Mechanisms.* Refrigerated bottled or canned beverage vending machines shall be tested with no payment mechanism in place, the payment mechanism in-place but de-energized, or the payment mechanism in place but set to the lowest energy consuming state, if it cannot be de-energized. A default payment mechanism energy consumption value of 0.20 kWh/day shall be added to the primary rated energy consumption per day, as noted in section 2.3 of this appendix.

2.2.5.2. *Internal Lighting.* All lighting that is contained within or is part of the internal physical boundary of the refrigerated bottled or canned beverage vending machine, as established by the top, bottom, and side panels of the equipment, shall be placed in its maximum energy consuming state.

2.2.5.3. *External Customer Display Signs, Lights, and Digital Screens.* All external customer display signs, lights, and digital screens that are independent from the refrigeration or vending performance of the refrigerated bottled or canned beverage vending machine must be disconnected, disabled, or otherwise de-energized for the duration of testing. Customer display signs, lighting, and digital screens that are integrated into the beverage vending machine cabinet or controls such that they cannot be de-energized without disabling the refrigeration or vending functions of the refrigerated bottled or canned beverage vending machine or modifying the circuitry must be placed in external accessory standby mode, if available, or their lowest energy-consuming state. Digital displays that also serve a vending or money processing function must be placed in the lowest energy-consuming state that still allows the money processing feature to function.

2.2.5.4. *Anti-sweat or Other Electric Resistance Heaters.* Anti-sweat or other electric resistance heaters must be operational during the entirety of the test procedure. Units with a user-selectable setting must have the heaters energized and set to the most energy-consumptive position. Units featuring an automatic, non-user-adjustable controller that turns on or off based on environmental conditions must be operating in the automatic state. Units that are not shipped with a controller from the point of manufacture, but are intended to be used with a controller, must be equipped with an appropriate controller when tested.

2.2.5.5. *Condensate Pan Heaters and Pumps.* All electric resistance condensate heaters and condensate pumps must be installed and operational during the test. Prior to the start of the test, including the 24 hour period used to determine temperature stabilization prior to the start of the test period, as described in ANSI/ASHRAE 32.1 section 7.2.2.2 (incorporated by reference, see §431.293), the condensate pan must be dry. For the duration of the test, including the 24 hour time period necessary for temperature stabilization, allow any condensate moisture generated to accumulate in the pan. Do not manually add or remove water from the condensate pan at any time during the test. Any automatic controls that initiate the operation of the condensate pan heater or pump based on water level or ambient conditions must be enabled and operated in the automatic setting.

2.2.5.6. *Illuminated Temperature Displays.* All illuminated temperature displays must be energized and operated during the test the same way they would be energized and operated during normal field operation, as recommended in manufacturer product literature, including manuals.

2.2.5.7. *Condenser Filters.* Remove any non-permanent filters provided to prevent particulates from blocking a model's condenser coil.

2.2.5.8. *Security Covers.* Remove any devices used to secure the model from theft or tampering.

2.2.5.9. *General Purpose Outlets.* During the test, do not connect any external load to any general purpose outlets available on a unit.

2.2.5.10. *Crankcase Heaters and Other Electric Resistance Heaters for Cold Weather.* Crankcase heaters and other electric resistance heaters for cold weather must be operational during the test. If a control system, such as a thermostat or electronic controller, is used to modulate the operation of the heater, it must be activated during the test and operated in accordance with the manufacturer's instructions.

2.2.6. *Sampling and Recording of Data.* Record the data listed in section 7.2.2.3 of ANSI/ASHRAE 32.1 (incorporated by reference, see §431.293), at least every 1 minute. For the purpose of this section, "average beverage temperature," listed in section 7.2.2.3 of ANSI/ASHRAE 32.1, means "instantaneous average next-to-vend beverage temperature."

2.3. *Determination of Daily Energy Consumption.* In section 7.2.3.1 of ANSI/ASHRAE 32.1 (incorporated by reference, see §431.293), the primary rated energy consumption per day (*ED*) shall be the energy measured during the vending mode test period and accessory low power mode test period, as specified in sections 2.2.3 and 2.2.4 of this appendix, as applicable.

2.3.1. *Energy Consumption of Payment Mechanisms.* Calculate the sum of:

(a) The default payment mechanism energy consumption value from section 2.2.5.1 and

(b) The primary rated energy consumption per day (E_D), in kWh, and determined in accordance with the calculation procedure in section 7.2.3.1, "Calculation of Daily Energy Consumption," of ANSI/ASHRAE 32.1 (incorporated by reference, see §431.293).

2.3.2. *Refrigeration Low Power Mode.* For refrigerated bottled or canned beverage vending machines with a refrigeration low power mode, multiply the value determined in section 2.3.1 of this appendix by 0.97 to determine the daily energy consumption of the unit tested. For refrigerated bottled or canned beverage vending machines without a refrigeration low power mode, the value determined in section 2.3.1 is the daily energy consumption of the unit tested.

2.3.2.1. *Refrigeration Low Power Mode Validation Test Method.* This test method is not required for the certification of refrigerated bottled or canned beverage vending machines. To verify the existence of a refrigeration low power mode, initiate the refrigeration low power mode in accordance with manufacturer instructions contained in product literature and manuals, after completion of the 6-hour low power mode test period. Continue recording all the data specified in section 2.2.6 of this appendix until existence of a refrigeration low power mode has been confirmed or denied. The refrigerated bottled or canned beverage vending machine shall be deemed to have a refrigeration low power mode if either:

(a) The following three requirements have been satisfied:

(1) The instantaneous average next-to-vend beverage temperature must reach at least 4 °F above the integrated average temperature or lowest application product temperature, as applicable, within 6 hours.

(2) The instantaneous average next-to-vend beverage temperature must be maintained at least 4 °F above the integrated average temperature or lowest application product temperature, as applicable, for at least 1 hour.

(3) After the instantaneous average next-to-vend beverage temperature is maintained at or above 4 °F above the integrated average temperature or lowest application product temperature, as applicable, for at least 1 hour, the refrigerated beverage vending machine must return to the specified integrated average temperature or lowest application product temperature, as applicable, automatically without direct physical intervention.

(b) Or, the compressor does not cycle on for the entire 6 hour period, in which case the instantaneous average beverage temperature does not have to reach 4 °F above the integrated average temperature or lowest application product temperature, as applicable, but, the equipment must still automatically return to the integrated average temperature or lowest application product temperature, as applicable, after the 6 hour period without direct physical intervention.

2.3.3. *Calculations and Rounding*. In all cases, the primary rated energy consumption per day (E_D) must be calculated with raw measured values and the final result rounded to units of 0.01 kWh/day.

3. *Determination of Refrigeration Volume, Vendible Capacity, and Surface Area*.

3.1. *Refrigerated Volume*. Determine the ''refrigerated volume'' of refrigerated bottled or canned beverage vending machines in accordance with Appendix C, ''Measurement of Volume,'' of ANSI/ASHRAE 32.1 (incorporated by reference, see § 431.293). For combination vending machines, the ''refrigerated volume'' does not include any non-refrigerated compartment(s).

3.2. *Vendible Capacity*. Determine the ''vendible capacity'' of refrigerated bottled or canned beverage vending machines in accordance with the first paragraph of section 5, ''Vending Machine Capacity,'' of ANSI/ASHRAE 32.1 (incorporated by reference, see § 431.293). For combination vending machines, the ''vendible capacity'' includes only the capacity of any portion of the refrigerated bottled or canned beverage vending machine that is refrigerated and does not include the capacity of the non-refrigerated compartment(s).

3.3. *Determination of Surface Area*. Note: This section is not required for the certification of refrigerated bottled or canned beverage vending machines. Determine the surface area of each beverage vending machine as the length multiplied by the height of outermost surface of the beverage vending machine cabinet, measured from edge to edge excluding any legs or other protrusions that extend beyond the dimensions of the primary cabinet. Determine the transparent and non-transparent areas on each side of a beverage vending machine as the total surface area of material that is transparent or is not transparent, respectively.

[80 FR 45793, July 31, 2015]

Subpart R—Walk-in Coolers and Walk-in Freezers

SOURCE: 74 FR 12074, Mar. 23, 2009, unless otherwise noted.

§ 431.301 Purpose and scope.

This subpart contains energy conservation requirements for walk-in coolers and walk-in freezers, pursuant to Part C of Title III of the Energy Policy and Conservation Act, as amended, 42 U.S.C. 6311–6317.

§ 431.302 Definitions concerning walk-in coolers and walk-in freezers.

Adaptive defrost means a factory-installed defrost control system that reduces defrost frequency by initiating defrosts or adjusting the number of defrosts per day in response to operating conditions (*e.g.*, moisture levels in the refrigerated space, measurements that represent coil frost load) rather than initiating defrost strictly based on compressor run time or clock time.

Basic model means all components of a given type of walk-in cooler or walk-in freezer (or class thereof) manufactured by one manufacturer, having the same primary energy source, and which have essentially identical electrical, physical, and functional (or hydraulic) characteristics that affect energy consumption, energy efficiency, water consumption, or water efficiency; and

(1) With respect to panels, which do not have any differing features or characteristics that affect U-factor.

(2) [Reserved]

Dedicated condensing unit means a positive displacement condensing unit that is part of a refrigeration system (as defined in this section) and is an assembly that

(1) Includes 1 or more compressors, a condenser, and one refrigeration circuit; and

(2) Is designed to serve one refrigerated load.

Dedicated condensing refrigeration system means one of the following:

(1) A dedicated condensing unit;

(2) A single-package dedicated system; or

(3) A matched refrigeration system.

Display door means a door that:

(1) Is designed for product display; or

(2) Has 75 percent or more of its surface area composed of glass or another transparent material.

Display panel means a panel that is entirely or partially comprised of glass, a transparent material, or both and is used for display purposes.

Door means an assembly installed in an opening on an interior or exterior wall that is used to allow access or close off the opening and that is movable in a sliding, pivoting, hinged, or revolving manner of movement. For walk-in coolers and walk-in freezers, a door includes the door panel, glass, framing materials, door plug, mullion, and any other elements that form the door or part of its connection to the wall.

Envelope means—

(1) The portion of a walk-in cooler or walk-in freezer that isolates the interior, refrigerated environment from the ambient, external environment; and

(2) All energy-consuming components of the walk-in cooler or walk-in freezer that are not part of its refrigeration system.

Freight door means a door that is not a display door and is equal to or larger than 4 feet wide and 8 feet tall.

Indoor dedicated condensing refrigeration system means a dedicated condensing refrigeration system designated by the manufacturer for indoor use or for which there is no designation regarding the use location.

K-factor means the thermal conductivity of a material.

Manufacturer of a walk-in cooler or walk-in freezer means any person who:

(1) Manufactures a component of a walk-in cooler or walk-in freezer that affects energy consumption, including, but not limited to, refrigeration, doors, lights, windows, or walls; or

(2) Manufactures or assembles the complete walk-in cooler or walk-in freezer.

Matched condensing unit means a dedicated condensing unit that is distributed in commerce with one or more unit cooler(s) specified by the condensing unit manufacturer.

Matched refrigeration system (also called ''matched-pair'') means a refrigeration system including the matched condensing unit and the one or more unit coolers with which it is distributed in commerce.

Outdoor dedicated condensing refrigeration system means a dedicated condensing refrigeration system designated by the manufacturer for outdoor use.

Panel means a construction component that is not a door and is used to construct the envelope of the walk-in, i.e., elements that separate the interior refrigerated environment of the walk-in from the exterior.

Passage door means a door that is not a freight or display door.

Refrigerated means held at a temperature at or below 55 degrees Fahrenheit using a refrigeration system.

Refrigerated storage space means a space held at refrigerated (as defined in this section) temperatures.

Refrigeration system means the mechanism (including all controls and other components integral to the system's operation) used to create the refrigerated environment in the interior of a walk-in cooler or walk-in freezer, consisting of:

(1) A dedicated condensing refrigeration system (as defined in this section); or

(2) A unit cooler.

Single-packaged dedicated system means a refrigeration system (as defined in this section) that is a single-package assembly that includes one or more compressors, a condenser, a means for forced circulation of refrigerated air, and elements by which heat is transferred from air to refrigerant, without any element external to the system imposing resistance to flow of the refrigerated air.

U-factor means the heat transmission in a unit time through a unit area of a specimen or product and its boundary air films, induced by a unit temperature difference between the environments on each side.

Unit cooler means an assembly, including means for forced air circulation and elements by which heat is transferred from air to refrigerant, thus cooling the air, without any element external to the cooler imposing air resistance.

Walk-in cooler and walk-in freezer mean an enclosed storage space refrigerated to temperatures, respectively, above, and at or below 32 degrees Fahrenheit that can be walked into, and has a total chilled storage area of less than 3,000 square feet; however the terms do not include products designed and marketed exclusively for medical, scientific, or research purposes.

Walk-in process cooling refrigeration system means a refrigeration system that is capable of rapidly cooling food or other substances from one temperature to another. The basic model of such a system must satisfy one of the following three conditions:

(1) Be distributed in commerce with an insulated enclosure consisting of panels and door(s) such that the assembled product has a refrigerating capacity of at least 100 Btu/h per cubic foot of enclosed internal volume;

(2) Be a unit cooler having an evaporator coil that is at least four-and-one-half (4.5) feet in height and whose height is at least one-and-one-half (1.5) times the width. The height of the evaporator coil is measured perpendicular to the tubes and is also the fin height, while its width is the finned length parallel to the tubes, as illustrated in Figure 1; or

(3) Be a dedicated condensing unit that is distributed in commerce exclusively with a unit cooler meeting description (2) or with an evaporator that is not a unit cooler, *i.e.*, an evaporator that is not distributed or installed as part of a package including one or more fans.

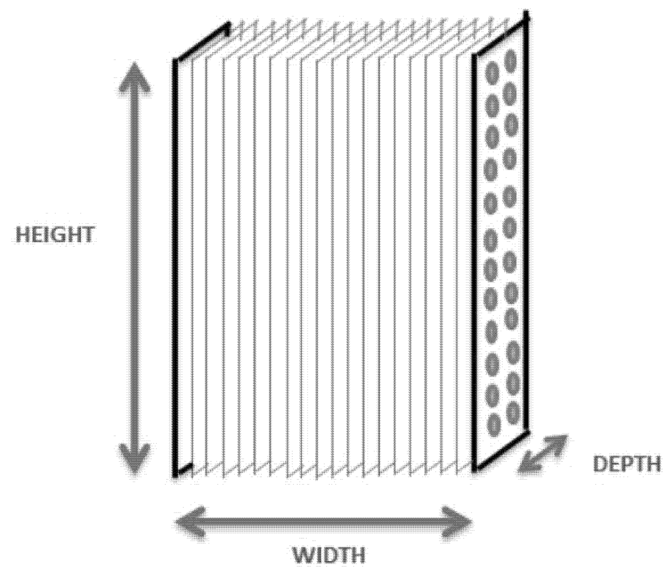

Figure 1: Evaporator Coil Dimensions

[74 FR 12074, Mar. 23, 2009, as amended at 76 FR 12504, Mar. 7, 2011; 76 FR 21604, Apr. 15, 2011; 76 FR 33631, June 9, 2011; 79 FR 32123, June 3, 2014; 81 FR 95801, Dec. 28, 2016]

TEST PROCEDURES

§ 431.303 Materials incorporated by reference.

(a) *General*. Certain material is incorporated by reference into this part with the approval of the Director of the Federal Register under 5 U.S.C. 552(a) and 1 CFR part 51. Any amendment to a standard by the standard-setting organization will not affect the DOE regulations unless and until amended by DOE. Material is incorporated as it exists on the date of the approval. To enforce any edition other than that specified in this section, the U.S. Department of Energy must publish a document in the FEDERAL REGISTER and the material must be available to the public. All approved material is available for inspection at U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Program, 6th Floor, 950 L'Enfant Plaza SW., Washington, DC 20024, 202–586–2945, between 9 a.m. and 4 p.m., Monday through Friday, except Federal holidays, or go to: *http://www1.eere.energy.gov/buildings/appliance_standards/*], and is available from the sources listed below. It is also available for inspection at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202–741–6030 or go to *http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html.*

(b) *AHRI.* Air-Conditioning, Heating, and Refrigeration Institute, 2111 Wilson Boulevard, Suite 500, Arlington, VA 22201, (703) 600–0366, or *http://www.ahrinet.org.*

(1) ANSI/AHRI Standard 420–2008 (''AHRI 420–2008''), ''Performance Rating of Forced-Circulation Free-Delivery Unit Coolers for Refrigeration,'' Copyright 2008, IBR approved for appendix C to subpart R of part 431.

(2) AHRI Standard 1250P (I–P)–2009 (''AHRI 1250–2009''), ''Standard for Performance Rating of Walk-in Coolers and Freezers, (including Errata sheet dated December 2015), copyright 2009, except Table 15 and Table 16. IBR approved for appendix C to subpart R of part 431.

(c) *ASHRAE.* The American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., 1971 Tullie Circle NE., Atlanta, GA 30329, or *www.ashrae.org/.*

(1) ANSI/ASHRAE Standard 23.1–2010, (''ASHRAE 23.1–2010''), ''Methods of Testing for Rating the Performance of Positive Displacement Refrigerant Compressors and Condensing Units that Operate at Subcritical Temperatures of the Refrigerant,'' ANSI approved January 28, 2010, IBR approved for appendix C to subpart R of part 431.

(2) [Reserved]

(d) *ASTM.* American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428–2959, (610) 832–9500, or *http://www.astm.org.*

(1) IBR approved for appendix B to subpart R of part 431.

(2) [Reserved]

(e) *NFRC.* National Fenestration Rating Council, 6305 Ivy Lane, Ste. 140, Greenbelt, MD 20770, (301) 589–1776, or *http://www.nfrc.org/.*

(1) NFRC 100–2010[E0A1], (''NFRC 100''), Procedure for Determining Fenestration Product U-factors, approved June 2010, IBR approved for appendix A to subpart R of part 431.

(2) [Reserved]

[74 FR 12074, Mar. 23, 2009, as amended at 76 FR 21605, Apr. 15, 2011; 76 FR 33631, June 9, 2011; 79 FR 27412, May 13, 2014; 81 FR 95802, Dec. 28, 2016]

§ 431.304 Uniform test method for the measurement of energy consumption of walk-in coolers and walk-in freezers.

(a) *Scope.* This section provides test procedures for measuring, pursuant to EPCA, the energy consumption of walk-in coolers and walk-in freezers.

(b) Determine the energy efficiency and/or energy consumption of the specified walk-in cooler and walk-in freezer components by conducting the appropriate test procedure as follows:

(1) Determine the U-factor, conduction load, and energy use of walk-in cooler and walk-in freezer display panels by conducting the test procedure set forth in appendix A to this subpart.

(2) Determine the energy use of walk-in cooler and walk-in freezer display doors and non-display doors by conducting the test procedure set forth in appendix A to this subpart.

(3) Determine the R-value of walk-in cooler and walk-in freezer non-display panels and non-display doors by conducting the test procedure set forth in appendix B to this subpart.

(4) Determine the AWEF and net capacity of walk-in cooler and walk-in freezer refrigeration systems by conducting the test procedure set forth in appendix C to this subpart.

[74 FR 12074, Mar. 23, 2009, as amended at 76 FR 21605, Apr. 15, 2011; 76 FR 33631, June 9, 2011; 76 FR 65365, Oct. 21, 2011; 79 FR 27412, May 13, 2014; 79 FR 32123, June 3, 2014; 81 FR 95802, Dec. 28, 2016]

§ 431.305 Walk-in cooler and walk-in freezer labeling requirements.

(a) Panel nameplate—(1) Required information. The permanent nameplate of a walk-in cooler or walk-in freezer panel for which standards are prescribed in § 431.306 must be marked clearly with the following information:

(i) The panel brand or manufacturer; and

(ii) One of the following statements, as appropriate:

(A) ''This panel is designed and certified for use in walk-in cooler applications.''

(B) ''This panel is designed and certified for use in walk-in freezer applications.''

(C) ''This panel is designed and certified for use in walk-in cooler and walk-in freezer applications.''

(2) Display of required information. All orientation, spacing, type sizes, typefaces, and line widths to display this required information must be the same as or similar to the display of the other performance data included on the panel's permanent nameplate. The permanent nameplate must be visible unless the panel is assembled into a completed walk-in.

(b) Door nameplate—(1) Required information. The permanent nameplate of a walk-in cooler or walk-in freezer door for which standards are prescribed in § 431.306 must be marked clearly with the following information:

(i) The door brand or manufacturer; and

(ii) One of the following statements, as appropriate:

(A) ''This door is designed and certified for use in walk-in cooler applications.''

(B) ''This door is designed and certified for use in walk-in freezer applications.''

(C) ''This door is designed and certified for use in walk-in cooler and walk-in freezer applications.''

(2) Display of required information. All orientation, spacing, type sizes, typefaces, and line widths to display this required information must be the same as or similar to the display of the other performance data included on the door's permanent nameplate. The permanent nameplate must be visible unless the door is assembled into a completed walk-in.

(c) Refrigeration system nameplate—(1) Required information. The permanent nameplate of a walk-in cooler or walk-in freezer refrigeration system for which standards are prescribed in § 431.306 must be marked clearly with the following information:

(i) The refrigeration system brand or manufacturer;

(ii) The refrigeration system model number;

(iii) The date of manufacture of the refrigeration system (if the date of manufacture is embedded in the unit's serial number, then the manufacturer of the refrigeration system must retain any relevant records to discern the date from the serial number);

(iv) If the refrigeration system is a dedicated condensing refrigeration system, and is not designated for outdoor use, the statement, ''Indoor use only'' (for a matched pair this must appear on the condensing unit); and

(v) One of the following statements, as appropriate:

(A) ''This refrigeration system is designed and certified for use in walk-in cooler applications.''

(B) ''This refrigeration system is designed and certified for use in walk-in freezer applications.''

(C) ''This refrigeration system is designed and certified for use in walk-in cooler and walk-in freezer applications.''

(2) Process cooling refrigeration systems. The permanent nameplate of a process cooling refrigeration system (as defined in § 431.302) must be marked clearly with the statement, ''This refrigeration system is designed for use exclusively in walk-in cooler and walk-in freezer process cooling refrigeration applications.''

(3) Display of required information. All orientation, spacing, type sizes, typefaces, and line widths to display this required information must be the same as or similar to the display of the other performance data included on the refrigeration system's permanent nameplate. The model number must be in one of the following forms: ''Model _____'' or ''Model number _____'' or ''Model No. _____.'' The permanent nameplate must be visible unless the

refrigeration system is assembled into a completed walk-in.

(d) A manufacturer may not mark the nameplate of a component with the required information if the manufacturer has not submitted a certification of compliance for the relevant model.

(e) Disclosure of efficiency information in marketing materials. Each catalog that lists the component and all materials used to market the component must include:

(1) For panels—The R-value in the form ''R-value___.''

(2) For doors—The energy consumption in the form ''EC___kWh/day.''

(3) For those refrigeration system for which standards are prescribed—The AWEF in the form ''AWEF ___.''

(4) The information that must appear on a walk-in cooler or walk-in freezer component's permanent nameplate pursuant to paragraphs (a)–(c) of this section must also be prominently displayed in each catalog that lists the component and all materials used to market the component.

[81 FR 95802, Dec. 28, 2016]

ENERGY CONSERVATION STANDARDS

§ 431.306 Energy conservation standards and their effective dates.

(a) Each walk-in cooler or walk-in freezer manufactured on or after January 1, 2009, shall—

(1) Have automatic door closers that firmly close all walk-in doors that have been closed to within 1 inch of full closure, except that this paragraph shall not apply to doors wider than 3 feet 9 inches or taller than 7 feet;

(2) Have strip doors, spring hinged doors, or other method of minimizing infiltration when doors are open;

(3) Contain wall, ceiling, and door insulation of at least R–25 for coolers and R–32 for freezers, except that this paragraph shall not apply to:

(i) Glazed portions of doors not to structural members and

(ii) A walk-in cooler or walk-in freezer component if the component manufacturer has demonstrated to the satisfaction of the Secretary in a manner consistent with applicable requirements that the component reduces energy consumption at least as much as if such insulation requirements of subparagraph (a)(3) were to apply.

(4) Contain floor insulation of at least R–28 for freezers;

(5) For evaporator fan motors of under 1 horsepower and less than 460 volts, use—

(i) Electronically commutated motors (brushless direct current motors); or

(ii) 3-phase motors;

(6) For condenser fan motors of under 1 horsepower, use—

(i) Electronically commutated motors (brushless direct current motors);

(ii) Permanent split capacitor-type motors; or

(iii) 3-phase motors; and

(7) For all interior lights, use light sources with an efficacy of 40 lumens per watt or more, including ballast losses (if any), except that light sources with an efficacy of 40 lumens per watt or less, including ballast losses (if any), may be used in conjunction with a timer or device that turns off the lights within 15 minutes of when the walk-in cooler or walk-in freezer is not occupied by people.

(b) Each walk-in cooler or walk-in freezer with transparent reach-in doors manufactured on or after January 1, 2009, shall also meet the following specifications:

(1) Transparent reach-in doors for walk-in freezers and windows in walk-in freezer doors shall be of triple-pane glass with either heat-reflective treated glass or gas fill.

(2) Transparent reach-in doors for walk-in coolers and windows in walk-in cooler doors shall be—

(i) Double-pane glass with heat-reflective treated glass and gas fill; or

(ii) Triple-pane glass with either heat-reflective treated glass or gas fill.

(3) If the walk-in cooler or walk-in freezer has an antisweat heater without antisweat heat controls, the walk-in cooler and walk-in freezer shall have a total door rail, glass, and frame heater power draw of not more than 7.1 watts per square foot of door opening (for freezers) and 3.0 watts per square foot of door opening (for coolers).

(4) If the walk-in cooler or walk-in freezer has an antisweat heater with antisweat heat controls, and the total door rail, glass, and frame heater

power draw is more than 7.1 watts per square foot of door opening (for freezers) and 3.0 watts per square foot of door opening (for coolers), the antisweat heat controls shall reduce the energy use of the antisweat heater in a quantity corresponding to the relative humidity in the air outside the door or to the condensation on the inner glass pane.

(c) *Walk-in cooler and freezer display doors.* All walk-in cooler and walk-in freezer display doors manufactured starting June 5, 2017, must satisfy the following standards:

Class descriptor	Class	Equations for maximum energy consumption (kWh/day) *
Display Door, Medium Temperature.	DD.M	$0.04 \times A_{dd} + 0.41$.
Display Door, Low Temperature.	DD.L	$0.15 \times A_{dd} + 0.29$.

*A_{dd} represents the surface area of the display door.

(d) *Walk-in cooler and freezer non-display doors.* All walk-in cooler and walk-in freezer non-display doors manufactured starting on June 5, 2017, must satisfy the following standards:

Class descriptor	Class	Equations for maximum energy consumption (kWh/day) *
Passage door, Medium Temperature.	PD.M	$0.05 \times A_{nd} + 1.7$.
Passage Door, Low Temperature.	PD.L	$0.14 \times A_{nd} + 4.8$.
Freight Door, Medium Temperature.	FD.M	$0.04 \times A_{nd} + 1.9$.
Freight Door, Low Temperature.	FD.L	$0.12 \times A_{nd} + 5.6$.

*A_{nd} represents the surface area of the non-display door.

(e) *Walk-in cooler refrigeration systems.* All walk-in cooler and walk-in freezer refrigeration systems manufactured starting on the dates listed in the table, except for walk-in process cooling refrigeration systems (as defined in §431.302), must satisfy the following standards:

Equipment class	Minimum AWEF (Btu/W-h)*	Compliance date: equipment manufactured starting on . . .
Dedicated Condensing System—Medium, Indoor	5.61	June 5, 2017.
Dedicated Condensing System—Medium, Outdoor	7.60.	
Dedicated Condensing System—Low, Indoor with a Net Capacity (q_{net}) of:		
< 6,500 Btu/h	$9.091 \times 10^{-5} \times q_{net} + 1.81$.	July 10, 2020.
≥ 6,500 Btu/h	2.40.	
Dedicated Condensing System—Low, Outdoor with a Net Capacity (q_{net}) of:		
< 6,500 Btu/h	$6.522 \times 10^{-5} \times q_{net} + 2.73$.	
≥ 6,500 Btu/h	3.15.	
Unit Cooler—Medium	9.00.	
Unit Cooler—Low with a Net Capacity (q_{net}) of:		
< 15,500 Btu/h	$1.575 \times 10^{-5} \times q_{net} + 3.91$.	
≥ 15,500 Btu/h	4.15.	

* Where q_{net} is net capacity as determined in accordance with §431.304 and certified in accordance with 10 CFR part 429.

[74 FR 12074, Mar. 23, 2009, as amended at 78 FR 62993, Oct. 23, 2013; 79 FR 32123, June 3, 2014; 80 FR 69838, Nov. 12, 2015; 82 FR 31885, July 10, 2017]

Appendix A to Subpart R of Part 431—Uniform Test Method for the Measurement of Energy Consumption of the Components of Envelopes of Walk-In Coolers and Walk-In Freezers

1.0 Scope

This appendix covers the test requirements used to measure the energy consumption of the components that make up the envelope of a walk-in cooler or walk-in freezer.

2.0 Definitions

The definitions contained in §431.302 are applicable to this appendix.

3.0 Additional Definitions

3.1 Automatic door opener/closer means a device or control system that "automatically" opens and closes doors without direct user contact, such as a motion sensor that senses when a forklift is approaching the entrance to a door and opens it, and then closes the door after the forklift has passed.

3.2–3.3 [Reserved]

3.4 Surface area means the area of the surface of the walk-in component that would be external to the walk-in cooler or walk-in freezer as appropriate.

3.5 Rated power means the electricity consuming device's power as specified on the device's nameplate. If the device does not have a nameplate or such nameplate does not list the device's power, then the rated power must be read from the device's product data sheet.

3.6 Rating conditions means, unless explicitly stated otherwise, all conditions shown in Table A.1 of this section.

3.7 Percent time off (PTO) means the percent of time that an electrical device is assumed to be off.

TABLE A.1—TEMPERATURE CONDITIONS

Internal Temperatures (cooled space within the envelope)	
Cooler Dry Bulb Temperature	35 °F
Freezer Dry Bulb Temperature.	−10 °F
External Temperatures (space external to the envelope)	
Freezer and Cooler Dry Bulb Temperatures.	75 °F.

4.0 Calculation Instructions

4.1 Display Panels

(a) Calculate the U-factor of the display panel in accordance with section 5.3 of this appendix, Btu/h-ft²- °F.

(b) Calculate the display panel surface area, as defined in section 3.4 of this appendix, A_{dp}, ft², with standard geometric formulas or engineering software.

(c) Calculate the temperature differential, ΔT_{dp}, °F, for the display panel, as follows:

$$\Delta T_{dp} = \left| T_{DB,ext,dp} - T_{DB,int,dp} \right| \qquad (4\text{-}1)$$

Where:

$T_{DB,ext,dp}$ = dry-bulb air external temperature, °F, as prescribed in Table A.1; and

$T_{DB,int,dp}$ = dry-bulb air temperature internal to the cooler or freezer, °F, as prescribed in Table A.1.

(d) Calculate the conduction load through the display panel, $Q_{cond-dp}$, Btu/h, as follows:

$$Q_{cond,dp} = A_{dp} \times \Delta T_{dp} \times U_{dp} \qquad (4\text{-}2)$$

Where:

A_{dp} = surface area of the walk-in display panel, ft²;

ΔT_{dp} = temperature differential between refrigerated and adjacent zones, °F; and

U_{dp} = thermal transmittance, U-factor, of the display panel in accordance with section 5.3 of this appendix, Btu/h-ft²- °F.

(e) Select Energy Efficiency Ratio (EER), as follows:

(1) For coolers, use EER = 12.4 Btu/W-h

(2) For freezers, use EER = 6.3 Btu/W-h

(f) Calculate the total daily energy consumption, E_{dp}, kWh/day, as follows:

$$E_{dp} = \frac{Q_{cond,dp}}{EER} \times \frac{24\ h \times 1\ kW}{1\ day \times 1000\ W} \qquad (4\text{-}3)$$

Where:

$Q_{cond,\ dp}$ = the conduction load through the display panel, Btu/h; and EER = EER of walk-in (cooler or freezer), Btu/W-h.

4.2 [Reserved]

4.3 [Reserved]

4.4 Display Doors

4.4.1 Conduction Through Display Doors

(a) Calculate the U-factor of the door in accordance with section 5.3 of this appendix, Btu/h-ft²- °F

(b) Calculate the surface area, as defined in section 3.4 of this appendix, of the display door, A_{dd}, ft^2, with standard geometric formulas or engineering software.

(c) Calculate the temperature differential, ΔT_{dd}, °F, for the display door as follows:

$$\Delta T_{dd} = \left| T_{DB,ext,dd} - T_{DB,int,dd} \right| \quad (4\text{-}18)$$

Where:

$T_{DB,ext,\ dd}$ = dry-bulb air temperature external to the display door, °F, as prescribed in Table A.1; and

$T_{DB,int,\ dd}$ = dry-bulb air temperature internal to the display door, °F, as prescribed in Table A.1.

(d) Calculate the conduction load through the display doors, $Q_{cond\text{-}dd}$, Btu/h, as follows:

$$Q_{cond,dd} = A_{dd} \times \Delta T_{dd} \times U_{dd} \quad (4\text{-}19)$$

Where:

ΔT_{dd} = temperature differential between refrigerated and adjacent zones, °F;

A_{dd} = surface area walk-in display doors, ft^2; and

U_{dd} = thermal transmittance, U-factor of the door, in accordance with section 5.3 of this appendix, Btu/h-ft^2- °F.

4.4.2 Direct Energy Consumption of Electrical Component(s) of Display Doors

Electrical components associated with display doors could include, but are not limited to: heater wire (for anti-sweat or anti-freeze application); lights (including display door lighting systems); control system units; and sensors.

(a) Select the required value for percent time off (PTO) for each type of electricity consuming device, PTO_t (%)

(1) For lights without timers, control system or other demand-based control, PTO = 25 percent. For lighting with timers, control system or other demand-based control, PTO = 50 percent.

(2) For anti-sweat heaters on coolers (if included): Without timers, control system or other demand-based control, PTO = 0 percent. With timers, control system or other demand-based control, PTO = 75 percent. For anti-sweat heaters on freezers (if included): Without timers, control system or other auto-shut-off systems, PTO = 0 percent. With timers, control system or other demand-based control, PTO = 50 percent.

(3) For all other electricity consuming devices: Without timers, control system, or other auto-shut-off systems, PTO = 0 percent. If it can be demonstrated that the device is controlled by a preinstalled timer, control system or other auto-shut-off system, PTO = 25 percent.

(b) Calculate the power usage for each type of electricity consuming device, $P_{dd\text{-}comp,u,t}$, kWh/day, as follows:

$$P_{dd-comp,u,t} = P_{rated,u,t} \times \left(1 - PTO_{u,t}\right) \times n_{u,t} \times \frac{24h}{day} \quad (4\text{-}20)$$

Where:

u = the index for each of type of electricity-consuming device located on either (1) the interior facing side of the display door or within the inside portion of the display door, (2) the exterior facing side of the display door, or (3) any combination of (1) and (2). For purposes of this calculation, the interior index is represented by u = int and the exterior index is represented by u = ext. If the electrical component is both on the interior and exterior side of the display door then u = int. For anti-sweat heaters sited anywhere in the display door, 75 percent of the total power is be attributed to u = int and 25 percent of the total power is attributed to u = ext;

t = index for each type of electricity consuming device with identical rated power;

$P_{rated,u,t}$ = rated power of each component, of type t, kW;

$PTO_{u,t}$ = percent time off, for device of type t, %; and

$n_{u,t}$ = number of devices at the rated power of type t, unitless.

(c) Calculate the total electrical energy consumption for interior and exterior power, $P_{dd\text{-}tot,\ int}$ (kWh/day) and $P_{dd\text{-}tot,\ ext}$ (kWh/day), respectively, as follows:

$$P_{dd-tot,int} = \sum_{1}^{t} P_{dd-comp,int,t} \qquad (4\text{-}21)$$

$$P_{dd-tot,ext} = \sum_{1}^{t} P_{dd-comp,ext,t} \qquad (4\text{-}22)$$

Where:

t = index for each type of electricity consuming device with identical rated power;

$P_{dd\text{-}comp,int,\ t}$ = the energy usage for an electricity consuming device sited on the interior facing side of or in the display door, of type t, kWh/day; and

$P_{dd\text{-}comp,ext,\ t}$ = the energy usage for an electricity consuming device sited on the external facing side of the display door, of type t, kWh/day.

(d) Calculate the total electrical energy consumption, $P_{dd\text{-}tot}$, (kWh/day), as follows:

$$P_{dd-tot} = P_{dd-tot,int} + P_{dd-tot,ext} \qquad (4\text{-}23)$$

Where:

$P_{dd\text{-}tot,int}$ = the total interior electrical energy usage for the display door, kWh/day; and

$P_{dd\text{-}tot,ext}$ = the total exterior electrical energy usage for the display door, kWh/day.

4.4.3 Total Indirect Electricity Consumption Due to Electrical Devices

(a) Select Energy Efficiency Ratio (EER), as follows:

(1) For coolers, use EER = 12.4 Btu/Wh

(2) For freezers, use EER = 6.3 Btu/Wh

(b) Calculate the additional refrigeration energy consumption due to thermal output from electrical components sited inside the display door, $C_{dd\text{-}load}$, kWh/day, as follows:

$$C_{dd-load} = P_{dd-tot,int} \times \frac{3.412}{EER}\frac{Btu}{W-h} \qquad (4\text{-}24)$$

Where:

EER = EER of walk-in cooler or walk-in freezer, Btu/W-h; and

$P_{dd\text{-}tot,int}$ = The total internal electrical energy consumption due for the display door, kWh/day.

4.4.4 Total Display Door Energy Consumption

(a) Select Energy Efficiency Ratio (EER), as follows:

(1) For coolers, use EER = 12.4 Btu/W-h

(2) For freezers, use EER = 6.3 Btu/W-h

(b) Calculate the total daily energy consumption due to conduction thermal load, $E_{dd,thermal}$, kWh/day, as follows:

$$E_{dd,thermal} = \frac{Q_{cond,dd}}{EER} \times \frac{24\ h \times 1\ kW}{1\ day \times 1000\ W} \qquad (4\text{-}25)$$

Where:

$Q_{cond,dd}$ = the conduction load through the display door, Btu/h; and

EER = EER of walk-in (cooler or freezer), Btu/W-h.

(c) Calculate the total energy, $E_{dd,tot}$, kWh/day,

$$E_{dd,tot} = E_{dd,thermal} + P_{dd-tot} + C_{dd-load} \qquad (4\text{-}26)$$

Where:

$E_{dd,thermal}$ = the total daily energy consumption due to thermal load for the display door, kWh/day;

P_{dd-tot} = the total electrical load, kWh/day; and

$C_{dd-load}$ = additional refrigeration load due to thermal output from electrical components contained within the display door, kWh/day.

4.5 Non-Display Doors

4.5.1 Conduction Through Non-Display Doors

(a) Calculate the surface area, as defined in section 3.4 of this appendix, of the non-display door, A_{nd}, ft^2, with standard geometric formulas or with engineering software.

(b) Calculate the temperature differential of the non-display door, ΔT_{nd}, °F, as follows:

$$\Delta T_{nd} = |T_{DB,ext,nd} - T_{DB,int,nd}| \qquad (4\text{-}27)$$

Where:

$T_{DB,ext,\ nd}$ = dry-bulb air external temperature, °F, as prescribed by Table A.1; and

$T_{DB,int,\ nd}$ = dry-bulb air internal temperature, °F, as prescribed by Table A.1. If the component spans both cooler and freezer spaces, the freezer temperature must be used.

(c) Calculate the conduction load through the non-display door: $Q_{cond-nd}$, Btu/h,

$$Q_{cond-nd} = \Delta T_{nd} \times A_{nd} \times U_{nd} \qquad (4\text{-}28)$$

Where:

ΔT_{nd} = temperature differential across the non-display door, °F;

U_{nd} = thermal transmittance, U-factor of the door, in accordance with section 5.3 of this appendix, Btu/h-ft^2- °F; and

A_{nd} = area of non-display door, ft^2.

4.5.2 Direct Energy Consumption of Electrical Components of Non-Display Doors

Electrical components associated with a walk-in non-display door comprise any components that are on the non-display door and that directly consume electrical energy. This includes, but is not limited to, heater wire (for anti-sweat or anti-freeze application), control system units, and sensors.

(a) Select the required value for percent time off for each type of electricity consuming device, PTO_t (%)

(1) For lighting without timers, control system or other demand-based control, PTO = 25 percent. For lighting with timers, control system or other demand-based control, PTO = 50 percent.

(2) For anti-sweat heaters on coolers (if included): Without timers, control system or other demand-based control, PTO = 0 percent. With timers, control system or other demand-based control, PTO = 75 percent. For anti-sweat heaters on freezers (if included): Without timers, control system or other auto-shut-off systems, PTO = 0 percent. With timers, control system or other demand-based control, PTO = 50 percent.

(3) For all other electricity consuming devices: Without timers, control system, or other auto-shut-off systems, PTO = 0 percent. If it can be demonstrated that the device is controlled by a preinstalled timer, control system or other auto-shut-off system, PTO = 25 percent.

(b) Calculate the power usage for each type of electricity consuming device, $P_{nd-comp,u,t}$, kWh/day, as follows:

$$P_{nd-comp,u,t} = P_{rated,u,t} \times \left(1 - PTO_{u,t}\right) \times n_{u,t} \times \frac{24h}{day} \qquad (4\text{-}29)$$

Where:

u = the index for each of type of electricity-consuming device located on either (1) the interior facing side of the display door or within the inside portion of the display door, (2) the exterior facing side of the display door, or (3) any combination of (1) and (2). For purposes of this calculation, the interior index is represented by u = int and the exterior index is represented by u = ext. If the electrical component is both on the interior and exterior side of the display door then u = int. For anti-sweat heaters sited anywhere in the display door, 75 percent of the total power is be attributed to u = int and 25 percent of the total power is attributed to u = ext;

t = index for each type of electricity consuming device with identical rated power;

$P_{rated,u,t}$ = rated power of each component, of type t, kW;

$PTO_{u,t}$ = percent time off, for device of type t, %; and

$n_{u,t}$ = number of devices at the rated power of type t, unitless.

(c) Calculate the total electrical energy consumption for interior and exterior power, $P_{nd\text{-}tot,\ int}$ (kWh/day) and $P_{nd\text{-}tot,\ ext}$ (kWh/day), respectively, as follows:

$$P_{nd-tot,int} = \sum_1^t P_{nd-comp,int,t} \qquad (4\text{-}30)$$

$$P_{nd-tot,ext} = \sum_1^t P_{nd-comp,ext,t} \qquad (4\text{-}31)$$

Where:

t = index for each type of electricity consuming device with identical rated power;

$P_{nd\text{-}comp,int,\ t}$ = the energy usage for an electricity consuming device sited on the internal facing side or internal to the non-display door, of type t, kWh/day; and

$P_{nd\text{-}comp,ext,\ t}$ = the energy usage for an electricity consuming device sited on the external facing side of the non-display door, of type t, kWh/day. For anti-sweat heaters,

(d) Calculate the total electrical energy consumption, $P_{nd\text{-}tot}$, kWh/day, as follows:

$$P_{nd-tot} = P_{nd-tot,int} + P_{nd-tot,ext} \qquad (4\text{-}32)$$

Where:

$P_{nd\text{-}tot,int}$ = the total interior electrical energy usage for the non-display door, of type t, kWh/day; and

$P_{nd\text{-}tot,ext}$ = the total exterior electrical energy usage for the non-display door, of type t, kWh/day.

4.5.3 Total Indirect Electricity Consumption Due to Electrical Devices

(a) Select Energy Efficiency Ratio (EER), as follows:

(1) For coolers, use EER = 12.4 Btu/Wh

(2) For freezers, use EER = 6.3 Btu/Wh

(b) Calculate the additional refrigeration energy consumption due to thermal output from electrical components associated with the non-display door, $C_{nd\text{-}load}$, kWh/day, as follows:

$$C_{nd-load} = P_{nd-tot,int} \times \frac{3.412}{EER}\frac{Btu}{W-h} \qquad (4\text{-}33)$$

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Where:

EER = EER of walk-in cooler or freezer, Btu/W-h; and

$P_{nd\text{-}tot,int}$ = the total interior electrical energy consumption for the non-display door, kWh/day.

4.5.4 Total Non-Display Door Energy Consumption

(a) Select Energy Efficiency Ratio (EER), as follows:

(1) For coolers, use EER = 12.4 Btu/W-h

(2) For freezers, use EER = 6.3 Btu/W-h

(b) Calculate the total daily energy consumption due to thermal load, $E_{nd,\ thermal}$, kWh/day, as follows:

$$E_{nd,thermal} = \frac{Q_{cond-nd}}{EER} \times \frac{24\ h \times 1\ kW}{1\ day \times 1000\ W} \qquad (4\text{-}34)$$

Where:

$Q_{cond\text{-}nd}$ = the conduction load through the non-display door, Btu/hr; and

EER = EER of walk-in (cooler or freezer), Btu/W-h.

(c) Calculate the total energy, $E_{nd,tot}$, kWh/day, as follows:

$$E_{nd,tot} = E_{nd,thermal} + P_{nd-tot} + C_{load} \qquad (4\text{-}35)$$

Where:

$E_{nd,\ thermal}$ = the total daily energy consumption due to thermal load for the non-display door, kWh/day;

$P_{nd\text{-}tot}$ = the total electrical energy consumption, kWh/day; and

$C_{nd\text{-}load}$ = additional refrigeration load due to thermal output from electrical components contained on the inside face of the non-display door, kWh/day.

5.0 Test Methods and Measurements

5.1–5.2 [Reserved]

5.3 U-factor of Doors and Display Panels

(a) Follow the procedure in NFRC 100, (incorporated by reference; see § 431.303), exactly, with these exceptions:

(1) The average surface heat transfer coefficient on the cold-side of the apparatus shall be 30 Watts per square-meter-Kelvin (W/m²*K) ±5%. The average surface heat transfer coefficient on the warm-side of the apparatus shall be 7.7 Watts per square-meter-Kelvin (W/m²*K) ±5%.

(2) Cold-side conditions:

(i) Air temperature of 35 °F (1.7 °C) for cooler doors and −10 °F (−23.3 °C) for freezer doors

(ii) Mean inside radiant temperature must be the same as shown in section 5.3(a)(2)(i), above.

(3) Warm-side conditions

(i) Air temperature of 75 °F (23.9 °C)

(ii) Mean outside radiant temperature must be the same as section 5.3(a)(3)(i), above.

(4) Direct solar irradiance = 0 W/m² (Btu/h-ft²).

(b) Required Test Measurements

(i) Display Doors and Display Panels

1. Thermal Transmittance: U_{dd}

(ii) Non-Display Door

1. Thermal Transmittance: U_{nd}

[76 FR 21606, Apr. 15, 2011, as amended at 76 FR 31796, June 2, 2011; 76 FR 33632, June 9, 2011; 79 FR 27414, May 13, 2014; 81 FR 95803, Dec. 28, 2016]

Appendix B to Subpart R of Part 431—Uniform Test Method for the Measurement of R-Value for Envelope Components of Walk-In Coolers and Walk-In Freezers

1.0 Scope

This appendix covers the test requirements used to measure the R-value of non-display panels and non-display doors of a walk-in cooler or walk-in freezer.

2.0 Definitions

The definitions contained in § 431.302 apply to this appendix.

3.0 Additional Definitions

3.1 *Edge region* means a region of the panel that is wide enough to encompass any framing members. If the panel contains framing members (*e.g.*, a wood frame) then the width of the edge region must be as wide as any framing member plus an additional 2 in. ± 0.25 in.

4.0 TEST METHODS, MEASUREMENTS, AND CALCULATIONS

4.1 The R value shall be the 1/K factor multiplied by the thickness of the panel.

4.2 The K factor shall be based on ASTM C518 (incorporated by reference; see § 431.303).

4.3 For calculating the R value for freezers, the K factor of the foam at 20 ± 1 degrees Fahrenheit (average foam temperature) shall be used. Test results from a test sample 1 ±0.1-inches in thickness may be used to determine the R value of panels with various foam thickness as long as the foam is of the same final chemical form.

4.4 For calculating the R value for coolers, the K factor of the foam at 55 ± 1 degrees Fahrenheit (average foam temperature) shall be used. Test results from a test sample 1 ± 0.1-inches in thickness may be used to determine the R value of panels with various foam thickness as long as the foam is of the same final chemical form.

4.5 Foam shall be tested after it is produced in its final chemical form. For foam produced inside of a panel (''foam-in-place''), ''final chemical form'' means the foam is cured as intended and ready for use as a finished panel. For foam produced as board stock (typically polystyrene), ''final chemical form'' means after extrusion and ready for assembly into a panel or after assembly into a panel. Foam from foam-in-place panels must not include any structural members or non-foam materials. Foam produced as board stock may be tested prior to its incorporation into a final panel. A test sample 1 ± 0.1-inches in thickness must be taken from the center of a panel and any protective skins or facers must be removed. A high-speed band-saw and a meat slicer are two types of recommended cutting tools. Hot wire cutters or other heated tools must not be used for cutting foam test samples. The two surfaces of the test sample that will contact the hot plate assemblies (as defined in ASTM C518 (incorporated by reference, see § 431.303)) must both maintain ±0.03 inches flatness tolerance and also maintain parallelism with respect to one another within ±0.03 inches. Testing must be completed within 24 hours of samples being cut for testing.

4.6 Internal non-foam member and/or edge regions shall not be considered when testing in accordance with ASTM C518 (incorporated by reference, see § 431.303).

4.7 For panels consisting of two or more layers of dissimilar insulating materials (excluding facers or protective skins), test each material as described in sections 4.1 through 4.6 of this appendix. For a panel with N layers of insulating material, the overall R-Value shall be calculated as follows:

$$R_{panel} = \sum_{i=1}^{N} \frac{t_i}{k_i}$$

Where:

k_i is the k factor of the ith material as measured by ASTM C518, (incorporated by reference, see § 431.303);

t_i is the thickness of the ith material that appears in the panel; and

N is the total number of material layers that appears in the panel.

[81 FR 95803, Dec. 28, 2016]

APPENDIX C TO SUBPART R OF PART 431—UNIFORM TEST METHOD FOR THE MEASUREMENT OF NET CAPACITY AND AWEF OF WALK-IN COOLER AND WALK-IN FREEZER REFRIGERATION SYSTEMS

1.0 SCOPE

This appendix covers the test requirements used to determine the net capacity and the AWEF of the refrigeration system of a walk-in cooler or walk-in freezer.

2.0 DEFINITIONS

The definitions contained in § 431.302 and AHRI 1250–2009 (incorporated by reference; see § 431.303) apply to this appendix. When definitions in standards incorporated by reference are in conflict or when they conflict with this section, the hierarchy of precedence shall be in the following order: § 431.302, AHRI 1250–2009, and then either AHRI 420–2008 (incorporated by reference; see § 431.303) for unit coolers or ASHRAE 23.1–2010 (incorporated by reference; see § 431.303) for dedicated condensing units.

3.0 TEST METHODS, MEASUREMENTS, AND CALCULATIONS

Determine the Annual Walk-in Energy Factor (AWEF) and net capacity of walk-in cooler and walk-in freezer refrigeration systems by conducting the test procedure set forth in AHRI 1250–2009 (incorporated by reference; see § 431.303), with the modifications to that test procedure provided in this section. When standards that are incorporated by reference are in conflict or when they conflict with this section, the hierarchy of precedence shall be in the following order: §431.302, AHRI 1250–2009, and then either AHRI 420–2008 (incorporated by reference; see §431.303) or ASHRAE 23.1–2010 (incorporated by reference; see §431.303).

3.1. *General modifications: Test Conditions and Tolerances.*

When conducting testing in accordance with AHRI 1250–2009 (incorporated by reference; see §431.303), the following modifications must be made.

3.1.1. In Table 1, Instrumentation Accuracy, refrigerant temperature measurements shall have a tolerance of ±0.5 F for unit cooler in/out, ±1.0 F for all other temperature measurements.

3.1.2. In Table 2, Test Operating and Test Condition Tolerances for Steady-State Test, electrical power frequency shall have a Test Condition Tolerance of 1 percent.

3.1.3. In Table 2, the Test Operating Tolerances and Test Condition Tolerances for Air Leaving Temperatures shall be deleted.

3.1.4. In Tables 2 through 14, the Test Condition Outdoor Wet Bulb Temperature requirement and its associated tolerance apply only to units with evaporative cooling.

3.1.5. Tables 15 and 16 shall be modified to read as follows:

TABLE 15—REFRIGERATOR UNIT COOLER

Test description	Unit cooler air entering dry-bulb, °F	Unit cooler air entering relative humidity, %	Saturated suction temp, °F	Liquid inlet saturation temp, °F	Liquid inlet subcooling temp, °F	Compressor capacity	Test objective
Off Cycle Fan Power.	35	<50	—	—	—	Compressor Off	Measure fan input power during compressor off cycle.
Refrigeration Capacity Suction A.	35	<50	25	105	9	Compressor On	Determine Net Refrigeration Capacity of Unit Cooler.
Refrigeration Capacity Suction B.	35	<50	20	105	9	Compressor On	Determine Net Refrigeration Capacity of Unit Cooler.

Note: Superheat to be set according to equipment specification in equipment or installation manual. If no superheat specification is given, a default superheat value of 6.5 °F shall be used. The superheat setting used in the test shall be reported as part of the standard rating.

TABLE 16—FREEZER UNIT COOLER

Test description	Unit cooler air entering dry-bulb, °F	Unit cooler air entering relative humidity, %	Saturated suction temp, °F	Liquid inlet saturation temp, °F	Liquid inlet subcooling temp, °F	Compressor capacity	Test objective
Off Cycle Fan Power.	−10	<50	—	—	—	Compressor Off	Measure fan input power during compressor off cycle.
Refrigeration Capacity Suction A.	−10	<50	−20	105	9	Compressor On	Determine Net Refrigeration Capacity of Unit Cooler.
Refrigeration Capacity Suction B.	−10	<50	−26	105	9	Compressor On	Determine Net Refrigeration Capacity of Unit Cooler.
Defrost	−10	Various	—	—	—	Compressor Off	Test according to Appendix C Section C11.

Note: Superheat to be set according to equipment specification in equipment or installation manual. If no superheat specification is given, a default superheat value of 6.5 °F shall be used. The superheat setting used in the test shall be reported as part of the standard rating.

3.2. General Modifications: Methods of Testing

When conducting testing in accordance with appendix C of AHRI 1250–2009 (incorporated by reference; see §431.303), the following modifications must be made.

3.2.1. In appendix C, section C3.1.6, any refrigerant temperature measurements upstream and downstream of the unit cooler may use sheathed sensors immersed in the flowing refrigerant instead of thermometer wells.

3.2.2. It is not necessary to perform composition analysis of refrigerant (appendix C, section C3.3.6) or refrigerant oil concentration testing (appendix C, section C3.4.6).

3.2.3. In appendix C, section C3.4.5, for verification of sub-cooling downstream of mass flow meters, only the sight glass and a temperature sensor located on the tube surface under the insulation are required.

3.2.4. In appendix C, section C3.5, regarding unit cooler fan power measurements, for a given motor winding configuration, the total power input shall be measured at the highest nameplate voltage. For three-phase power, voltage imbalances shall be no more than 2 percent from phase to phase.

3.2.5. In the test setup (appendix C, section C8.3), the liquid line and suction line shall be constructed of pipes of the manufacturer-specified size. The pipe lines shall be insulated with a minimum total thermal resistance equivalent to ½-inch thick insulation having a flat-surface R-Value of 3.7 ft^2- °F-hr/Btu per inch or greater. Flow meters need not be insulated but must not be in contact with the floor. The lengths of the connected liquid line and suction line shall be 25 feet ± 3 inches, not including the requisite flow meters, each. Of this length, no more than 15 feet shall be in the conditioned space. Where there are multiple branches of piping, the maximum length of piping applies to each branch individually as opposed to the total length of the piping.

3.3. *Matched systems, single-package dedicated systems, and unit coolers tested alone:* Use the test method in AHRI 1250–2009 (incorporated by reference; see §431.303), appendix C as the method of test for matched refrigeration systems, single-package dedicated systems, or unit coolers tested alone, with the following modifications:

3.3.1. For unit coolers tested alone, use test procedures described in AHRI 1250–2009 (incorporated by reference; see §431.303) for testing unit coolers for use in mix-match system ratings, except that for the test conditions in Tables 15 and 16, use the Suction A saturation condition test points only. Also for unit coolers tested alone, use the calculations in section 7.9 to determine AWEF and net capacity described in AHRI 1250–2009 for unit coolers matched to parallel rack systems.

3.3.2. In appendix C, section C.13, the version of AHRI Standard 420 used for test methods, requirements, and procedures shall be AHRI 420–2008 (incorporated by reference; see §431.303).

3.3.3. Use appendix C, section C10 of AHRI 1250–2009 for off-cycle evaporator fan testing, with the exception that evaporator fan controls using periodic stir cycles shall be adjusted so that the greater of a 50% duty cycle (rather than a 25% duty cycle) or the manufacturer default is used for measuring off-cycle fan energy. For adjustable-speed controls, the greater of 50% fan speed (rather than 25% fan speed) or the manufacturer's default fan speed shall be used for measuring off-cycle fan energy. Also, a two-speed or multi-speed fan control may be used as the qualifying evaporator fan control. For such a control, a fan speed no less than 50% of the speed used in the maximum capacity tests shall be used for measuring off-cycle fan energy.

3.3.4. Use appendix C, section C11 of AHRI 1250–2009 (incorporated by reference, see §431.303) for defrost testing. The Frost Load Condition Defrost Test (C11.1.1) is optional.

3.3.4.1. If the frost load condition defrost test is performed:

3.3.4.1.1 Operate the unit cooler at the dry coil conditions as specified in appendix C, section C11.1 to obtain dry coil defrost energy, DF_d, in W-h.

3.3.4.1.2 Operate the unit cooler at the frost load conditions as specified in appendix C, sections C11.1 and C11.1.1 to obtain frosted coil defrost energy, DF_f, in W-h.

3.3.4.1.3 The number of defrosts per day, N_{DF}, shall be calculated from the time interval between successive defrosts from the start of one defrost to the start of the next defrost at the frost load conditions.

3.3.4.1.4 Use appendix C, equations C13 and C14 in section C11.3 to calculate, respectively, the daily average defrost energy, DF, in W-h and the daily contribution of the load attributed to defrost Q_{DF} in Btu.

3.3.4.1.5 The defrost adequacy requirements in appendix C, section C11.3 shall apply.

3.3.4.2 If the frost load test is not performed:

3.3.4.2.1 Operate the unit cooler at the dry coil conditions as specified in appendix C, section C11.1 to obtain dry coil defrost energy, DF_d, in W-h.

3.3.4.2.2 The frost load defrost energy, DF_f, in W-h shall be equal to 1.05 multiplied by the dry coil energy consumption, DF_d, measured using the dry coil condition test in appendix C, section C11.1.

3.3.4.2.3 The number of defrosts per day N_{DF} used in subsequent calculations shall be 4.

3.3.4.2.4 Use appendix C, equation C13 in section C11.3 to calculate the daily average defrost energy, DF, in W-h.

3.3.4.2.5 The daily contribution of the load attributed to defrost Q_{DF} in Btu shall be calculated as follows:

$$Q_{DF} = 0.95 \times 3.412 \text{ Btu/W-h} \times \frac{2.05 \times DF_d}{2} \times 4$$

Where:

DF_d = the defrost energy, in W-h, measured at the dry coil condition

3.3.5. If a unit has adaptive defrost, use appendix C, section C11.2 of AHRI 1250–2009 as follows:

3.3.5.1. When testing to certify to the energy conservation standards in § 431.306, do not perform the optional test for adaptive or demand defrost in appendix C, section C11.2.

3.3.5.2. When determining the represented value of the calculated benefit for the inclusion of adaptive defrost, conduct the optional test for adaptive or demand defrost in appendix C, section C11.2 to establish the maximum time interval allowed between dry coil defrosts. If this time is greater than 24 hours, set its value to 24 hours. Then, calculate N_{DF} (the number of defrosts per day) by averaging the time in hours between successive defrosts for the dry coil condition with the time in hours between successive defrosts for the frosted coil condition, and dividing 24 by this average time. (The time between successive defrosts for the frosted coil condition is found as specified in section 3.3.4 of this appendix C of AHRI 1250–2009: That is, if the optional frosted coil test was performed, the time between successive defrosts for the frosted coil condition is found by performing the frosted coil test as specified in section 3.3.4.1 of this appendix; and if the optional frosted coil test was not performed, the time between successive defrosts for the frosted coil condition shall be set to 4 as specified in section 3.3.4.2. of this appendix) Use this new value of N_{DF} in subsequent calculations.

3.3.6. For matched refrigeration systems and single-package dedicated systems, calculate the AWEF using the calculations in AHRI 1250–2009 (incorporated by reference; see § 431.303), section 7.4, 7.5, 7.6, or 7.7, as applicable.

3.3.7. For unit coolers tested alone, calculate the AWEF and net capacity using the calculations in AHRI 1250–2009, (incorporated by reference; see § 431.303), section 7.9. If the unit cooler has variable-speed evaporator fans that vary fan speed in response to load, then:

3.3.7.1. When testing to certify compliance with the energy conservation standards in § 431.306, fans shall operate at full speed during on-cycle operation. Do not conduct the calculations in AHRI 1250–2009, section 7.9.3. Instead, use AHRI 1250–2009, section 7.9.2 to determine the system's AWEF.

3.3.7.2. When calculating the benefit for the inclusion of variable-speed evaporator fans that modulate fan speed in response to load for the purposes of making representations of efficiency, use AHRI 1250–2009, section 7.9.3 to determine the system AWEF.

3.4. *Dedicated condensing units that are not matched for testing and are not single-package dedicated systems*

3.4.1. Refer to appendix C, section C.12 of AHRI 1250–2009 (incorporated by reference; see § 431.303), for the method of test for dedicated condensing units. The version of ASHRAE Standard 23 used for test methods, requirements, and procedures shall be ANSI/ASHRAE Standard 23.1–2010 (incorporated by reference; see § 431.303). When applying this test method, use the applicable test method modifications listed in sections 3.1 and 3.2 of this appendix. For the test conditions in AHRI 1250–2009, Tables 11, 12, 13, and 14, use the Suction A condition test points only.

3.4.2. Calculate the AWEF and net capacity for dedicated condensing units using the calculations in AHRI 1250–2009 (incorporated by reference; see § 431.303) section 7.8. Use the following modifications to the calculations in lieu of unit cooler test data:

3.4.2.1. For calculating enthalpy leaving the unit cooler to calculate gross capacity, (a) The saturated refrigerant temperature (dew point) at the unit cooler coil exit, T_{evap}, shall be 25 °F for medium-temperature systems (coolers) and −20 °F for low-temperature systems (freezers), and (b) the refrigerant temperature at the unit cooler exit shall be 35 °F for medium-temperature systems (coolers) and −14 °F for low-temperature systems (freezers). For calculating gross capacity, the measured enthalpy at the condensing unit exit shall be used as the enthalpy entering the unit cooler.

3.4.2.2. The on-cycle evaporator fan power in watts, $EF_{comp,on}$, shall be calculated as follows:

For medium-temperature systems (coolers), $EF_{comp,on} = 0.013 \times q_{mix,cd}$

For low-temperature systems (freezers), $EF_{comp,on} = 0.016 \times q_{mix,cd}$

Where:

$q_{mix,cd}$ is the gross cooling capacity of the system in Btu/h, found by a single test at the Capacity A, Suction A condition for outdoor units and the Suction A condition for indoor units.

3.4.2.3. The off-cycle evaporator fan power in watts, $EF_{comp,off}$, shall be calculated as follows:

$$EF_{comp,off} = 0.2 \times EF_{comp,on}$$

Where:

$EF_{comp,on}$ is the on-cycle evaporator fan power in watts.

3.4.2.4. The daily defrost energy use in watt-hours, DF, shall be calculated as follows:

For medium-temperature systems (coolers), DF = 0

For low-temperature systems (freezers), $DF = 8.5 \times 10^{-3} \times q_{mix,cd}^{1.27} \times N_{DF}$

Where:

$q_{mix,cd}$ is the gross cooling capacity of the system in Btu/h, found by a single test at the Capacity A, Suction A condition for outdoor units and the Suction A condition for indoor units, and

N_{DF} is the number of defrosts per day, equal to 4.

3.4.2.5. The daily defrost heat load contribution in Btu, Q_{DF}, shall be calculated as follows:

For medium-temperature systems (coolers), $Q_{DF} = 0$

For low-temperature systems (freezers), $Q_{DF} = 0.95 \times DF \times 3.412$

Where:

DF is the daily defrost energy use in watt-hours.

3.5 Hot Gas Defrost Refrigeration Systems

For all hot gas defrost refrigeration systems, remove the hot gas defrost mechanical components and disconnect all such components from electrical power.

3.5.1 Hot Gas Defrost Dedicated Condensing Units Tested Alone: Test these units as described in section 3.4 of this appendix for electric defrost dedicated condensing units that are not matched for testing and are not single-package dedicated systems.

3.5.2 Hot Gas Defrost Matched Systems and Single-package Dedicated Systems: Test these units as described in section 3.3 of this appendix for electric defrost matched systems and single-package dedicated systems, but do not conduct defrost tests as described in sections 3.3.4 and 3.3.5 of this appendix. Calculate daily defrost energy use as described in section 3.4.2.4 of this appendix. Calculate daily defrost heat contribution as described in section 3.4.2.5 of this appendix.

3.5.3 Hot Gas Defrost Unit Coolers Tested Alone: Test these units as described in section 3.3 of this appendix for electric defrost unit coolers tested alone, but do not conduct defrost tests as described in sections 3.3.4 and 3.3.5 of this appendix. Calculate average defrost heat load $\dot{Q}_{DF}$, expressed in Btu/h, as follows:

If $\dot{Q}_{gross} \leq 25{,}000$ Btu/h:

$$\dot{Q}_{DF} = 0.195 \times \dot{Q}_{gross} \times \frac{N_{DF}}{24}$$

If $\dot{Q}_{gross} > 25{,}000$ Btu/h and $\dot{Q}_{gross} \leq 70{,}000$ Btu/h:

$$\dot{Q}_{DF} = \dot{Q}_{gross} \times \left[0.195 - \frac{0.049 \times (\dot{Q}_{gross} - 25{,}000)}{45{,}000}\right] \times \frac{N_{DF}}{24}$$

If $\dot{Q}_{gross} > 70{,}000$ Btu/h:

$$\dot{Q}_{DF} = 0.146 \times \dot{Q}_{gross} \times \frac{N_{DF}}{24}$$

Where:

$\dot{Q}_{gross}$ is the measured gross capacity in Btu/h at the Suction A condition; and

N_{DF} is the number of defrosts per day, equal to 4.

Calculate average defrost power input $\dot{DF}$, expressed in Watts, as follows:

$$\dot{DF} = \frac{\dot{Q}_{DF}}{0.95 \times 3.412}$$

Where:

$\dot{Q}_{DF}$ is the average defrost heat load in Btu/h

[81 FR 95803, Dec. 28, 2016, as amended at 86 FR 16035, Mar. 26, 2021]

Subpart S—Metal Halide Lamp Ballasts and Fixtures

SOURCE: 74 FR 12075, Mar. 23, 2009, unless otherwise noted.

§431.321 Purpose and scope.

This subpart contains energy conservation requirements for metal halide lamp ballasts and fixtures, pursuant to Part A of Title III of the Energy Policy and Conservation Act, as amended, 42 U.S.C. 6291–6309.

[75 FR 10966, Mar. 9, 2010]

§431.322 Definitions concerning metal halide lamp ballasts and fixtures.

Active mode means the condition in which an energy-using product:

(1) Is connected to a main power source;

(2) Has been activated; and

(3) Provides one or more main functions.

Ballast means a device used with an electric discharge lamp to obtain necessary circuit conditions (voltage, current, and waveform) for starting and operating.

Ballast efficiency means, in the case of a high intensity discharge fixture, the efficiency of a lamp and ballast combination, expressed as a percentage, and calculated in accordance with the following formula: Efficiency = P_{out}/P_{in} where:

(1) P_{out} equals the measured operating lamp wattage; and

(2) P_{in} equals the measured operating input wattage.

(3) The lamp, and the capacitor when the capacitor is provided, shall constitute a nominal system in accordance with the ANSI C78.43–2017 (incorporated by reference; see §431.323);

(4) For ballasts with a frequency of 60 Hz, Pin and Pout shall be measured after lamps have been stabilized according to Section 4.4 of ANSI C82.6–2015 (incorporated by reference; see §431.323) using a wattmeter with accuracy specified in Section 4.5 of ANSI C82.6–2015; and

(5) For ballasts with a frequency greater than 60 Hz, Pin and Pout shall have a basic accuracy of ±0.5 percent at the higher of either 3 times the output operating frequency of the ballast or 2.4 kHz.

Basic model means all units of a given type of covered product (or class thereof) manufactured by one manufacturer, having the same primary energy source, and which have essentially identical electrical, physical, and functional (or hydraulic) characteristics that affect energy consumption, energy efficiency, water consumption, or water efficiency, and are rated to operate a given lamp type and wattage.

Ceramic metal halide lamp means a metal halide lamp with an arc tube made of ceramic materials.

Electronic ballast means a device that uses semiconductors as the primary means to control lamp starting and operation.

General lighting application means lighting that provides an interior or exterior area with overall illumination.

High-frequency electronic metal halide ballast means an electronic ballast that operates a lamp at an output frequency of 1000 Hz or greater.

Metal halide ballast means a ballast used to start and operate metal halide lamps.

Metal halide lamp means a high intensity discharge lamp in which the major portion of the light is produced by radiation of metal halides and their products of dissociation, possibly in combination with metallic vapors.

Metal halide lamp fixture means a light fixture for general lighting application designed to be operated with a metal halide lamp and a ballast for a metal halide lamp.

Nonpulse-start electronic ballast means an electronic ballast with a starting method other than pulse-start.

Off mode means the condition in which an energy-using product:

(1) Is connected to a main power source; and

(2) Is not providing any standby or active mode function.

PLC control signal means a power line carrier (PLC) signal that is supplied to the ballast using the input ballast wiring for the purpose of controlling the ballast and putting the ballast in standby mode.

Probe-start metal halide ballast means a ballast that starts a probe-start metal halide lamp that contains a third starting electrode (probe) in the arc tube, and does not generally contain an igniter but instead starts lamps with high ballast open circuit voltage.

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Pulse-start metal halide ballast means an electronic or electromagnetic ballast that starts a pulse-start metal halide lamp with high voltage pulses, where lamps shall be started by the ballast first providing a high voltage pulse for ionization of the gas to produce a glow discharge and then power to sustain the discharge through the glow-to-arc transition.

Quartz metal halide lamp means a metal halide lamp with an arc tube made of quartz materials.

Reference lamp is a metal halide lamp that meets the operating conditions of a reference lamp as defined by ANSI C82.9–2016 (incorporated by reference; see § 431.323).

Standby mode means the condition in which an energy-using product:

(1) Is connected to a main power source; and

(2) Offers one or more of the following user-oriented or protective functions:

(i) To facilitate the activation or deactivation of other functions (including active mode) by remote switch (including remote control), internal sensor, or timer;

(ii) Continuous functions, including information or status displays (including clocks) or sensor-based functions.

[74 FR 12075, Mar. 23, 2009, as amended at 75 FR 10966, Mar. 9, 2010; 74 FR 12074, Mar. 23, 2009; 79 FR 7843, Feb. 10, 2014; 87 FR 37699, June 24, 2022]

TEST PROCEDURES

§ 431.323 Materials incorporated by reference.

(a) Certain material is incorporated by reference into this subpart with the approval of the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. To enforce any edition other than that specified in this section, the U.S. Department of Energy (DOE) must publish a document in the FEDERAL REGISTER and the material must be available to the public. All approved incorporation by reference (IBR) material is available for inspection at DOE, and at the National Archives and Records Administration (NARA). Contact DOE at: the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Program, Sixth Floor, 950 L'Enfant Plaza SW, Washington, DC 20024, (202) 586–9127, *Buildings@ee.doe.gov*, *https://www.energy.gov/eere/buildings/building-technologies-office*. For information on the availability of this material at NARA, email: *fr.inspection@nara.gov*, or go to: *www.archives.gov/federal-register/cfr/ibr-locations.html*. The material may be obtained from the sources in the following paragraphs of this section.

(b) *ANSI*. American National Standards Institute, 25 W. 43rd Street, 4th Floor, New York, NY 10036; 212–642–4900; *www.ansi.org*.

(1) ANSI C78.43–2017, American National Standard for Electric Lamps—Single-Ended Metal Halide Lamps, approved December 21, 2017; IBR approved for § 431.324.

(2) ANSI C78.44–2016, American National Standard for Electric Lamps—Double-Ended Metal Halide Lamps, approved July 1, 2016; IBR approved for § 431.324.

(3) ANSI C82.6–2015 (R2020), American National Standard for Lamp Ballasts—Ballasts for High-Intensity Discharge Lamps—Methods of Measurement, approved March 30, 2020; IBR approved for §§ 431.322; 431.324.

(4) ANSI C82.9–2016, American National Standard for Lamp Ballasts—High Intensity Discharge and Low-Pressure Sodium Lamps—Definitions, approved July 12, 2016; IBR approved for §§ 431.322; 431.324.

(c) *IEC*. International Electrotechnical Commission, 3 rue de Varembé, 1st Floor, P.O. Box 131, CH—1211 Geneva 20—Switzerland, +41 22 919 02 11, or go to *webstore.iec.ch/home*.

(1) IEC 63103, Lighting Equipment—Non-active Mode Power Measurement, Edition 1.0, dated 2020–07; IBR approved for § 431.324.

(2) [Reserved]

(d) *NFPA*. National Fire Protection Association, 11 Tracy Drive, Avon, MA 02322, 1–800–344–3555, or go to *http://www.nfpa.org;*

(1) NFPA 70–2002 (''NFPA 70''), National Electrical Code 2002 Edition, IBR approved for § 431.326;

(2) [Reserved]

(e) UL. Underwriters Laboratories, Inc., COMM 2000, 1414 Brook Drive, Downers Grove, IL 60515, 1–888–853–3503, or go to *http://www.ul.com.*

(1) UL 1029 (ANSI/UL 1029–2007) (''UL 1029''), Standard for Safety High-Intensity-Discharge Lamp Ballasts, 5th edition, May 25, 1994, which consists of pages dated May 25, 1994, September 28, 1995, August 3, 1998, February 7, 2001 and December 11, 2007, IBR approved for § 431.326.

(2) [Reserved]

[74 FR 12075, Mar. 23, 2009, as amended at 75 FR 10966, Mar. 9, 2010; 87 FR 37699, June 24, 2022]

§ 431.324 Uniform test method for the measurement of energy efficiency and standby mode energy consumption of metal halide lamp ballasts.

(a) *Scope.* This section provides test procedures for measuring, pursuant to EPCA, the energy efficiency of metal halide lamp ballasts. After July 25, 2022, and prior to December 21, 2022, any representations with respect to energy use or efficiency of metal halide lamp fixtures must be in accordance with the results of testing pursuant to this section or the test procedures as they appeared in 10 CFR 431.324 as it appeared in the 10 CFR parts 200–499 edition revised as of January 1, 2022. On or after December 21, 2022, any representations, including certifications of compliance for metal halide lamp fixtures subject to any energy conservation standard, made with respect to the energy use or efficiency of metal halide lamp fixtures must be made in accordance with the results of testing pursuant to this section.

(b) *Active mode procedure*—(1) *General instructions.* Specifications in referenced standards that are recommended, that ''shall'' or ''should'' be met, or that are not otherwise explicitly optional, are mandatory. In cases where there is a conflict between any industry standard(s) and this section, the language of the test procedure in this section takes precedence over the industry standard(s).

(2) *Test conditions and setup.* (i) The power supply, ballast conditions, lamp position, and instrumentation must all conform to the requirements specified in Section 4.0 of ANSI C82.6–2015 (R2020) (incorporated by reference; see § 431.323).

(ii) Airflow in the room for the testing period must be ≤0.5 meters/second.

(iii) Test circuits must be in accordance with the circuit connections specified in Section 6.3 of ANSI C82.6–2015 (R2020).

(iv) For ballasts designed to operate lamps rated less than 150 W that have 120 V as an available input voltage, testing must be performed at 120 V. For ballasts designed to operate lamps rated less than 150 W that do not have 120 V as an available voltage, testing must be performed at the highest available input voltage. For ballasts designed to operate lamps rated greater than or equal to 150 W that have 277 V as an available input voltage, testing must be conducted at 277 V. For ballasts designed to operate lamps rated greater than or equal to 150 W that do not have 277 V as an available input voltage, testing must be conducted at the highest available input voltage.

(v) Operate dimming ballasts at maximum input power.

(vi) Select the metal halide lamp for testing as follows:

(A) The metal halide lamp used for testing must meet the specifications of a reference lamp as defined by ANSI C82.9–2016 and the rated values of the corresponding lamp data sheet as specified in ANSI C78.43–2017 (both incorporated by reference; *see* § 431.323) for single-ended lamps and ANSI C78.44–2016 (incorporated by reference; *see* § 431.323) for double-ended lamps.

(B) Ballasts designated with ANSI codes corresponding to more than one lamp must be tested with the lamp having the highest nominal lamp wattage as specified in ANSI C78.43–2017 or ANSI C78.44–2016, as applicable.

(C) Ballasts designated with ANSI codes corresponding to both ceramic metal halide lamps (code beginning with ''C'') and quartz metal halide lamps (code beginning with ''M'') of the same nominal lamp wattage must be tested with the quartz metal halide lamp.

(3) *Test method*—(i) *Stabilization criteria*—(A) *General instruction.* Lamp must be seasoned as prescribed in Section 4.4.1 of ANSI C82.6–2015 (R2020).

(B) *Basic stabilization method.* Lamps using the basic stabilization method must be stabilized in accordance with

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Section 4.4.2 of ANSI C82.6–2015 (R2020). Stabilization is reached when the lamp's electrical characteristics vary by no more than 3-percent in three consecutive 10- to 15-minute intervals measured after the minimum burning time of 30 minutes.

(C) *Alternative stabilization method.* In cases where switching from the reference ballast to test ballast without extinguishing the lamp is impossible, such as for low-frequency electronic ballasts, the alternative stabilization method must be used. Lamps using the alternative stabilization method must be stabilized in accordance with Section 4.4.3 of ANSI C82.6–2015 (R2020).

(ii) *Test measurements.* (A) The ballast input power during operating conditions must be measured in accordance with the methods specified in Sections 6.1 and 6.8 of ANSI C82.6–2015 (R2020).

(B) The ballast output (lamp) power during operating conditions must be measured in accordance with the methods specified in Sections 6.2 and 6.10 of ANSI C82.6–2015 (R2020).

(C) For ballasts with a frequency of 60 Hz, the ballast input and output power shall be measured after lamps have been stabilized according to Section 4.4 of ANSI C82.6–2015 (R2020) using a wattmeter with accuracy specified in Section 4.5 of ANSI C82.6–2015 (R2020); and

(D) For ballasts with a frequency greater than 60 Hz, the ballast input and output power shall have a basic accuracy of ±0.5 percent at the higher of either 3 times the output operating frequency of the ballast or 2.4 kHz.

(iii) *Calculations.* (A) To determine the percent efficiency of the ballast under test, divide the measured ballast output (lamp) power, as measured in paragraph (b)(3)(ii) of this section, by the measured ballast input power, as measured in paragraph (b)(3)(ii) of this section. Calculate percent efficiency to three significant figures.

(B) [Reserved]

(c) *Standby mode procedure*—(1) *General instructions.* Measure standby mode energy consumption only for a ballast that is capable of operating in standby mode. Specifications in referenced standards that are recommended, that ''shall'' or ''should'' be met, or that are not otherwise explicitly optional, are mandatory. When there is a conflict, the language of the test procedure in this section takes precedence over IEC 63103 (incorporated by reference; see § 431.323).

(2) *Test conditions and setup.* (i) Establish and maintain test conditions and setup in accordance with paragraph (b)(2) of this section.

(ii) Connect each ballast to a lamp as specified in paragraph (b)(2)(vi) of this section. Note: ballast operation with a reference lamp is not required.

(3) *Test method and measurement.* (i) Turn on all of the lamps at full light output. If any lamp is not functional, replace the lamp and repeat the test procedure. If the ballast will not operate any lamps, replace the unit under test.

(ii) Send a signal to the ballast instructing it to have zero light output using the appropriate ballast communication protocol or system for the ballast being tested.

(iii) Stabilize the ballast prior to measurement using one of the methods as specified in Section 5.4 of IEC 63103.

(iv) Measure the standby mode energy consumption in watts using one of the methods as specified in Section 5.4 of IEC 63103.

[87 FR 37699, June 24, 2022]

ENERGY CONSERVATION STANDARDS

§ 431.326 Energy conservation standards and their effective dates.

(a) Except as provided in paragraph (b) of this section, each metal halide lamp fixture manufactured on or after January 1, 2009, and designed to be operated with lamps rated greater than or equal to 150 watts but less than or equal to 500 watts shall contain—

(1) A pulse-start metal halide ballast with a minimum ballast efficiency of 88 percent;

(2) A magnetic probe-start ballast with a minimum ballast efficiency of 94 percent; or

(3) A nonpulse-start electronic ballast with either a minimum ballast efficiency of 92 percent for wattages greater than 250 watts; or a minimum ballast efficiency of 90 percent for wattages less than or equal to 250 watts.

(b) The standards described in paragraph (a) of this section do not apply to—

(1) Metal halide lamp fixtures with regulated lag ballasts;

(2) Metal halide lamp fixtures that use electronic ballasts that operate at 480 volts; or

(3) Metal halide lamp fixtures that;

(i) Are rated only for 150 watt lamps;

(ii) Are rated for use in wet locations; as specified by the National Fire Protection Association in NFPA 70 (incorporated by reference; *see* § 431.323); and

(iii) Contain a ballast that is rated to operate at ambient air temperatures above 50 °C, as specified in UL 1029, (incorporated by reference; *see* § 431.323).

(c) Except when the requirements of paragraph (a) of this section are more stringent (*i.e.*, require a larger minimum efficiency value) or as provided by paragraph (e) of this section, each metal halide lamp fixture manufactured on or after February 10, 2017, must contain a metal halide ballast with an efficiency not less than the value determined from the appropriate equation in the following table:

Designed to be operated with lamps of the following rated lamp wattage	Tested input voltage‡‡	Minimum standard equation‡‡ %
≥50 W and ≤100 W	Tested at 480 V	(1/(1 + 1.24 × P^(−0.351))) − 0.020††
≥50 W and ≤100 W	All others	1/(1 + 1.24 × P^(−0.351))
>100 W and <150† W	Tested at 480 V	(1/(1 + 1.24 × P^(−0.351))) − 0.020
>100 W and <150† W	All others	1/(1 + 1.24 × P^(−0.351))
≥150‡ W and ≤250 W	Tested at 480 V	0.880
≥150‡ W and ≤250 W	All others	For ≥150 W and ≤200 W: 0.880 For >200 W and ≤250 W: 1/(1 + 0.876 × P^(−0.351))
>250 W and ≤500 W	Tested at 480 V	For >250 and <265 W: 0.880 For ≥265 W and ≤500 W: (1/(1 + 0.876 × P^(−0.351)) − 0.010
>250 W and ≤500 W	All others	1/(1 + 0.876 × P^(−0.351))
>500 W and ≤1000 W	Tested at 480 V	For >500 W and ≤750 W: 0.900 For >750 W and ≤1000 W: 0.000104 × P + 0.822 For >500 W and ≤1000 W: may not utilize a probe-start ballast
>500 W and ≤1000 W	All others	For >500 W and ≤750 W: 0.910 For >750 W and ≤1000 W: 0.000104 × P + 0.832 For >500 W and ≤1000 W: may not utilize a probe-start ballast

† Includes 150 W fixtures specified in paragraph (b)(3) of this section, that are fixtures rated only for 150 W lamps; rated for use in wet locations, as specified by the NFPA 70 (incorporated by reference, see § 431.323), section 410.4(A); and containing a ballast that is rated to operate at ambient air temperatures above 50 °C, as specified by UL 1029 (incorporated by reference, see § 431.323).

‡ Excludes 150 W fixtures specified in paragraph (b)(3) of this section, that are fixtures rated only for 150 W lamps; rated for use in wet locations, as specified by the NFPA 70, section 410.4(A); and containing a ballast that is rated to operate at ambient air temperatures above 50 °C, as specified by UL 1029.

†† P is defined as the rated wattage of the lamp the fixture is designed to operate.

‡‡ Tested input voltage is specified in 10 CFR 431.324.

(d) Except as provided in paragraph (e) of this section, metal halide lamp fixtures manufactured on or after February 10, 2017, that operate lamps with rated wattage >500 W to ≤1000 W must not contain a probe-start metal halide ballast.

(e) The standards described in paragraphs (c) and (d) of this section do not apply to—

(1) Metal halide lamp fixtures with regulated-lag ballasts;

(2) Metal halide lamp fixtures that use electronic ballasts that operate at 480 volts; and

(3) Metal halide lamp fixtures that use high-frequency electronic ballasts.

[74 FR 12075, Mar. 23, 2009, as amended at 79 FR 7844, Feb. 10, 2014]

Subpart T—Compressors

SOURCE: 81 FR 79998, Nov. 15, 2016, unless otherwise noted.

§ 431.341 Purpose and scope.

This subpart contains and energy conservation requirements for compressors, pursuant to Part A–1 of Title III of the Energy Policy and Conservation Act, as amended, 42 U.S.C. 6311–6317.

§ 431.342 Definitions concerning compressors.

The following definitions are applicable to this subpart, including appendix A. In cases where there is a conflict, the language of the definitions adopted in this section take precedence over any descriptions or definitions found in any other source, including in ISO Standard 1217:2009(E), ''Displacement compressors—Acceptance tests,'' as amended through Amendment 1:2016(E), ''Calculation of isentropic efficiency and relationship with specific energy'' (incorporated by reference, see § 431.343). In cases where definitions reference design intent, DOE will consider all relevant information, including marketing materials, labels and certifications, and equipment design, to determine design intent.

Actual volume flow rate means the volume flow rate of air, compressed and delivered at the standard discharge point, referred to conditions of total temperature, total pressure and composition prevailing at the standard inlet point, and as determined in accordance with the test procedures prescribed in § 431.344.

Air compressor means a compressor designed to compress air that has an inlet open to the atmosphere or other source of air, and is made up of a compression element (bare compressor), driver(s), mechanical equipment to drive the compressor element, and any ancillary equipment.

Air-cooled compressor means a compressor that utilizes air to cool both the compressed air and, if present, any auxiliary substance used to facilitate compression, and that is not a liquid-cooled compressor.

Ancillary equipment means any equipment distributed in commerce with an air compressor but that is not a bare compressor, driver, or mechanical equipment. Ancillary equipment is considered to be part of a given air compressor, regardless of whether the ancillary equipment is physically attached to the bare compressor, driver, or mechanical equipment at the time when the air compressor is distributed in commerce.

Auxiliary substance means any substance deliberately introduced into a compression process to aid in compression of a gas by any of the following: Lubricating, sealing mechanical clearances, or absorbing heat.

Bare compressor means the compression element and auxiliary devices (*e.g.*, inlet and outlet valves, seals, lubrication system, and gas flow paths) required for performing the gas compression process, but does not include any of the following:

(1) The driver;

(2) Speed-adjusting gear(s);

(3) Gas processing apparatuses and piping; and

(4) Compressor equipment packaging and mounting facilities and enclosures.

Basic model means all units of a class of compressors manufactured by one manufacturer, having the same primary energy source, the same compressor motor nominal horsepower, and essentially identical electrical, physical, and functional (or pneumatic) characteristics that affect energy consumption and energy efficiency.

Brushless electric motor means a machine that converts electrical power into rotational mechanical power without use of sliding electrical contacts.

Compressor means a machine or apparatus that converts different types of energy into the potential energy of gas pressure for displacement and compression of gaseous media to any higher pressure values above atmospheric pressure and has a pressure ratio at full-load operating pressure greater than 1.3.

Compressor motor nominal horsepower means the motor horsepower of the electric motor, as determined in accordance with the applicable procedures in subparts B and X of this part, with which the rated air compressor is distributed in commerce.

Driver means the machine providing mechanical input to drive a bare compressor directly or through the use of mechanical equipment.

Fixed-speed compressor means an air compressor that is not capable of adjusting the speed of the driver continuously over the driver operating speed range in response to incremental changes in the required compressor flow rate.

Full-load actual volume flow rate means the actual volume flow rate of the compressor at the full-load operating pressure.

Liquid-cooled compressor means a compressor that utilizes liquid coolant provided by an external system to cool both the compressed air and, if present, any auxiliary substance used to facilitate compression.

Lubricant-free compressor means a compressor that does not introduce any auxiliary substance into the compression chamber at any time during operation.

Lubricated compressor means a compressor that introduces an auxiliary substance into the compression chamber during compression.

Maximum full-flow operating pressure means the maximum discharge pressure at which the compressor is capable of operating, as determined in accordance with the test procedure prescribed in § 431.344.

Mechanical equipment means any component of an air compressor that transfers energy from the driver to the bare compressor.

Package isentropic efficiency means the ratio of power required for an ideal isentropic compression process to the actual packaged compressor power input used at a given load point, as determined in accordance with the test procedures prescribed in § 431.344.

Package specific power means the compressor power input at a given load point, divided by the actual volume flow rate at the same load point, as determined in accordance with the test procedures prescribed in § 431.344.

Positive displacement compressor means a compressor in which the admission and diminution of successive volumes of the gaseous medium are performed periodically by forced expansion and diminution of a closed space(s) in a working chamber(s) by means of displacement of a moving member(s) or by displacement and forced discharge of the gaseous medium into the high-pressure area.

Pressure ratio at full-load operating pressure means the ratio of discharge pressure to inlet pressure, determined at full-load operating pressure in accordance with the test procedures prescribed in § 431.344.

Reciprocating compressor means a positive displacement compressor in which gas admission and diminution of its successive volumes are performed cyclically by straight-line alternating movements of a moving member(s) in a compression chamber(s).

Rotary compressor means a positive displacement compressor in which gas admission and diminution of its successive volumes or its forced discharge are performed cyclically by rotation of one or several rotors in a compressor casing.

Rotor means a compression element that rotates continually in a single direction about a single shaft or axis.

Variable-speed compressor means an air compressor that is capable of adjusting the speed of the driver continuously over the driver operating speed range in response to incremental changes in the required compressor actual volume flow rate.

Water-injected lubricated compressor means a lubricated compressor that uses injected water as an auxiliary substance.

[82 FR 1101, Jan. 4, 2017, as amended at 85 FR 1591, Jan. 10, 2020]

§ 431.343 Materials incorporated by reference.

(a) *General.* DOE incorporates by reference the following standards into part 431. The material listed has been approved for incorporation by reference by the Director of the Federal Register in accordance with 6 U.S.C. 522(a) and 1 CFR part 51. Any subsequent amendment to a standard by the standard-setting organization will not affect the DOE test procedures unless and until amended by DOE. Material is incorporated as it exists on the date of the approval and a notice of any change in the material will be published in the FEDERAL REGISTER. All approved material is available from the sources below. It is available for inspection at U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Program, Sixth Floor, 950 L'Enfant Plaza SW., Washington, DC 20024, (202) 586–6636, or go to *http://www1.eere.energy.gov/buildings/appliance_standards/*. Also, this material is available for inspection at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202–741–6030, or go to: *http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html*.

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(b) *ISO*. International Organization for Standardization, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland +41 22 749 01 11, *www.iso.org*.

(1) ISO Standard 1217:2009(E), (''ISO 1217:2009(E)''), ''Displacement compressors—Acceptance tests,'' July 1, 2009, IBR approved for appendix A to this subpart:

(i) Section 2. Normative references;

(ii) Section 3. Terms and definitions;

(iii) Section 4. Symbols;

(iv) Section 5. Measuring equipment, methods and accuracy (excluding 5.1, 5.5, 5.7, and 5.8);

(v) Section 6. Test procedures, introductory text to Section 6.2, Test arrangements, and paragraphs 6.2(g) and 6.2(h) including Table 1—Maximum deviations from specified values and fluctuations from average readings;

(vi) Annex C (normative), Simplified acceptance test for electrically driven packaged displacement compressors (excluding C.1.2, C.2.1, C.3, C.4.2.2, C.4.3.1, and C.4.5).

(2) ISO 1217:2009/Amd.1:2016(E), Displacement compressors—Acceptance tests (Fourth edition); Amendment 1: ''Calculation of isentropic efficiency and relationship with specific energy,'' April 15, 2016, IBR approved for appendix A to this subpart:

(i) Section 3.5.1: isentropic power;

(ii) Section 3.6.1: isentropic efficiency;

(iii) Annex H (informative), Isentropic efficiency and its relation to specific energy requirement, sections H.2, Symbols and subscripts, and H.3, Derivation of isentropic power.

[82 FR 1102, Jan. 4, 2017]

§ 431.344 Test procedure for measuring and determining energy efficiency of compressors.

(a) *Scope*. This section is a test procedure that is applicable to a compressor that meets the following criteria:

(1) Is an air compressor;

(2) Is a rotary compressor;

(3) Is not a liquid ring compressor;

(4) Is driven by a brushless electric motor;

(5) Is a lubricated compressor;

(6) Has a full-load operating pressure greater than or equal to 75 pounds per square inch gauge (psig) and less than or equal to 200 psig;

(7) Is not designed and tested to the requirements of the American Petroleum Institute Standard 619, ''Rotary-Type Positive-Displacement Compressors for Petroleum, Petrochemical, and Natural Gas Industries;''

(8) Has full-load actual volume flow rate greater than or equal to 35 cubic feet per minute (cfm), or is distributed in commerce with a compressor motor nominal horsepower greater than or equal to 10 horsepower (hp); and

(9) Has a full-load actual volume flow rate less than or equal to 1,250 cfm, or is distributed in commerce with a compressor motor nominal horsepower less than or equal to 200 hp.

(b) *Testing and calculations*. Determine the applicable full-load package isentropic efficiency ($\eta_{isen,FL}$), part-load package isentropic efficiency ($\eta_{isen,PL}$), package specific power, maximum full-flow operating pressure, full-load operating pressure, full-load actual volume flow rate, and pressure ratio at full-load operating pressure using the test procedure set forth in appendix A of this subpart.

[82 FR 1102, Jan. 4, 2017]

§ 431.345 Energy conservation standards and effective dates.

(a) Each compressor that is manufactured starting on January 10, 2025 and that:

(1) Is an air compressor,

(2) Is a rotary compressor,

(3) Is not a liquid ring compressor,

(4) Is driven by a brushless electric motor,

(5) Is a lubricated compressor,

(6) Has a full-load operating pressure greater than or equal to 75 pounds per square inch gauge (psig) and less than or equal to 200 psig,

(7) Is not designed and tested to the requirements of The American Petroleum Institute standard 619, ''Rotary-Type Positive-Displacement Compressors for Petroleum, Petrochemical, and Natural Gas Industries,''

(8) Has full-load actual volume flow rate greater than or equal to 35 cubic feet per minute (cfm), or is distributed in commerce with a compressor motor nominal horsepower greater than or equal to 10 horsepower (hp),

(9) Has a full-load actual volume flow rate less than or equal to 1,250 cfm, or is distributed in commerce with a compressor motor nominal horsepower less than or equal to 200 hp,

(10) Is driven by a three-phase electric motor,

(11) Is manufactured alone or as a component of another piece of equipment; and

(12) Is in one of the equipment classes listed in the Table 1, must have a full-load package isentropic efficiency or part-load package isentropic efficiency that is not less than the appropriate "Minimum Package Isentropic Efficiency" value listed in Table 1 of this section.

TABLE 1—ENERGY CONSERVATION STANDARDS FOR CERTAIN COMPRESSORS

Equipment class	Minimum package isentropic efficiency	η_{Regr} (package isentropic efficiency reference curve)	d (percentage loss reduction)
Rotary, lubricated, air-cooled, fixed-speed compressor.	$\eta_{Regr} + (1 - \eta_{Regr}) * (d/100)$.	$-0.00928 * \ln^2(.4719 * V_1) + 0.13911 * \ln(.4719 * V_1) + 0.27110$.	−15
Rotary, lubricated, air-cooled, variable-speed compressor.	$\eta_{Regr} + (1 - \eta_{Regr}) * (d/100)$.	$-0.01549 * \ln^2(.4719 * V_1) + 0.21573 * \ln(.4719 * V_1) + 0.00905$.	−10
Rotary, lubricated, liquid-cooled, fixed-speed compressor.	$.02349 + \eta_{Regr} + (1 - \eta_{Regr}) * (d/100)$.	$-0.00928 * \ln^2(.4719 * V_1) + 0.13911 * \ln(.4719 * V_1) + 0.27110$.	−15
Rotary, lubricated, liquid-cooled, variable-speed compressor.	$.02349 + \eta_{Regr} + (1 - \eta_{Regr}) * (d/100)$.	$-0.01549 * \ln^2(.4719 * V_1) + 0.21573 * \ln(.4719 * V_1) + 0.00905$.	−15

(b) Instructions for the use of Table 1 of this section:

(1) To determine the standard level a compressor must meet, the correct equipment class must be identified. The descriptions are in the first column ("Equipment Class"); definitions for these descriptions are found in § 431.342.

(2) The second column ("Minimum Package Isentropic Efficiency") contains the applicable energy conservation standard level, provided in terms of package isentropic efficiency.

(3) For "Fixed-speed compressor" equipment classes, the relevant Package Isentropic Efficiency is Full-load Package Isentropic Efficiency. For "Variable-speed compressor" equipment classes, the relevant Package Isentropic Efficiency is Part-load Package Isentropic Efficiency. Both Full- and Part-load Package Isentropic Efficiency are determined in accordance with the test procedure in § 431.344.

(4) The second column ("Minimum Package Isentropic Efficiency") references the third column ("η_{Regr}"), also a function of full-load actual volume flow rate, and the fourth column ("d"). The equations are provided separately to maintain consistency with the language of the preamble and analysis.

(5) The second and third columns contain the term V_1, which denotes compressor full-load actual volume flow rate, given in terms of cubic feet per minute ("cfm") and determined in accordance with the test procedure in § 431.344.

[85 FR 1591, Jan. 10, 2020]

§§ 431.346–431.346 [Reserved]

APPENDIX A TO SUBPART T OF PART 431—UNIFORM TEST METHOD FOR CERTAIN AIR COMPRESSORS

NOTE: Starting on July 3, 2017, any representations made with respect to the energy use or efficiency of compressors subject to testing pursuant to 10 CFR 431.344 must be made in accordance with the results of testing pursuant to this appendix.

I. MEASUREMENTS, TEST CONDITIONS, AND EQUIPMENT CONFIGURATION

A. Measurement Equipment

A.1. For the purposes of measuring air compressor performance, the equipment necessary to measure volume flow rate, inlet and discharge pressure, temperature, condensate, and packaged compressor power input must comply with the equipment and accuracy requirements specified in ISO 1217:2009(E) sections 5.2, 5.3, 5.4, 5.6, 5.9, and Annex C, sections C.2.3 and C.2.4 (incorporated by reference, see §431.343).

A.2. Electrical measurement equipment must be capable of measuring true root mean square (RMS) current, true RMS voltage, and real power up to the 40th harmonic of fundamental supply source frequency.

A.3. Any instruments used to measure a particular parameter specified in paragraph (A.1.) must have a combined accuracy of ±2.0 percent of the measured value at the fundamental supply source frequency, where combined accuracy is the square root of the sum of the squares of individual instrument accuracies.

A.4. Any instruments used to directly measure the density of air must have an accuracy of ±1.0 percent of the measured value.

A.5. Any pressure measurement equipment used in a calculation of another variable (*e.g.*, actual volume flow rate) must also meet all accuracy and measurement requirements of section 5.2 of ISO 1217:2009(E) (incorporated by reference, see §431.343).

A.6. Any temperature measurement equipment used in a calculation of another variable (*e.g.*, actual volume flow rate) must also meet all accuracy and measurement requirements of section 5.3 of ISO 1217:2009(E) (incorporated by reference, see §431.343).

A.7. Where ISO 1217:2009(E) refers to ''corrected volume flow rate,'' the term is deemed synonymous with the term ''actual volume flow rate,'' as defined in section 3.4.1 of ISO 1217:2009(E) (incorporated by reference, see §431.343).

B. Test Conditions and Configuration of Unit Under Test

B.1. For both fixed-speed and variable-speed compressors, conduct testing in accordance with the test conditions, unit configuration, and specifications of ISO 1217:2009(E), Section 6.2 paragraphs (g) and (h) and Annex C, sections C.1.1, C.2.2, C.2.3, C.2.4, C.4.1, C.4.2.1, C.4.2.3, and C.4.3.2 (incorporated by reference, see §431.343).

B.2. The power supply must:

(1) Maintain the voltage greater than or equal to 95 percent and less than or equal to 110 percent of the rated value of the motor,

(2) Maintain the frequency within ±5 percent of the rated value of the motor,

(3) Maintain the voltage unbalance of the power supply within ±3 percent of the rated values of the motor, and

(4) Maintain total harmonic distortion below 12 percent throughout the test.

B.3. Ambient Conditions. The ambient air temperature must be greater than or equal to 68 °F and less than or equal to 90 °F for the duration of testing. There are no ambient condition requirements for inlet pressure or relative humidity.

B.4. All equipment indicated in Table 1 of this appendix must be present and installed for all tests specified in this appendix. If the compressor is distributed in commerce without an item from Table 1 of this appendix, the manufacturer must provide an appropriate item to be installed for the test. Additional ancillary equipment may be installed for the test, if distributed in commerce with the compressor, but this additional ancillary equipment is not required. If any of the equipment listed in Table 2 of this appendix is distributed in commerce with units of the compressor basic model, it must be present and installed for all tests specified in this appendix.

TABLE 1—EQUIPMENT REQUIRED DURING TEST

Equipment	Fixed-speed rotary air compressors	Variable-speed rotary air compressors
Driver	Yes	Yes.
Bare compressors	Yes	Yes.
Inlet filter	Yes	Yes.
Inlet valve	Yes	Yes.
Minimum pressure check valve/backflow check valve	Yes	Yes.
Lubricant separator	Yes	Yes.
Air piping	Yes	Yes.
Lubricant piping	Yes	Yes.
Lubricant filter	Yes	Yes.
Lubricant cooler	Yes	Yes.
Thermostatic valve	Yes	Yes.
Electrical switchgear or frequency converter for the driver	Yes	Not applicable.[1]
Device to control the speed of the driver (e.g., variable speed drive)	Not applicable[2]	Yes.
Compressed air cooler(s)	Yes	Yes.
Pressure switch, pressure transducer, or similar pressure control device.	Yes	Yes.
Moisture separator and drain	Yes	Yes.

[1] This category is not applicable to variable-speed rotary air compressors.
[2] This category is not applicable to fixed-speed rotary air compressors.

TABLE 2—EQUIPMENT REQUIRED DURING TEST, IF DISTRIBUTED IN COMMERCE WITH THE BASIC MODEL

Equipment	Fixed-speed rotary air compressors	Variable-speed rotary air compressors
Cooling fan(s) and motors	Yes	Yes.
Mechanical equipment	Yes	Yes.
Lubricant pump	Yes	Yes.
Interstage cooler	Yes	Yes.
Electronic or electrical controls and user interface	Yes	Yes.
All protective and safety devices	Yes	Yes.

B.5. The inlet of the compressor under test must be open to the atmosphere and take in ambient air for all tests specified in this appendix.

B.6. The compressor under test must be set up according to all manufacturer instructions for normal operation (*e.g.*, verify lubricant level, connect all loose electrical connections, close off bottom of unit to floor, cover forklift holes).

B.7. The piping connected to the discharge orifice of the compressor must be of a diameter at least equal to that of the compressor discharge orifice to which it is connected. The piping must be straight with a length of at least 6 inches.

B.8. Transducers used to record compressor discharge pressure must be located on the discharge piping between 2 inches and 6 inches, inclusive, from the discharge orifice of the compressor. The pressure tap for transducers must be located at the highest point of the pipe's cross section.

II. DETERMINATION OF PACKAGE ISENTROPIC EFFICIENCY, PACKAGE SPECIFIC POWER, AND PRESSURE RATIO AT FULL-LOAD OPERATING PRESSURE

A. Data Collection and Analysis

A.1. Stabilization. Record data at each load point under steady-state conditions. Steady-state conditions are achieved when a set of two consecutive readings taken at least 10 seconds apart and no more than 60 seconds apart are within the maximum permissible fluctuation from the average (of the two consecutive readings), as specified in Table 1 of ISO 1217:2009(E) (incorporated by reference, see § 431.343) for—

(1) Discharge pressure;

(2) Temperature at the nozzle or orifice plate, measured per section 5.3 of ISO 1217:2009(E) (incorporated by reference, see § 431.343); and

(3) Differential pressure over the nozzle or orifice plate, measured per section 5.2 of ISO 1217:2009(E) (incorporated by reference, see § 431.343).

A.2. Data Sampling and Frequency. At each load point, record a minimum set of 16 unique readings, collected over a minimum time of 15 minutes. Each consecutive reading must be no more than 60 seconds apart, and not less than 10 seconds apart. All readings at each load point must be within the maximum permissible fluctuation from average specified in Table 1 of ISO 1217:2009(E) (incorporated by reference, see § 431.343) for—

(1) Discharge pressure;

(2) Temperature at the nozzle or orifice plate, measured per section 5.3 of ISO 1217:2009(E) (incorporated by reference, see § 431.343); and

(3) Differential pressure over the nozzle or orifice plate, measured per section 5.2 of ISO 1217:2009(E) (incorporated by reference, see § 431.343).

If one or more readings do not meet the requirements, then all previous readings must be disregarded and a new set of at least 16 new unique readings must be collected over a minimum time of 15 minutes. Average the readings to determine the value of each parameter to be used in subsequent calculations.

A.3. Calculations and Rounding. Perform all calculations using raw measured values. Round the final result for package isentropic efficiency to the thousandth (*i.e.*, 0.001), for package specific power in kilowatts per 100 cubic feet per minute to the nearest hundredth (*i.e.*, 0.01), for pressure ratio at full-load operating pressure to the nearest tenth (*i.e.*, 0.1), for full-load actual volume flow rate in cubic feet per minute to the nearest tenth (*i.e.*, 0.1), and for full-load operating pressure in pounds per square inch gauge (psig) to the nearest integer (*i.e.*, 1). All terms and quantities refer to values determined in accordance with the procedures set forth in this appendix for the tested unit.

B. Full-Load Operating Pressure and Full-Load Actual Volume Flow Rate

Determine the full-load operating pressure and full-load actual volume flow rate (referenced throughout this appendix) in accordance with the procedures prescribed in section III of this appendix.

C. Full-Load Package Isentropic Efficiency for Fixed- and Variable-Speed Air Compressors

Use this test method to test fixed-speed air compressors and variable-speed air compressors.

C.1. Test unit at full-load operating pressure and full-load volume flow rate according to the requirements established in sections I, II.A, and II.B of this appendix. Measure volume flow rate and calculate actual volume flow rate in accordance with section C.4.2.1 of Annex C of ISO 1217:2009(E) (incorporated by reference, see § 431.343) with no corrections made for shaft speed. Measure discharge gauge pressure and packaged compressor power input. Measured discharge gauge pressure and calculated actual volume flow rate must be within the deviation limits for discharge pressure and volume flow rate specified in Tables C.1 and C.2 of Annex C of ISO 1217:2009(E) (incorporated by reference, see § 431.343), where full-load operating pressure and full-load actual volume flow rate (as determined in section III of this appendix) are the targeted values.

C.2. Calculate the package isentropic efficiency at full-load operating pressure and full-load actual volume flow rate (full-load package isentropic efficiency, $\eta_{isen,FL}$) using the equation for isentropic efficiency in section 3.6.1 of ISO 1217:2009(E) as modified by ISO 1217:2009/Amd.1:2016(E) (incorporated by reference, see § 431.343). For P_{isen}, use the isentropic power required for compression at full-load operating pressure and full-load actual volume flow rate, as determined in section II.C.2.1 of this appendix. For P_{real}, use the real packaged compressor power input at full-load operating pressure and full-load actual volume flow rate, as determined in section II.C.2.2 of this appendix.

C.2.1. Calculate the isentropic power required for compression at full-load operating pressure and full-load actual volume flow rate using equation (H.6) of Annex H of ISO 1217:2009/Amd.1:2016(E) (incorporated by reference, see § 431.343). For q_{V1}, use the actual volume flow rate (cubic meters per second) calculated in section II.C.1 of this appendix. For p_1, use 100 kPa. For p_2, use the sum of (a) 100 kPa, and (b) the measured discharge gauge pressure (Pa) from section II.C.1 of this appendix. For K, use the isentropic exponent (ratio of specific heats) of air, which, for the purposes of this test procedure, is 1.400.

C.2.2. Calculate real packaged compressor power input at full-load operating pressure and full-load actual volume flow rate using the following equation:

$$P_{real,100\%} = K_5 \cdot P_{PR,100\%}$$

Where:

K_5 = correction factor for inlet pressure, as determined in section C.4.3.2 of Annex C to ISO 1217:2009(E) (incorporated by reference, see § 431.343). For calculations of this variable use a value of 100 kPa for contractual inlet pressure; and

$P_{PR,100\%}$ = packaged compressor power input reading at full-load operating pressure and full-load actual volume flow rate measured in section II.C.1 of this appendix (W).

D. Part-Load Package Isentropic Efficiency for Variable-Speed Air Compressors

Use this test method to test variable-speed air compressors.

D.1. Test unit at two load points: (1) Full-load operating pressure and 70 percent of full-load actual volume flow rate and (2) full-load operating pressure and 40 percent of full-load actual volume flow rate, according to the requirements established in sections I, II.A, and II.B of this appendix. To reach each specified load point, adjust the speed of the driver and the backpressure of the system. For each load point, measure volume flow rate and calculate actual volume flow rate in accordance with section C.4.2.1 of Annex C of ISO 1217:2009(E) (incorporated by reference, see § 431.343), with no corrections made for shaft speed. For each load point, measure discharge gauge pressure and packaged compressor power input. Measured discharge gauge pressure and calculated actual volume flow rate must be within the deviation limits for discharge pressure and volume flow rate specified in Tables C.1 and C.2 of Annex C of ISO 1217:2009(E), where the targeted values are as specified in the beginning of this section.

D.2. For variable-speed compressors, calculate the part-load package isentropic efficiency using the following equation:

$$\eta_{isen,PL} = \omega_{40\%} \times \eta_{isen,40\%} + \omega_{70\%} \times \eta_{isen,70\%} + \omega_{100\%} \times \eta_{isen,100\%}$$

Where:

$\eta_{isen,PL}$ = part-load package isentropic efficiency for a variable-speed compressor;

$\eta_{isen,100\%}$ = package isentropic efficiency at full-load operating pressure and 100 percent of full-load actual volume flow rate, as determined in section II.C.2 of this appendix;

$\eta_{isen,70\%}$ = package isentropic efficiency at full-load operating pressure and 70 percent of full-load actual volume flow rate, as determined in section II.D.3 of this appendix;

$\eta_{isen,40\%}$ = package isentropic efficiency at full-load operating pressure and 40 percent of full-load actual volume flow rate, as determined in section II.D.4 of this appendix;

$\omega_{40\%}$ = weighting at 40 percent of full-load actual volume flow rate and is 0.25;

$\omega_{70\%}$ = weighting at 70 percent of full-load actual volume flow rate and is 0.50; and

$\omega_{100\%}$ = weighting at 100 percent of full-load actual volume flow rate and is 0.25.

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D.3. Calculate package isentropic efficiency at full-load operating pressure and 70 percent of full-load actual volume flow rate using the equation for isentropic efficiency in section 3.6.1 of ISO 1217:2009(E) as modified by ISO 1217:2009/Amd.1:2016(E) (incorporated by reference, see § 431.343). For P_{isen}, use the isentropic power required for compression at full-load operating pressure and 70 percent of full-load actual volume flow rate, as determined in section II.D.3.1 of this appendix. For P_{real}, use the real packaged compressor power input at full-load operating pressure and 70 percent of full-load actual volume flow rate, as determined in section II.D.3.2 of this appendix.

D.3.1. Calculate the isentropic power required for compression at full-load operating pressure and 70 percent of full-load actual volume flow rate using equation (H.6) of Annex H of ISO 1217:2009/Amd.1:2016(E) (incorporated by reference, see § 431.343). For q_{V1}, use actual volume flow rate (cubic meters per second) at full-load operating pressure and 70 percent of full-load actual volume flow rate, as calculated in section II.D.1 of this appendix. For p_1, use 100 kPa. For p_2, use the sum of (a) 100 kPa, and (b) discharge gauge pressure (Pa) at full-load operating pressure and 70 percent of full-load actual volume flow rate, as calculated in section II.D.1 of this appendix. For K, use the isentropic exponent (ratio of specific heats) of air, which, for the purposes of this test procedure, is 1.400.

D.3.2. Calculate real packaged compressor power input at full-load operating pressure and 70 percent of full-load actual volume flow rate using the following equation:

$$P_{real,70\%} = K_5 \cdot P_{PR,70\%}$$

Where:

K_5 = correction factor for inlet pressure, as determined in section C.4.3.2 of Annex C to ISO 1217:2009(E) (incorporated by reference, see § 431.343). For calculations of this variable use a value of 100 kPa for contractual inlet pressure; and

$P_{PR,70\%}$ = packaged compressor power input reading at full-load operating pressure and 70 percent of full-load actual volume flow rate, as measured in section II.D.1 of this appendix (W).

D.4. Calculate package isentropic efficiency at full-load operating pressure and 40 percent of full-load actual volume flow rate using the equation for isentropic efficiency in section 3.6.1 of ISO 1217:2009(E) as modified by ISO 1217:2009/Amd.1:2016(E) (incorporated by reference, see § 431.343). For $P_{isen,}$ use the isentropic power required for compression at full-load operating pressure and 40 percent of full-load actual volume flow rate, as determined in section II.D.4.1 of this appendix. For $P_{real,}$ use the real packaged compressor power input at full-load operating pressure and 40 percent of full-load actual volume flow rate, as determined in section II.D.4.2 of this appendix.

D.4.1. Calculate the isentropic power required for compression at full-load operating pressure and 40 percent of full-load actual volume flow rate using equation (H.6) of Annex H of ISO 1217:2009/Amd.1:2016(E) (incorporated by reference, see § 431.343). For q_{V1}, use actual volume flow rate (cubic meters per second) at full-load operating pressure and 40 percent of full-load actual volume flow rate, as calculated in section II.D.1 of this appendix. For p_1, use 100 kPa. For p_2, use the sum of (a) 100 kPa, and (b) discharge gauge pressure (Pa) at full-load operating pressure and 40 percent of full-load actual volume flow rate, as calculated in section II.D.1 of this appendix. For K, use the isentropic exponent (ratio of specific heats) of air, which, for the purposes of this test procedure, is 1.400.

D.4.2. Calculate real packaged compressor power input at full-load operating pressure and 40 percent of full-load actual volume flow rate using the following equation:

$$P_{real,40\%} = K_5 \cdot P_{PR,40\neq}$$

Where:

K_5 = correction factor for inlet pressure, as determined in section C.4.3.2 of Annex C to ISO 1217:2009(E) (incorporated by reference, see § 431.343). For calculations of this variable use a value of 100 kPa for contractual inlet pressure; and

$P_{PR,40\%}$ = packaged compressor power input reading at full-load operating pressure and 40 percent of full-load actual volume flow rate, as measured in section II.D.1 of this appendix (W).

E. Determination of Package Specific Power

For both fixed and variable-speed air compressors, determine the package specific power, at any load point, using the equation for specific energy consumption in section C.4.4 of Annex C of ISO 1217:2009(E) (incorporated by reference, see § 431.343) and other values measured pursuant to this appendix, with no correction for shaft speed. Calculate P_{Pcorr} in section C.4.4 of Annex C of ISO 1217:2009(E) (incorporated by reference, see § 431.343) using the following equation:

$$P_{Pcorr} = K_5 \cdot P_{PR}$$

Where:

K_5 = correction factor for inlet pressure, as determined in section C.4.3.2 of Annex C to ISO 1217:2009(E) (incorporated by reference, see § 431.343). For calculations of this variable use a value of 100 kPa for contractual inlet pressure; and

P_{PR} = packaged compressor power input reading (W), as determined in section C.2.4 of Annex C to ISO 1217:2009(E) (incorporated by reference, see § 431.343).

F. Determination of Pressure Ratio at Full-Load Operating Pressure

Pressure ratio at full-load operating pressure, as defined in § 431.342, is calculated using the following equation:

$$LCL = \bar{x} - t_{0.95}\left(\frac{s}{\sqrt{n}}\right)$$

Where:

PR = pressure ratio at full-load operating pressure;

p_I = 100 kPa; and

p_{FL} = full-load operating pressure, determined in section III.C.4 of this appendix (Pa gauge).

III. METHOD TO DETERMINE MAXIMUM FULL-FLOW OPERATING PRESSURE, FULL-LOAD OPERATING PRESSURE, AND FULL-LOAD ACTUAL VOLUME FLOW RATE

A. Principal Strategy

The principal strategy of this method is to incrementally increase discharge pressure by 2 psig relative to a starting point, and identify the maximum full-flow operating pressure at which the compressor is capable of operating. The maximum discharge pressure achieved is the maximum full-flow operating pressure. The full-load operating pressure and full-load actual volume flow rate are determined based on the maximum full-flow operating pressure.

B. Pre-test Instructions

B.1. Safety

For the method presented in section III.C.1 of this appendix, only test discharge pressure within the safe operating range of the compressor, as specified by the manufacturer in the installation and operation manual shipped with the unit. Make no changes to safety limits or equipment. Do not violate any manufacturer-provided motor operational guidelines for normal use, including any restriction on instantaneous and continuous input power draw and output shaft power (*e.g.*, electrical rating and service factor limits).

B.2. Adjustment of Discharge Pressure

B.2.1. If the air compressor is not equipped, as distributed in commerce by the manufacturer, with any mechanism to adjust the maximum discharge pressure output limit, proceed to section III.B.3 of this appendix.

B.2.2. If the air compressor is equipped, as distributed in commerce by the manufacturer, with any mechanism to adjust the maximum discharge pressure output limit, then adjust this mechanism to the maximum pressure allowed, according to the manufacturer's operating instructions for these mechanisms. Mechanisms to adjust discharge pressure may include, but are not limited to, onboard digital or analog controls, and user-adjustable inlet valves.

B.3. Driver speed

If the unit under test is a variable-speed compressor, maintain maximum driver speed throughout the test. If the unit under test is a fixed-speed compressor with a multi-speed driver, maintain driver speed at the maximum speed throughout the test.

B.4. Measurements and Tolerances

B.4.1. Recording

Record data by electronic means such that the requirements of section B.4.5 of section III of this appendix are met.

B.4.2. Discharge Pressure

Measure discharge pressure in accordance with section 5.2 of ISO 1217:2009(E) (incorporated by reference, see § 431.343). Express compressor discharge pressure in psig in reference to ambient conditions, and record it to the nearest integer. Specify targeted discharge pressure points in integer values only. The maximum allowable measured deviation from the targeted discharge pressure at each tested point is ±1 psig.

B.4.3. Actual Volume Flow Rate

Measure actual volume flow rate in accordance with section C.4.2.1 of Annex C of ISO 1217:2009(E) (incorporated by reference, see § 431.343) (where it is called "corrected volume flow rate") with no corrections made for shaft speed. Express compressor actual volume flow rate in cubic feet per minute at inlet conditions (cfm).

B.4.4. Stabilization

Record data at each tested load point under steady-state conditions, as determined in section II.A.1 of this appendix.

B.4.5. Data Sampling and Frequency

At each load point, record a set of at least of two readings, collected at a minimum of 10 seconds apart. All readings at each load point must be within the maximum permissible fluctuation from the average (of the two consecutive readings), as specified in II.A.2 of this appendix. Average the measurements to determine the value of each parameter to be used in subsequent calculations.

B.5. Adjusting System Backpressure

Set up the unit under test so that backpressure on the unit can be adjusted (*e.g.*, by valves) incrementally, causing the measured discharge pressure to change, until the compressor is in an unloaded condition.

B.6. Unloaded Condition

A unit is considered to be in an unloaded condition if capacity controls on the unit automatically reduce the actual volume flow rate from the compressor (*e.g.*, shutting the motor off, or unloading by adjusting valves).

C. Test Instructions

C.1. Adjust the backpressure of the system so the measured discharge pressure is 90 percent of the expected maximum full-flow operating pressure, rounded to the nearest integer, in psig. If the expected maximum full-flow operating pressure is not known, then adjust the backpressure of the system so that the measured discharge pressure is 65 psig. Allow the unit to remain at this setting for 15 minutes to allow the unit to thermally stabilize. Then measure and record discharge pressure and actual volume flow rate at the starting pressure.

C.2. Adjust the backpressure of the system to increase the discharge pressure by 2 psig from the previous value, allow the unit to remain at this setting for a minimum of 2 minutes, and proceed to section III.C.3 of this appendix.

C.3. If the unit is now in an unloaded condition, end the test and proceed to section III.C.4 of this appendix. If the unit is not in an unloaded condition, measure discharge pressure and actual volume flow rate, and repeat section III.C.2 of this appendix.

C.4. Of the discharge pressures recorded under stabilized conditions in sections III.C.1 through III.C.3 of this appendix, identify the largest. This is the maximum full-flow operating pressure. Determine the full-load operating pressure as a self-declared value greater than or equal to the lesser of (A) 90 percent of the maximum full-flow operating pressure, or (B) 10 psig less than the maximum full-flow operating pressure.

C.5. The full-load actual volume flow rate is the actual volume flow rate measured at the full-load operating pressure. If the self-declared full-load operating pressure falls on a previously tested value of discharge pressure, then use the previously measured actual volume flow rate as the full-load actual volume flow rate. If the self-declared full-load operating pressure does not fall on a previously tested value of discharge pressure, then adjust the backpressure of the system to the self-declared full-load operating pressure and allow the unit to remain at this setting for a minimum of 2 minutes. The measured actual volume flow rate at this setting is the full-load actual volume flow rate.

[82 FR 1102, Jan. 4, 2017]

Subpart U—Enforcement for Electric Motors

SOURCE: 69 FR 61941, Oct. 21, 2004, unless otherwise noted. Redesignated at 70 FR 60416, Oct. 18, 2005.

§ 431.381 Purpose and scope for electric motors.

This subpart describes violations of EPCA's energy conservation requirements, specific procedures we will follow in pursuing alleged non-compliance of an electric motor with an applicable energy conservation standard or labeling requirement, and general procedures for enforcement action, largely drawn directly from EPCA, that apply to electric motors.

[76 FR 12505, Mar. 7, 2011]

§ 431.382 Prohibited acts.

(a) Each of the following is a prohibited act under sections 332 and 345 of the Act:

(1) Distribution in commerce by a manufacturer or private labeler of any ''new covered equipment'' which is not labeled in accordance with an applicable labeling rule prescribed in accordance with Section 344 of the Act, and in this part;

(2) Removal from any ''new covered equipment'' or rendering illegible, by a manufacturer, distributor, retailer, or private labeler, of any label required under this part to be provided with such covered equipment;

(3) Failure to permit access to, or copying of records required to be supplied under the Act and this part, or failure to make reports or provide other information required to be supplied under the Act and this part;

(4) Advertisement of an electric motor or motors, by a manufacturer, distributor, retailer, or private labeler, in a catalog from which the equipment may be purchased, without including in the catalog all information as required by § 431.31(b)(1), provided, however, that this shall not apply to an advertisement of an electric motor in a catalog if distribution of the catalog began before the effective date of the labeling rule applicable to that motor;

(5) Failure of a manufacturer to supply at his expense a reasonable number of units of covered equipment to a test laboratory designated by the Secretary;

(6) Failure of a manufacturer to permit a representative designated by the Secretary to observe any testing required by the Act and this part, and to inspect the results of such testing; and

(7) Distribution in commerce by a manufacturer or private labeler of any new covered equipment which is not in compliance with an applicable energy efficiency standard prescribed under the Act and this part.

(b) In accordance with sections 333 and 345 of the Act, any person who knowingly violates any provision of paragraph (a) of this section may be subject to assessment of a civil penalty of no more than $503 for each violation.

(c) For purposes of this section:

(1) The term ''new covered equipment'' means covered equipment the title of which has not passed to a purchaser who buys such product for purposes other than:

(i) Reselling it; or

(ii) Leasing it for a period in excess of one year; and

(2) The term ''knowingly'' means:

(i) Having actual knowledge; or

(ii) Presumed to have knowledge deemed to be possessed by a reasonable person who acts in the circumstances, including knowledge obtainable upon the exercise of due care.

[69 FR 61941, Oct. 21, 2004. Redesignated at 70 FR 60416, Oct. 18, 2005, as amended at 79 FR 19, Jan. 2, 2014; 81 FR 41794, June 28, 2016; 81 FR 96351, Dec. 30, 2016; 83 FR 1291, Jan. 11, 2018; 83 FR 66083, Dec. 26, 2018; 85 FR 830, Jan. 8, 2020; 86 FR 2955, Jan. 14, 2021; 87 FR 1063, Jan. 10, 2022]

§ 431.383 Enforcement process for electric motors.

(a) *Test notice.* Upon receiving information in writing, concerning the energy performance of a particular electric motor sold by a particular manufacturer or private labeler, which indicates that the electric motor may not be in compliance with the applicable energy efficiency standard, or upon undertaking to ascertain the accuracy of the efficiency rating on the nameplate or in marketing materials for an electric motor, disclosed pursuant to subpart B of this part, the Secretary may conduct testing of that electric motor under this subpart by means of a test notice addressed to the manufacturer in accordance with the following requirements:

(1) The test notice procedure will only be followed after the Secretary or his/her designated representative has examined the underlying test data (or, where appropriate, data as to use of an alternative efficiency determination method) provided by the manufacturer and after the manufacturer has been offered the opportunity to meet with the Department to verify, as applicable, compliance with the applicable efficiency standard, or the accuracy of labeling information, or both. In addition, where compliance of a basic model was certified based on an AEDM, the Department shall have the discretion to pursue the provisions of § 431.17(a)(4)(iii) prior to invoking the test notice procedure. A representative designated by the Secretary shall be permitted to observe any reverification procedures undertaken pursuant to this subpart, and to inspect the results of such reverification.

(2) The test notice will be signed by the Secretary or his/her designee. The test notice will be mailed or delivered by the Department to the plant manager or other responsible official, as designated by the manufacturer.

(3) The test notice will specify the model or basic model to be selected for testing, the method of selecting the test sample, the date and time at which testing shall be initiated, the date by which testing is scheduled to be completed and the facility at which testing will be conducted. The test notice may also provide for situations in

which the specified basic model is unavailable for testing, and may include alternative basic models.

(4) The Secretary may require in the test notice that the manufacturer of an electric motor shall ship at his expense a reasonable number of units of a basic model specified in such test notice to a testing laboratory designated by the Secretary. The number of units of a basic model specified in a test notice shall not exceed 20.

(5) Within five working days of the time the units are selected, the manufacturer shall ship the specified test units of a basic model to the testing laboratory.

(b) *Testing laboratory*. Whenever the Department conducts enforcement testing at a designated laboratory in accordance with a test notice under this section, the resulting test data shall constitute official test data for that basic model. Such test data will be used by the Department to make a determination of compliance or noncompliance if a sufficient number of tests have been conducted to satisfy the requirements of appendix A of this subpart.

(c) *Sampling*. The determination that a manufacturer's basic model complies with its labeled efficiency, or the applicable energy efficiency standard, shall be based on the testing conducted in accordance with the statistical sampling procedures set forth in appendix A of this subpart and the test procedures set forth in appendix B to subpart B of this part.

(d) *Test unit selection*. A Department inspector shall select a batch, a batch sample, and test units from the batch sample in accordance with the provisions of this paragraph and the conditions specified in the test notice.

(1) The batch may be subdivided by the Department utilizing criteria specified in the test notice.

(2) A batch sample of up to 20 units will then be randomly selected from one or more subdivided groups within the batch. The manufacturer shall keep on hand all units in the batch sample until such time as the basic model is determined to be in compliance or noncompliance.

(3) Individual test units comprising the test sample shall be randomly selected from the batch sample.

(4) All random selection shall be achieved by sequentially numbering all of the units in a batch sample and then using a table of random numbers to select the units to be tested.

(e) *Test unit preparation*. (1) Prior to and during the testing, a test unit selected in accordance with paragraph (d) of this section shall not be prepared, modified, or adjusted in any manner unless such preparation, modification, or adjustment is allowed by the applicable Department of Energy test procedure. One test shall be conducted for each test unit in accordance with the applicable test procedures prescribed in appendix B to subpart B of this part.

(2) No quality control, testing, or assembly procedures shall be performed on a test unit, or any parts and sub-assemblies thereof, that is not performed during the production and assembly of all other units included in the basic model.

(3) A test unit shall be considered defective if such unit is inoperative or is found to be in noncompliance due to failure of the unit to operate according to the manufacturer's design and operating instructions. Defective units, including those damaged due to shipping or handling, shall be reported immediately to the Department. The Department shall authorize testing of an additional unit on a case-by-case basis.

(4)(i) *Non-standard endshields or flanges*. For purposes of DOE-initiated testing of electric motors with non-standard endshields or flanges, the Department will have the discretion to determine whether the lab should test a general purpose electric motor of equivalent electrical design and enclosure rather than replacing the non-standard flange or endshield.

(ii) *Partial electric motors*. For purposes of DOE-initiated testing, the Department has the discretion to determine whether the lab should test a general purpose electric motor of equivalent electrical design and enclosure rather than machining and attaching an endshield.

(f) *Testing at manufacturer's option*. (1) If a manufacturer's basic model is determined to be in noncompliance with the applicable energy performance standard at the conclusion of Department testing in accordance with the sampling plan specified in appendix A of this subpart, the manufacturer may request that the Department conduct additional testing of the basic model according to procedures set forth in appendix A of this subpart.

(2) All units tested under this paragraph shall be selected and tested in accordance with the provisions given in paragraphs (a) through (e) of this section.

(3) The manufacturer shall bear the cost of all testing conducted under this paragraph.

(4) The manufacturer shall cease distribution of the basic model tested under the provisions of this paragraph from the time the manufacturer elects to exercise the option provided in this paragraph until the basic model is determined to be in compliance. The Department may seek civil penalties for all units distributed during such period.

(5) If the additional testing results in a determination of compliance, a notice of allowance to resume distribution shall be issued by the Department.

[69 FR 61941, Oct. 21, 2004. Redesignated at 70 FR 60416, Oct. 18, 2005, as amended at 78 FR 75995, Dec. 13, 2013]

§ 431.384 [Reserved]

§ 431.385 Cessation of distribution of a basic model of an electric motor.

(a) In the event that a model of an electric motor is determined non-compliant by the Department in accordance with § 431.192 or if a manufacturer or private labeler determines a model of an electric motor to be in noncompliance, then the manufacturer or private labeler shall:

(1) Immediately cease distribution in commerce of the basic model.

(2) Give immediate written notification of the determination of noncompliance, to all persons to whom the manufacturer has distributed units of the basic model manufactured since the date of the last determination of compliance.

(3) Pursuant to a request made by the Secretary, provide the Department within 30 days of the request, records, reports, and other documentation pertaining to the acquisition, ordering, storage, shipment, or sale of a basic model determined to be in noncompliance.

(4) The manufacturer may modify the non-compliant basic model in such manner as to make it comply with the applicable performance standard. Such modified basic model shall then be treated as a new basic model and must be certified in accordance with the provisions of this subpart; except that in addition to satisfying all requirements of this subpart, the manufacturer shall also maintain records that demonstrate that modifications have been made to all units of the new basic model prior to distribution in commerce.

(b) If a basic model is not properly certified in accordance with the requirements of this subpart, the Secretary may seek, among other remedies, injunctive action to prohibit distribution in commerce of such basic model.

§ 431.386 Remedies.

If the Secretary determines that a basic model of any covered equipment does not comply with an applicable energy conservation standard:

(a) The Secretary will notify the manufacturer, private labeler, or any other person as required, of this finding and of the Secretary's intent to seek a judicial order restraining further distribution in commerce of units of such a basic model unless the manufacturer, private labeler or other person as required, delivers, within 15 calendar days, a satisfactory statement to the Secretary, of the steps the manufacturer, private labeler or other person will take to insure that the noncompliant basic model will no longer be distributed in commerce. The Secretary will monitor the implementation of such statement.

(b) If the manufacturer, private labeler or any other person as required, fails to stop distribution of the noncompliant basic model, the Secretary may seek to restrain such violation in accordance with sections 334 and 345 of the Act.

(c) The Secretary will determine whether the facts of the case warrant the assessment of civil penalties for knowing violations in accordance with sections 333 and 345 of the Act.

§ 431.387 Hearings and appeals.

(a) Under sections 333(d) and 345 of the Act, before issuing an order assessing a civil penalty against any person, the Secretary must provide to such a person a notice of the proposed penalty. Such notice must inform the person that such person can choose (in writing within 30 days after receipt of the notice) to have the procedures of paragraph (c) of this section (in lieu of those in paragraph (b) of this section) apply with respect to such assessment.

(b)(1) Unless a person elects, within 30 calendar days after receipt of a notice under paragraph (a) of this section, to have paragraph (c) of this section apply with respect to the civil penalty under paragraph (a), the Secretary will assess the penalty, by order, after providing an opportunity for an agency hearing under 5 U.S.C. 554, before an administrative law judge appointed under 5 U.S.C. 3105, and making a determination of violation on the record. Such assessment order will include the administrative law judge's findings and the basis for such assessment.

(2) Any person against whom the Secretary assesses a penalty under this paragraph may, within 60 calendar days after the date of the order assessing such penalty, initiate action in the United States Court of Appeals for the appropriate judicial circuit for judicial review of such order in accordance with 5 U.S.C. chapter 7. The court will have jurisdiction to enter a judgment affirming, modifying, or setting aside in whole or in part, the order of the Secretary, or the court may remand the proceeding to the Secretary for such further action as the court may direct.

(c)(1) In the case of any civil penalty with respect to which the procedures of this paragraph have been elected, the Secretary will promptly assess such penalty, by order, after the date of the receipt of the notice under paragraph (a) of this section of the proposed penalty.

(2) If the person has not paid the civil penalty within 60 calendar days after the assessment has been made under paragraph (c)(1) of this section, the Secretary will institute an action in the appropriate District Court of the United States for an order affirming the assessment of the civil penalty. The court will have authority to review de novo the law and the facts involved and jurisdiction to enter a judgment enforcing, modifying, and enforcing as so modified, or setting aside in whole or in part, such assessment.

(3) Any election to have this paragraph apply can only be revoked with the consent of the Secretary.

(d) If any person fails to pay an assessment of a civil penalty after it has become a final and unappealable order under paragraph (b) of this section, or after the appropriate District Court has entered final judgment in favor of the Secretary under paragraph (c) of this section, the Secretary will institute an action to recover the amount of such penalty in any appropriate District Court of the United States. In such action, the validity and appropriateness of such final assessment order or judgment will not be subject to review.

(e)(1) In accordance with the provisions of sections 333(d)(5)(A) and 345 of the Act and notwithstanding the provisions of title 28, United States Code, or Section 502(c) of the Department of Energy Organization Act, the General Counsel of the Department of Energy (or any attorney or attorneys within DOE designated by the Secretary) will represent the Secretary, and will supervise, conduct, and argue any civil litigation to which paragraph (c) of this section applies (including any related collection action under paragraph (d) of this section) in a court of the United States or in any other court, except the Supreme Court of the United States. However, the Secretary or the General Counsel will consult with the Attorney General concerning such litigation and the Attorney General will provide, on request, such assistance in the conduct of such litigation as may be appropriate.

(2) In accordance with the provisions of sections 333(d)(5)(B) and 345 of the Act, and subject to the provisions of Section 502(c) of the Department of Energy Organization Act, the Secretary will be represented by the Attorney General, or the Solicitor General, as

appropriate, in actions under this section, except to the extent provided in paragraph (e)(1) of this section.

(3) In accordance with the provisions of Section 333(d)(5)(c) and 345 of the Act, Section 402(d) of the Department of Energy Organization Act will not apply with respect to the function of the Secretary under this section.

APPENDIX A TO SUBPART U OF PART 431—SAMPLING PLAN FOR ENFORCEMENT TESTING OF ELECTRIC MOTORS

Step 1. The first sample size (n_1) must be five or more units.

Step 2. Compute the mean ($\bar{X}_1$ of the measured energy performance of the n_1 units in the first sample as follows:

$$\overline{X}_1 = \frac{1}{n_1}\sum_{i=1}^{n_1} X_i \qquad (1)$$

where X_i is the measured full-load efficiency of unit i.

Step 3. Compute the sample standard deviation (S_1) of the measured full-load efficiency of the n_1 units in the first sample as follows:

$$S_1 = \sqrt{\frac{\sum_{i=1}^{n_1}\left(X_i - \overline{X}_1\right)^2}{n_1 - 1}} \qquad (2)$$

Step 4. Compute the standard error ($SE(\bar{X}_1)$) of the mean full-load efficiency of the first sample as follows:

$$SE\left(\overline{X}_1\right) = \frac{S_1}{\sqrt{n_1}} \qquad (3)$$

Step 5. Compute the lower control limit (LCL_1) for the mean of the first sample using RE as the desired mean as follows:

$$LCL_1 = RE - tSE\left(\overline{X}_1\right) \qquad (4)$$

where: RE is the applicable EPCA nominal full-load efficiency when the test is to determine compliance with the applicable statutory standard, or is the labeled nominal full-load efficiency when the test is to determine compliance with the labeled efficiency value, and t is the 2.5th percentile of a t-distribution for a sample size of n_1, which yields a 97.5 percent confidence level for a one-tailed t-test.

Step 6. Compare the mean of the first sample ($\bar{X}_1$) with the lower control limit (LCL_1) to determine one of the following:

(i) If the mean of the first sample is below the lower control limit, then the basic model is in non-compliance and testing is at an end.

(ii) If the mean is equal to or greater than the lower control limit, no final determination of compliance or non-compliance can be made; proceed to Step 7.

Step 7. Determine the recommended sample size (n) as follows:

$$n = \left[\frac{tS_1(120 - 0.2RE)}{RE\,(20 - 0.2RE)}\right]^2 \qquad (5)$$

where S_1, RE and t have the values used in Steps 3 and 5, respectively. The factor

$$\frac{120 - 0.2RE}{RE\,(20 - 0.2RE)}$$

is based on a 20 percent tolerance in the total power loss at full-load and fixed output power.

Given the value of n, determine one of the following:

(i) If the value of n is less than or equal to n_1 and if the mean energy efficiency of the first sample ($\bar{X}_1$) is equal to or greater than the lower control limit (LCL_1), the basic model is in compliance and testing is at an end.

(ii) If the value of n is greater than n1, the basic model is in non-compliance. The size of a second sample n_2 is determined to be the smallest integer equal to or greater than the difference $n - n_1$. If the value of n_2 so calculated is greater than $20 - n1$, set n_2 equal to $20 - n_1$.

Step 8. Compute the combined ($\bar{X}_2$) mean of the measured energy performance of the n_1 and n_2 units of the combined first and second samples as follows:

$$\overline{X}_2 = \frac{1}{n_1 + n_2}\sum_{i=1}^{n_1+n_2} X_i \qquad (6)$$

Step 9. Compute the standard error ($SE(\bar{X}_2)$) of the mean full-load efficiency of the n_1 and n_2 units in the combined first and second samples as follows:

$$SE\,(\overline{X}_2) = \frac{S_1}{\sqrt{n_1 + n_2}} \qquad (7)$$

(Note that S_1 is the value obtained above in Step 3.)

Step 10. Set the lower control limit (LCL_2) to,

$$LCL_2 = RE - tSE\,(\overline{X}_2) \qquad (8)\sqrt{b^2 - 4ac}$$

where t has the value obtained in Step 5, and compare the combined sample mean ($\bar{X}_2$) to the lower control limit (LCL_2) to find one of the following:

(i) If the mean of the combined sample ($\bar{X}_2$) is less than the lower control limit (LCL_2), the basic model is in non-compliance and testing is at an end.

(ii) If the mean of the combined sample ($\bar{X}_2$) is equal to or greater than the lower control limit (LCL_2), the basic model is in compliance and testing is at an end.

MANUFACTURER-OPTION TESTING

If a determination of non-compliance is made in Steps 6, 7 or 10, of this appendix A, the manufacturer may request that additional testing be conducted, in accordance with the following procedures.

Step A. The manufacturer requests that an additional number, n_3, of units be tested, with n_3 chosen such that $n_1 + n_2 + n_3$ does not exceed 20.

Step B. Compute the mean full-load efficiency, standard error, and lower control limit of the new combined sample in accordance with the procedures prescribed in Steps 8, 9, and 10, of this appendix A.

Step C. Compare the mean performance of the new combined sample to the lower control limit (LCL_2) to determine one of the following:

(a) If the new combined sample mean is equal to or greater than the lower control limit, the basic model is in compliance and testing is at an end.

(b) If the new combined sample mean is less than the lower control limit and the value of $n_1 + n_2 + n_3$ is less than 20, the manufacturer may request that additional units be tested. The total of all units tested may not exceed 20. Steps A, B, and C are then repeated.

(c) Otherwise, the basic model is determined to be in non-compliance.

Subpart V—General Provisions

SOURCE: 69 FR 61941, Oct. 21, 2004, unless otherwise noted. Redesignated at 70 FR 60417, Oct. 18, 2005.

§ 431.401 Petitions for waiver and interim waiver.

(a) *General information.* This section provides a means for seeking waivers of the test procedure requirements of this part for basic models that meet the requirements of paragraph (a)(1) of this section. In granting a waiver or interim waiver, DOE will not change the energy use or efficiency metric that the manufacturer must use to certify compliance with the applicable energy conservation standard and to make representations about the energy use or efficiency of the covered equipment. The granting of a waiver or interim waiver by DOE does not exempt such basic models from any other regulatory requirement contained in this part or the certification and compliance requirements of 10 CFR part 429 and specifies an alternative method for testing the basic model(s) addressed in the waiver.

(1) Any interested person may submit a petition to waive for a particular basic model the requirements of any uniform test method contained in this part, upon the grounds that either the basic model contains one or more design characteristics that prevent testing of the basic model according to the prescribed test procedures or cause the prescribed test procedures to evaluate the basic model in a manner so unrepresentative of its true energy or water consumption characteristics as to provide materially inaccurate comparative data.

(2) Manufacturers of basic model(s) subject to a waiver or interim waiver are responsible for complying with the other requirements of this part and with the requirements of 10 CFR part 429 regardless of the person that originally submitted the petition for waiver and/or interim waiver. The filing of a petition for waiver and/or interim waiver shall not constitute grounds for noncompliance with any requirements of this part.

(3) All correspondence regarding waivers and interim waivers must be submitted to DOE either electronically to *AS_Waiver_Requests@ee.doe.gov* (preferred method of transmittal) or by mail to U.S. Department of Energy, Building Technologies Program, Test Procedure Waiver, 1000 Independence Avenue SW., Mailstop EE–5B, Washington, DC 20585–0121.

(b) *Petition content and publication.* (1) Each petition for interim waiver and waiver must:

(i) Identify the particular basic model(s) for which a waiver is requested, each brand name under which the identified basic model(s) will be distributed in commerce, the design characteristic(s) constituting the grounds for the petition, and the specific requirements sought to be waived, and must discuss in detail the need for the requested waiver;

(ii) Identify manufacturers of all other basic models distributed in commerce in the United States and known to the petitioner to incorporate design characteristic(s) similar to those found in the basic model that is the subject of the petition;

(iii) Include any alternate test procedures known to the petitioner to evaluate the performance of the equipment type in a manner representative of the energy and/or water consumption characteristics of the basic model; and

(iv) Be signed by the petitioner or an authorized representative. In accordance with the provisions set forth in 10 CFR 1004.11, any request for confidential treatment of any information contained in a petition or in supporting documentation must be accompanied by a copy of the petition, application or supporting documentation from which the information claimed to be confidential has been deleted. DOE will publish in the FEDERAL REGISTER the petition and supporting documents from which confidential information, as determined by DOE, has been deleted in accordance with 10 CFR 1004.11 and will solicit comments, data and information with respect to the determination of the petition.

(2) In addition to the requirements in paragraph (b)(1) of this section, each petition for interim waiver must reference the related petition for waiver, demonstrate likely success of the petition for waiver, and address what economic hardship and/or competitive disadvantage is likely to result absent a favorable determination on the petition for interim waiver.

(c) *Notification to other manufacturers.* (1) Each petitioner for interim waiver must, upon publication of a grant of an interim waiver in the FEDERAL REGISTER, notify in writing all known manufacturers of domestically marketed basic models of the same equipment class (as specified in the relevant subpart of 10 CFR part 431), and of other equipment classes known to the petitioner to use the technology or have the characteristic at issue in the waiver. The notice must include a statement that DOE has published the interim waiver and petition for waiver in the FEDERAL REGISTER and the date the petition for waiver was published. The notice must also include a statement that DOE will receive and consider timely written comments on the petition for waiver. Within five working days, each petitioner must file with DOE a statement certifying the names and addresses of each person to whom a notice of the petition for waiver has been sent.

(2) If a petitioner does not request an interim waiver and notification has not been provided pursuant to paragraph (c)(1) of this section, each petitioner, after filing a petition for waiver with DOE, and after the petition for waiver has been published in the FEDERAL REGISTER, must, within five working days of such publication, notify in writing all known manufacturers of domestically marketed basic models of the same equipment class (as listed in the relevant subpart of 10 CFR part 431), and of other equipment classes known to the petitioner to use the technology or have the characteristic at issue in the waiver. The notice must include a statement that DOE has published the petition in the FEDERAL REGISTER and the date the petition for waiver was published. Within five working days of the publication of the petition in the FEDERAL REGISTER, each petitioner must file with DOE a statement certifying the names and addresses of each person to whom a notice of the petition for waiver has been sent.

(d) *Public comment and rebuttal.* (1) Any person submitting written comments to DOE with respect to an interim waiver must also send a copy of the comments to the petitioner by the deadline specified in the notice.

(2) Any person submitting written comments to DOE with respect to a petition for waiver must also send a copy of such comments to the petitioner.

(3) A petitioner may, within 10 working days of the close of the comment period specified in the FEDERAL REGISTER, submit a rebuttal statement to DOE. A petitioner may rebut more than one comment in a single rebuttal statement.

(e) *Provisions specific to interim waivers.* (1) DOE will post a petition for interim waiver on its website within 5 business days of receipt of a complete petition. DOE will make best efforts to

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review a petition for interim waiver within 90 business days of receipt of a complete petition.

(2) A petition for interim waiver that does not meet the content requirements of paragraph (b) of this section will be considered incomplete. DOE will notify the petitioner of an incomplete petition via email.

(3) DOE will grant an interim waiver from the test procedure requirements if it appears likely that the petition for waiver will be granted and/or if DOE determines that it would be desirable for public policy reasons to grant immediate relief pending a determination on the petition for waiver. Notice of DOE's determination on the petition for interim waiver will be published in the FEDERAL REGISTER.

(f) *Provisions specific to waivers*—(1) Disposition of application. The petitioner shall be notified in writing as soon as practicable of the disposition of each petition for waiver. DOE shall issue a decision on the petition as soon as is practicable following receipt and review of the Petition for Waiver and other applicable documents, including, but not limited to, comments and rebuttal statements.

(2) Criteria for granting. DOE will grant a waiver from the test procedure requirements if DOE determines either that the basic model(s) for which the waiver was requested contains a design characteristic that prevents testing of the basic model according to the prescribed test procedures, or that the prescribed test procedures evaluate the basic model in a manner so unrepresentative of its true energy or water consumption characteristics as to provide materially inaccurate comparative data. DOE may grant a waiver subject to conditions, which may include adherence to alternate test procedures specified by DOE. DOE will promptly publish in the FEDERAL REGISTER notice of each waiver granted or denied, and any limiting conditions of each waiver granted.

(g) *Extension to additional basic models*. A petitioner may request that DOE extend the scope of a waiver or an interim waiver to include additional basic models employing the same technology as the basic model(s) set forth in the original petition. The petition for extension must identify the particular basic model(s) for which a waiver extension is requested, each brand name under which the identified basic model(s) will be distributed in commerce, and documentation supporting the claim that the additional basic models employ the same technology as the basic model(s) set forth in the original petition. DOE will publish any such extension in the FEDERAL REGISTER.

(h) *Duration*. (1) Within one year of issuance of an interim waiver, DOE will either:

(i) Publish in the FEDERAL REGISTER a final determination on the petition for waiver; or

(ii) Publish in the FEDERAL REGISTER a new or amended test procedure that addresses the issues presented in the waiver.

(2) When DOE publishes a decision and order on a petition for waiver in the FEDERAL REGISTER pursuant to paragraph (f) of this section, the interim waiver will terminate upon the date specified in the decision and order, in accordance with paragraph (i) of this section.

(3) When DOE amends the test procedure to address the issues presented in a waiver, the waiver or interim waiver will automatically terminate on the date on which use of that test procedure is required to demonstrate compliance.

(4) When DOE publishes a decision and order in the FEDERAL REGISTER to modify a waiver pursuant to paragraph (k) of this section, the existing waiver will terminate upon the date specified in the decision and order, in accordance with paragraph (i) of this section.

(i) *Compliance certification and representations*. (1) If the interim waiver test procedure methodology is different than the decision and order test procedure methodology, certification reports to DOE required under 10 CFR 429.12 and any representations must be based on either of the two methodologies until 180–360 days after the publication date of the decision and order, as specified by DOE in the decision and order. Thereafter, certification reports and any representations must be based on the decision and order test procedure methodology, unless otherwise

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specified by DOE. Once a manufacturer uses the decision and order test procedure methodology in a certification report or any representation, all subsequent certification reports and any representations must be made using the decision and order test procedure methodology while the waiver is valid.

(2) When DOE publishes a new or amended test procedure, certification reports to DOE required under 10 CFR 429.12 and any representations must be based on the testing methodology of an applicable waiver or interim waiver, or the new or amended test procedure until the date on which use of such test procedure is required to demonstrate compliance, unless otherwise specified by DOE in the test procedure final rule. Thereafter, certification reports and any representations must be based on the test procedure final rule methodology. Once a manufacturer uses the test procedure final rule methodology in a certification report or any representation, all subsequent certification reports and any representations must be made using the test procedure final rule methodology.

(3) If DOE publishes a decision and order modifying an existing waiver, certification reports to DOE required under 10 CFR 429.12 and any representations must be based on either of the two methodologies until 180–360 days after the publication date of the decision and order modifying the waiver, as specified by DOE in the decision and order. Thereafter, certification reports and any representations must be based on the modified test procedure methodology unless otherwise specified by DOE. Once a manufacturer uses the modified test procedure methodology in a certification report or any representation, all subsequent certification reports and any representations must be made using the modified test procedure methodology while the modified waiver is valid.

(j) *Petition for waiver required of other manufactures.* Any manufacturer of a basic model employing a technology or characteristic for which a waiver was granted for another basic model and that results in the need for a waiver (as specified by DOE in a published decision and order in the FEDERAL REGISTER) must petition for and be granted a waiver for that basic model. Manufacturers may also submit a request for interim waiver pursuant to the requirements of this section.

(k) *Rescission or modification.* (1) DOE may rescind or modify a waiver or interim waiver at any time upon DOE's determination that the factual basis underlying the petition for waiver or interim waiver is incorrect, upon a determination that the results from the alternate test procedure are unrepresentative of the basic model(s)' true energy consumption characteristics, or for other appropriate reason. Waivers and interim waivers are conditioned upon the validity of statements, representations, and documents provided by the requestor; any evidence that the original grant of a waiver or interim waiver was based upon inaccurate information will weigh against continuation of the waiver. DOE's decision will specify the basis for its determination and, in the case of a modification, will also specify the change to the authorized test procedure.

(2) A person may request that DOE rescind or modify a waiver or interim waiver issued to that person if the person discovers an error in the information provided to DOE as part of its petition, determines that the waiver is no longer needed, or for other appropriate reasons. In a request for rescission, the requestor must provide a statement explaining why it is requesting rescission. In a request for modification, the requestor must explain the need for modification to the authorized test procedure and detail the modifications needed and the corresponding impact on measured energy consumption.

(3) DOE will publish a proposed rescission or modification (DOE-initiated or at the request of the original requestor) in the FEDERAL REGISTER for public comment. A requestor may, within 10 working days of the close of the comment period specified in the proposed rescission or modification published in the FEDERAL REGISTER, submit a rebuttal statement to DOE. A requestor may rebut more than one comment in a single rebuttal statement.

(4) DOE will publish its decision in the FEDERAL REGISTER. DOE's determination will be based on relevant information contained in the record and any comments received.

(5) After the effective date of a rescission, any basic model(s) previously subject to a waiver must be tested and certified using the applicable DOE test procedure in 10 CFR part 431.

(l) *Revision of regulation.* As soon as practicable after the granting of any waiver, DOE will publish in the FEDERAL REGISTER a notice of proposed rulemaking to amend its regulations so as to eliminate any need for the continuation of such waiver. As soon thereafter as practicable, DOE will publish in the FEDERAL REGISTER a final rule.

(m) To exhaust administrative remedies, any person aggrieved by an action under this section must file an appeal with the DOE's Office of Hearings and Appeals as provided in 10 CFR part 1003, subpart C.

[79 FR 26601, May 9, 2014, as amended at 85 FR 79820, Dec. 11, 2020; 86 FR 70960, Dec. 14, 2021]

§431.402 Preemption of State regulations for commercial HVAC & WH products.

Beginning on the effective date of such standard, an energy conservation standard set forth in this part for a commercial HVAC & WH product supersedes any State or local regulation concerning the energy efficiency or energy use of that product, except as provided for in Section 345(b)(2)(B)–(D) of the Act.

§431.403 Maintenance of records for electric motors.

(a) Manufacturers of electric motors must establish, maintain and retain records of the following:

(1) The test data for all testing conducted pursuant to this part;

(2) The development, substantiation, application, and subsequent verification of any AEDM used under this part;

(3) Any written certification received from a certification program, including a certificate or conformity, relied on under the provisions of this part;

(b) You must organize such records and index them so that they are readily accessible for review. The records must include the supporting test data associated with tests performed on any test units to satisfy the requirements of this part (except tests performed by DOE).

(c) For each basic model, you must retain all such records for a period of two years from the date that production of all units of that basic model has ceased. You must retain records in a form allowing ready access to DOE, upon request.

[76 FR 12505, Mar. 7, 2011]

§431.404 Imported electric motors.

(a) Under sections 331 and 345 of the Act, any person importing an electric motor into the United States must comply with the provisions of the Act and of this part, and is subject to the remedies of this part.

(b) Any electric motor offered for importation in violation of the Act and of this part will be refused admission into the customs territory of the United States under rules issued by the Secretary of the Treasury, except that the Secretary of the Treasury may, by such rules, authorize the importation of such electric motor upon such terms and conditions (including the furnishing of a bond) as may appear to the Secretary of the Treasury appropriate to ensure that such electric motor will not violate the Act and this part, or will be exported or abandoned to the United States.

[76 FR 12505, Mar. 7, 2011]

§431.405 Exported electric motors.

Under Sections 330 and 345 of the Act, this part does not apply to any electric motor if:

(a) Such electric motor is manufactured, sold, or held for sale for export from the United States (or such electric motor was imported for export), unless such electric motor is, in fact, distributed in commerce for use in the United States; and,

(b) Such electric motor, when distributed in commerce, or any container in which it is enclosed when so distributed, bears a stamp or label stating that such electric motor is intended for export.

[76 FR 12505, Mar. 7, 2011]

§ 431.406 Subpoena—Electric Motors.

Pursuant to sections 329(a) and 345 of the Act, for purposes of carrying out this part, the Secretary or the Secretary's designee, may sign and issue subpoenas for the attendance and testimony of witnesses and the production of relevant books, records, papers, and other documents, and administer the oaths. Witnesses summoned under the provisions of this section shall be paid the same fees and mileage as are paid to witnesses in the courts of the United States. In case of contumacy by, or refusal to obey a subpoena served upon any persons subject to this part, the Secretary may seek an order from the District Court of the United States for any District in which such person is found or resides or transacts business requiring such person to appear and give testimony, or to appear and produce documents. Failure to obey such order is punishable by such court as a contempt thereof.

[76 FR 12505, Mar. 7, 2011]

§ 431.407 Confidentiality—Electric Motors.

Pursuant to the provisions of 10 CFR 1004.11, any manufacturer or private labeler of electric motors submitting information or data which they believe to be confidential and exempt from public disclosure should submit one complete copy, and 15 copies from which the information believed to be confidential has been deleted. In accordance with the procedures established at 10 CFR 1004.11, the Department shall make its own determination with regard to any claim that information submitted be exempt from public disclosure.

[76 FR 12505, Mar. 7, 2011]

§ 431.408 Preemption of State regulations for covered equipment other than electric motors and commercial heating, ventilating, air-conditioning and water heating products.

This section concerns State regulations providing for any energy conservation standard, or water conservation standard (in the case of commercial prerinse spray valves or commercial clothes washers), or other requirement with respect to the energy efficiency, energy use, or water use (in the case of commercial prerinse spray valves or commercial clothes washers), for any covered equipment other than an electric motor or commercial HVAC and WH product. Any such regulation that contains a standard or requirement that is not identical to a Federal standard in effect under this subpart is preempted by that standard, except as provided for in sections 327(b) and (c) and 345(a)(10), (e), (f) and (g) of the Act.

[75 FR 675, Jan. 5, 2010, as amended at 78 FR 62993, Oct. 23, 2013]

Subpart W—Petitions To Exempt State Regulation From Preemption; Petitions To Withdraw Exemption of State Regulation

SOURCE: 69 FR 61941, Oct. 21, 2004, unless otherwise noted. Redesignated at 70 FR 60417, Oct. 18, 2005.

§ 431.421 Purpose and scope.

(a) The regulations in this subpart prescribe the procedures to be followed in connection with petitions requesting a rule that a State regulation prescribing an energy conservation standard or other requirement respecting energy use or energy efficiency of a type (or class) of covered equipment not be preempted.

(b) The regulations in this subpart also prescribe the procedures to be followed in connection with petitions to withdraw a rule exempting a State regulation prescribing an energy conservation standard or other requirement respecting energy use or energy efficiency of a type (or class) of covered equipment.

§ 431.422 Prescriptions of a rule.

(a) *Criteria for exemption from preemption.* Upon petition by a State which has prescribed an energy conservation standard or other requirement for a type or class of covered equipment for which a Federal energy conservation standard is applicable, the Secretary shall prescribe a rule that such standard not be preempted if he/she determines that the State has established by a preponderance of evidence that such requirement is needed to meet unusual and compelling State or local energy interests. For the purposes of this regulation, the term ''unusual and compelling State or local energy interests'' means interests which are substantially different in nature or magnitude from those prevailing in the U.S. generally, and are such that when evaluated within the context of the State's energy plan and forecast, the costs, benefits, burdens, and reliability of energy savings resulting from the State regulation make such regulation preferable or necessary when measured against the costs, benefits, burdens, and reliability of alternative approaches to energy savings or production, including reliance on reasonably predictable market-induced improvements in efficiency of all equipment subject to the State regulation. The Secretary may not prescribe such a rule if he finds that interested persons have established, by a preponderance of the evidence, that the State's regulation will significantly burden manufacturing, marketing, distribution, sale or servicing of the covered equipment on a national basis. In determining whether to make such a finding, the Secretary shall evaluate all relevant factors including: The extent to which the State regulation will increase manufacturing or distribution costs of manufacturers, distributors, and others; the extent to which the State regulation will disadvantage smaller manufacturers, distributors, or dealers or lessen competition in the sale of the covered equipment in the State; the extent to which the State regulation would cause a burden to manufacturers to redesign and produce the covered equipment type (or class), taking into consideration the extent to which the regulation would result in a reduction in the current models, or in the projected availability of models, that could be shipped on the effective date of the regulation to the State and within the U.S., or in the current or projected sales volume of the covered equipment type (or class) in the State and the U.S.; and the extent to which the State regulation is likely to contribute significantly to a proliferation of State commercial and industrial equipment efficiency requirements and the cumulative impact such requirements would have. The Secretary may not prescribe such a rule if he/she finds that such a rule will result in the unavailability in the State of any covered equipment (or class) of performance characteristics (including reliability), features, sizes, capacities, and volumes that are substantially the same as those generally available in the State at the time of the Secretary's finding. The failure of some classes (or types) to meet this criterion shall not affect the Secretary's determination of whether to prescribe a rule for other classes (or types).

(1) Requirements of petition for exemption from preemption. A petition from a State for a rule for exemption from preemption shall include the information listed in paragraphs (a)(1)(i) through (a)(1)(vi) of this section. A petition for a rule and correspondence relating to such petition shall be available for public review except for confidential or proprietary information submitted in accordance with the Department of Energy's Freedom of Information Regulations set forth in 10 CFR part 1004.

(i) The name, address, and telephone number of the petitioner;

(ii) A copy of the State standard for which a rule exempting such standard is sought;

(iii) A copy of the State's energy plan and forecast;

(iv) Specification of each type or class of covered equipment for which a rule exempting a standard is sought;

(v) Other information, if any, believed to be pertinent by the petitioner; and

(vi) Such other information as the Secretary may require.

(b) *Criteria for exemption from preemption when energy emergency conditions exist within State.* Upon petition by a State which has prescribed an energy conservation standard or other requirement for a type or class of covered equipment for which a Federal energy conservation standard is applicable, the Secretary may prescribe a rule, effective upon publication in the FEDERAL REGISTER, that such regulation not be preempted if he determines that in addition to meeting the requirements of paragraph (a) of this Section the State has established that: an energy emergency condition exists within the State that imperils the health, safety, and welfare of its residents because of the inability of the State or utilities within the State to provide adequate quantities of gas or electric energy to its residents at less than prohibitive costs; and cannot be substantially alleviated by the importation of energy or the use of interconnection agreements; and the State regulation is necessary to alleviate substantially such condition.

(1) Requirements of petition for exemption from preemption when energy emergency conditions exist within a State. A petition from a State for a rule for exemption from preemption when energy emergency conditions exist within a State shall include the information listed in paragraphs (a)(1)(i) through (a)(1)(vi) of this section. A petition shall also include the information prescribed in paragraphs (b)(1)(i) through (b)(1)(iv) of this section, and shall be available for public review except for confidential or proprietary information submitted in accordance with the Department of Energy's Freedom of Information Regulations set forth in 10 CFR part 1004:

(i) A description of the energy emergency condition which exists within the State, including causes and impacts.

(ii) A description of emergency response actions taken by the State and utilities within the State to alleviate the emergency condition;

(iii) An analysis of why the emergency condition cannot be alleviated substantially by importation of energy or the use of interconnection agreements;

(iv) An analysis of how the State standard can alleviate substantially such emergency condition.

(c) *Criteria for withdrawal of a rule exempting a State standard.* Any person subject to a State standard which, by rule, has been exempted from Federal preemption and which prescribes an energy conservation standard or other requirement for a type or class of covered equipment, when the Federal energy conservation standard for such equipment subsequently is amended, may petition the Secretary requesting that the exemption rule be withdrawn. The Secretary shall consider such petition in accordance with the requirements of paragraph (a) of this section, except that the burden shall be on the petitioner to demonstrate that the exemption rule received by the State should be withdrawn as a result of the amendment to the Federal standard. The Secretary shall withdraw such rule if he determines that the petitioner has shown the rule should be withdrawn.

(1) Requirements of petition to withdraw a rule exempting a State standard. A petition for a rule to withdraw a rule exempting a State standard shall include the information prescribed in paragraphs (c)(1)(i) through (c)(1)(vii) of this section, and shall be available for public review, except for confidential or proprietary information submitted in accordance with the Department of Energy's Freedom of Information Regulations set forth in 10 CFR part 1004:

(i) The name, address and telephone number of the petitioner;

(ii) A statement of the interest of the petitioner for which a rule withdrawing an exemption is sought;

(iii) A copy of the State standard for which a rule withdrawing an exemption is sought;

(iv) Specification of each type or class of covered equipment for which a rule withdrawing an exemption is sought;

(v) A discussion of the factors contained in paragraph (a) of this section;

(vi) Such other information, if any, believed to be pertinent by the petitioner; and

(vii) Such other information as the Secretary may require.

(2) [Reserved]

§ 431.423 Filing requirements.

(a) *Service.* All documents required to be served under this subpart shall, if mailed, be served by first class mail. Service upon a person's duly authorized representative shall constitute service upon that person.

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(b) *Obligation to supply information.* A person or State submitting a petition is under a continuing obligation to provide any new or newly discovered information relevant to that petition. Such information includes, but is not limited to, information regarding any other petition or request for action subsequently submitted by that person or State.

(c) *The same or related matters.* A person or State submitting a petition or other request for action shall state whether to the best knowledge of that petitioner the same or related issue, act, or transaction has been or presently is being considered or investigated by any State agency, department, or instrumentality.

(d) *Computation of time.* (1) Computing any period of time prescribed by or allowed under this subpart, the day of the action from which the designated period of time begins to run is not to be included. If the last day of the period is Saturday, or Sunday, or Federal legal holiday, the period runs until the end of the next day that is neither a Saturday, or Sunday or Federal legal holiday.

(2) Saturdays, Sundays, and intervening Federal legal holidays shall be excluded from the computation of time when the period of time allowed or prescribed is 7 days or less.

(3) When a submission is required to be made within a prescribed time, DOE may grant an extension of time upon good cause shown.

(4) Documents received after regular business hours are deemed to have been submitted on the next regular business day. Regular business hours for the DOE's National Office, Washington, DC, are 8:30 a.m. to 4:30 p.m.

(5) DOE reserves the right to refuse to accept, and not to consider, untimely submissions.

(e) *Filing of petitions.* (1) A petition for a rule shall be submitted in triplicate to: The Assistant Secretary for Energy Efficiency and Renewable Energy, U.S. Department of Energy, Section 327 Petitions, Building Technologies, EE–2J, Forrestal Building,1000 Independence Avenue, SW., Washington, DC 20585.

(2) A petition may be submitted on behalf of more than one person. A joint petition shall indicate each person participating in the submission. A joint petition shall provide the information required by § 431.212 for each person on whose behalf the petition is submitted.

(3) All petitions shall be signed by the person(s) submitting the petition or by a duly authorized representative. If submitted by a duly authorized representative, the petition shall certify this authorization.

(4) A petition for a rule to withdraw a rule exempting a State regulation, all supporting documents, and all future submissions shall be served on each State agency, department, or instrumentality whose regulation the petitioner seeks to supersede. The petition shall contain a certification of this service which states the name and mailing address of the served parties, and the date of service.

(f) *Acceptance for filing.* (1) Within 15 days of the receipt of a petition, the Secretary will either accept it for filing or reject it, and the petitioner will be so notified in writing. The Secretary will serve a copy of this notification on each other party served by the petitioner. Only such petitions which conform to the requirements of this subpart and which contain sufficient information for the purposes of a substantive decision will be accepted for filing. Petitions which do not so conform will be rejected and an explanation provided to petitioner in writing.

(2) For purposes of the Act and this subpart, a petition is deemed to be filed on the date it is accepted for filing.

(g) *Docket.* A petition accepted for filing will be assigned an appropriate docket designation. Petitioner shall use the docket designation in all subsequent submissions.

§ 431.424 Notice of petition.

(a) Promptly after receipt of a petition and its acceptance for filing, notice of such petition shall be published in the FEDERAL REGISTER. The notice shall set forth the availability for public review of all data and information available, and shall solicit comments, data and information with respect to the determination on the petition. Except as may otherwise be specified, the period for public comment shall be 60 days after the notice appears in the FEDERAL REGISTER.

(b) In addition to the material required under paragraph (a) of this section, each notice shall contain a summary of the State regulation at issue and the petitioner's reasons for the rule sought.

§ 431.425 Consolidation.

DOE may consolidate any or all matters at issue in two or more proceedings docketed where there exist common parties, common questions of fact and law, and where such consolidation would expedite or simplify consideration of the issues. Consolidation shall not affect the right of any party to raise issues that could have been raised if consolidation had not occurred.

§ 431.426 Hearing.

The Secretary may hold a public hearing, and publish notice in the FEDERAL REGISTER of the date and location of the hearing, when he determines that such a hearing is necessary and likely to result in a timely and effective resolution of the issues. A transcript shall be kept of any such hearing.

§ 431.427 Disposition of petitions.

(a) After the submission of public comments under § 431.213(a), the Secretary shall prescribe a final rule or deny the petition within 6 months after the date the petition is filed.

(b) The final rule issued by the Secretary or a determination by the Secretary to deny the petition shall include a written statement setting forth his findings and conclusions, and the reasons and basis therefor. A copy of the Secretary's decision shall be sent to the petitioner and the affected State agency. The Secretary shall publish in the FEDERAL REGISTER a notice of the final rule granting or denying the petition and the reasons and basis therefor.

(c) If the Secretary finds that he cannot issue a final rule within the 6-month period pursuant to paragraph (a) of this section, he shall publish a notice in the FEDERAL REGISTER extending such period to a date certain, but no longer than one year after the date on which the petition was filed. Such notice shall include the reasons for the delay.

§ 431.428 Effective dates of final rules.

(a) A final rule exempting a State standard from Federal preemption will be effective:

(1) Upon publication in the FEDERAL REGISTER if the Secretary determines that such rule is needed to meet an "energy emergency condition" within the State;

(2) Three years after such rule is published in the FEDERAL REGISTER; or

(3) Five years after such rule is published in the FEDERAL REGISTER if the Secretary determines that such additional time is necessary due to the burdens of retooling, redesign or distribution.

(b) A final rule withdrawing a rule exempting a State standard will be effective upon publication in the FEDERAL REGISTER.

§ 431.429 Request for reconsideration.

(a) Any petitioner whose petition for a rule has been denied may request reconsideration within 30 days of denial. The request shall contain a statement of facts and reasons supporting reconsideration and shall be submitted in writing to the Secretary.

(b) The denial of a petition will be reconsidered only where it is alleged and demonstrated that the denial was based on error in law or fact and that evidence of the error is found in the record of the proceedings.

(c) If the Secretary fails to take action on the request for reconsideration within 30 days, the request is deemed denied, and the petitioner may seek such judicial review as may be appropriate and available.

(d) A petitioner has not exhausted other administrative remedies until a request for reconsideration has been filed and acted upon or deemed denied.

§ 431.430 Finality of decision.

(a) A decision to prescribe a rule that a State energy conservation standard or other requirement not be preempted is final on the date the rule is issued, *i.e.*, signed by the Secretary. A decision to prescribe such a rule has no effect on other regulations of covered equipment of any other State.

(b) A decision to prescribe a rule withdrawing a rule exempting a State standard or other requirement is final on the date the rule is issued, *i.e.*, signed by the Secretary. A decision to deny such a petition is final on the day a denial of a request for reconsideration is issued, *i.e.*, signed by the Secretary.

Subpart X—Small Electric Motors

SOURCE: 74 FR 32072, July 7, 2009, unless otherwise noted.

§431.441 Purpose and scope.

This subpart contains definitions, test procedures, and energy conservation requirements for small electric motors, pursuant to Part A–1 of Title III of the Energy Policy and Conservation Act, as amended, 42 U.S.C. 6311–6317. This subpart does not cover ''electric motors,'' which are addressed in subpart B of this part. This subpart does not cover electric motors that are ''dedicated-purpose pool pump motors,'' which are addressed in subpart Z of this part.

[77 FR 26638, May 4, 2012, as amended at 86 FR 40774, July 29, 2021]

§431.442 Definitions.

The following definitions are applicable to this subpart:

Alternative efficiency determination method, or AEDM, means, with respect to a small electric motor, a method of calculating the total power loss and average full-load efficiency.

Average full-load efficiency means the arithmetic mean of the full-load efficiencies of a population of small electric motors of duplicate design, where the full-load efficiency of each motor in the population is the ratio (expressed as a percentage) of the motor's useful power output to its total power input when the motor is operated at its full rated load, rated voltage, and rated frequency.

Basic model means, with respect to a small electric motor, all units of a given type of small electric motor (or class thereof) manufactured by a single manufacturer, and which have the same rating, have electrical characteristics that are essentially identical, and do not have any differing physical or functional characteristics that affect energy consumption or efficiency. For the purpose of this definition, ''rating'' means a combination of the small electric motor's group (i.e., capacitor-start, capacitor-run; capacitor-start, induction-run; or polyphase), horsepower rating (or standard kilowatt equivalent), and number of poles with respect to which §431.446 prescribes nominal full load efficiency standards.

Breakdown torque means the maximum torque that the motor will develop with rated voltage and frequency applied without an abrupt drop in speed. The breakdown torque is the local maximum of the torque-speed plot of the motor, closest to the synchronous speed of the motor, determined in accordance with NEMA MG 1–2016 (incorporated by reference, see §431.443).

CSA means Canadian Standards Association.

DOE or *the Department* means the U.S. Department of Energy.

EPCA means the Energy Policy and Conservation Act, as amended, 42 U.S.C. 6291–6317.

IEC means International Electrotechnical Commission.

IEEE means Institute of Electrical and Electronics Engineers, Inc.

NEMA means National Electrical Manufacturers Association.

Rated frequency means 60 hertz.

Rated load (or *full load*, *full rated load*, or *rated full load*) means the rated output power of a small electric motor.

Rated output power means the mechanical output power that corresponds to the small electric motor's breakdown torque as specified in NEMA MG 1–2016 Table 10–5 (incorporated by reference, see §431.443) for single-phase motors or 140 percent of the breakdown torque values specified in NEMA MG 1–2016 Table 10–5 for polyphase motors. For purposes of this definition, NEMA MG 1–2016 Table 10–5 is applied regardless of whether elements of NEMA MG 1–2016 Table 10–5 are identified as for small or medium motors.

Rated voltage means the input voltage of a small electric motor used when making representations of the performance characteristics of a given small electric motor and selected by the motor's manufacturer to be used for testing the motor's efficiency.

Small electric motor means a NEMA general purpose alternating current single-speed induction motor, built in a two-digit frame number series in accordance with NEMA Standards Publication MG1–1987, including IEC metric equivalent motors.

[74 FR 32072, July 7, 2009, as amended at 77 FR 26638, May 4, 2012; 86 FR 23, Jan. 4, 2021]

TEST PROCEDURES

§ 431.443 Materials incorporated by reference.

(a) *General.* Certain material is incorporated by reference into subpart X of part 431 with the approval of the Director of the Federal Register under 5 U.S.C. 552(a) and 1 CFR part 51. Material is incorporated as it exists on the date of the approval, and a notification of any change in the material will be published in the FEDERAL REGISTER. Standards can be obtained from the sources below. All approved material is available for inspection at U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Program, Sixth Floor, 950 L'Enfant Plaza SW, Washington, DC 20024, (202) 586–2945, or go to *http://www1.eere.energy.gov/buildings/appliance_standards/.* It is also available at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, email: *fedreg.legal@nara.gov*, or go to: *www.archives.gov/federal-register/cfr/ibr-locations.html.*

(b) *CAN/CSA.* Canadian Standards Association, Sales Department, 5060 Spectrum Way, Suite 100, Mississauga, Ontario, L4W 5N6, Canada, 1–800–463–6727, or go to *http://www.shopcsa.ca/onlinestore/welcome.asp.*

(1) CSA C747–09 (''CSA C747''), Energy efficiency test methods for small motors, October 2009, IBR approved for §§ 431.444; 431.447.

(2) CSA C390–10, Test methods, marking requirements, and energy efficiency levels for three-phase induction motors, March 2010, IBR approved for §§ 431.444; 431.447.

(c) *IEC.* International Electrotechnical Commission, 3 rue de Varembé, 1st Floor, P.O. Box 131, CH—1211 Geneva 20—Switzerland, +41 22 919 02 11, or go to *https://webstore.iec.ch/home.*

(1) IEC 60034–1, Edition 12.0 2010–02, (''IEC 60034–1:2010''), Rotating electrical machines—Part 1: Rating and performance, IBR approved for §§ 431.444.

(2) IEC 60034–2–1:2014, Edition 2.0 2014–06, (''IEC 60034–2–1:2014''), Rotating electrical machines—Part 2–1: Standard methods for determining losses and efficiency from tests (excluding machines for traction vehicles), IBR approved for §§ 431.444, and 431.447.

(3) IEC 60051–1:2016, Edition 6.0 2016–02, (''IEC 60051–1:2016), Direct acting indicating analogue electrical measuring instruments and their accessories—Part 1: Definitions and general requirements common to all parts, IBR approved for §§ 431.444.

(d) *IEEE.* Institute of Electrical and Electronics Engineers, Inc., 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855–1331, 1–800–678–IEEE (4333), or go to *http://www.ieee.org/web/publications/home/index.html.*

(1) IEEE 112™–2017 (''IEEE 112–2017''), IEEE Standard Test Procedure for Polyphase Induction Motors and Generators, approved December 6, 2017, IBR approved for §§ 431.444, and 431.447.

(2) IEEE Std 114–2010, Test Procedure for Single-Phase Induction Motors, approved September 30, 2010, IBR approved for §§ 431.444; 431.447.

(e) *NEMA.* National Electrical Manufacturers Association, 1300 North 17th Street, Suite 900, Arlington, Virginia 22209, +1 703 841 3200, or go to *https://www.nema.org.*

(1) NEMA MG 1–2016, American National Standard for Motors and Generators, ANSI approved June 1, 2018, IBR approved for § 431.442.

(2) [Reserved]

[74 FR 32072, July 7, 2009, as amended at 77 FR 26638, May 4, 2012; 86 FR 23, Jan. 4, 2021]

§ 431.444 Test Procedures for the measurement of energy efficiency of small electric motors.

(a) *Scope.* Pursuant to section 346(b)(1) of EPCA, this section provides the test procedures for measuring the full-load efficiency of small electric motors pursuant to EPCA. (42 U.S.C.

6317(b)(1)) For purposes of this part 431 and EPCA, the test procedures for measuring the efficiency of small electric motors shall be the test procedures specified in paragraph (b) of this section.

(b) *Testing and Calculations*. Determine the full-load efficiency of a small electric motor using one of the test methods listed in this paragraphs (b)(1) through (4) of this section.

(1) *Incorporation by reference:* In § 431.443, DOE incorporated by reference the entire standard for CSA C747–09, CSA C390–10, IEC 60034–1:2010, IEC 60034–2–1:2014, IEC 60051–1:2016, IEEE 112–2017, and IEEE 114–2010 into this section; however, only enumerated provisions of those documents referenced in this section are applicable as follows:

(i) CSA C747–09:

(A) Section 1.6 ''Scope'' as specified in paragraphs (b)(2)(ii) and (b)(3)(ii) of this section;

(B) Section 3 ''Definitions'' as specified in paragraphs (b)(2)(ii) and (b)(3)(ii) of this section;

(C) Section 5 ''General test requirements'' as specified in paragraphs (b)(2)(ii) and (b)(3)(ii) of this section; and

(D) Section 6 ''Test method'' as specified in paragraphs (b)(2)(ii) and (b)(3)(ii) of this section.

(ii) CSA C390–10:

(A) Section 1.3, ''Scope'' as specified in paragraph (b)(4)(ii) of this section;

(B) Section 3.1, ''Definitions'' as specified in paragraph (b)(4)(ii) of this section;

(C) Section 5, ''General test requirements—Measurements'' as specified in paragraph (b)(4)(ii) of this section;

(D) Section 7, ''Test method'' as specified in paragraph (b)(4)(ii) of this section;

(E) Table 1, ''Resistance measurement time delay'' as specified in paragraph (b)(4)(ii) of this section;

(F) Annex B, ''Linear regression analysis'' as specified in paragraph (b)(4)(ii) of this section; and

(G) Annex C, ''Procedure for correction of dynamometer torque readings'' as specified in paragraph (b)(4)(ii) of this section.

(iii) IEC 60034–1:2010:

(A) Section 7.2 as specified in paragraphs (b)(2)(iii), (b)(3)(iii), and (b)(4)(iii) of this section;

(B) Section 8.6.2.3.3 as specified in paragraphs (b)(2)(iii), (b)(3)(iii), and (b)(4)(iii) of this section; and

(C) Table 5 as specified in paragraphs (b)(2)(iii), (b)(3)(iii), and (b)(4)(iii) of this section.

(iv) IEC 60034–2–1:2014:

(A) Method 2–1–1A as specified in paragraphs (b)(2)(iii) and (b)(3)(iii) of this section;

(B) Method 2–1–1B as specified in paragraph (b)(4)(iii) of this section;

(C) Section 3 ''Terms and definitions'' as specified in paragraphs (b)(2)(iii), (b)(3)(iii), and (b)(4)(iii) of this section;

(D) Section 4 ''Symbols and abbreviations'' as specified in paragraphs (b)(2)(iii), (b)(3)(iii), (b)(4)(iii) of this section;

(E) Section 5 ''Basic requirements'' as specified in paragraphs (b)(2)(iii), (b)(3)(iii), and (b)(4)(iii) of this section;

(F) Section 6.1.2 ''Method 2–1–1A—Direct measurement of input and output'' (except Section 6.1.2.2, ''Test Procedure'') as specified in paragraphs (b)(2)(iii) and (b)(3)(iii) of this section;

(G) Section 6.1.3 ''Method 2–1–1B—Summations of losses, additional load losses according to the method of residual losses'' as specified in paragraph (b)(4)(iii) of this section; and

(H) Annex D, ''Test report template for 2–1–1B'' as specified in paragraph (b)(4)(iii) of this section.

(v) IEC 60051–1:2016:

(A) Section 5.2 as specified in paragraphs (b)(2)(iii), (b)(3)(iii) and (b)(4)(iii), of this section; and

(B) [Reserved]

(vi) IEEE 112–2017:

(A) Test Method A as specified in paragraph (b)(3)(i) of this section;

(B) Test Method B as specified in paragraph (b)(4)(i) of this section;

(C) Section 3, ''General'' as specified in paragraphs (b)(3)(i) and (b)(4)(i) of this section;

(D) Section 4, ''Measurements'' as specified in paragraphs (b)(3)(i) and (b)(4)(i) of this section;

(E) Section 5, ''Machine losses and tests for losses'' as specified in paragraphs (b)(3)(i) and (b)(4)(i) of this section;

(F) Section 6.1, ''General'' as specified in paragraphs (b)(3)(i) and (b)(4)(i) of this section;

(G) Section 6.3, ''Efficiency test method A—Input-output'' as specified in paragraph (b)(3)(i) of this section;

(H) Section 6.4, ''Efficiency test method B—Input-output'' as specified in paragraph (b)(4)(i) of this section;

(I) Section 9.2, ''Form A—Method A'' as specified in paragraph (b)(3)(i) of this section;

(J) Section 9.3, ''Form A2—Method A calculations'' as specified in paragraph (b)(3)(i) of this section;

(K) Section 9.4, ''Form B—Method B'' as specified in paragraph (b)(4)(i) of this section; and

(L) Section 9.5, ''Form B2—Method B calculations'' as specified in paragraph (b)(4)(i) of this section.

(vii) IEEE 114–2010:

(A) Section 3.2, ''Test with load'' as specified in paragraph (b)(2)(i) of this section;

(B) Section 4, ''Testing Facilities as specified in paragraph (b)(2)(i) of this section;

(C) Section 5, ''Measurements'' as specified in paragraph (b)(2)(i) of this section;

(D) Section 6, ''General'' as specified in paragraph (b)(2)(i) of this section;

(E) Section 7, ''Type of loss'' as specified in paragraph (b)(2)(i) of this section;

(F) Section 8, ''Efficiency and Power Factor'' as specified in paragraph (b)(2)(i) of this section;

(G) Section 10 ''Temperature Tests'' as specified in paragraph (b)(2)(i) of this section;

(H) Annex A, Section A.3 ''Determination of Motor Efficiency'' as specified in paragraph (b)(2)(i) of this section; and

(I) Annex A, Section A.4 ''Explanatory notes for form 3, test data'' as specified in paragraph (b)(2)(i) of this section.

(viii) In cases where there is a conflict, the language of this appendix takes precedence over those documents. Any subsequent amendment to a referenced document by the standard-setting organization will not affect the test procedure in this appendix, unless and until the test procedure is amended by DOE.

(2) *Single-phase small electric motors*. For single-phase small electric motors, use one of the following methods:

(i) IEEE 114–2010, Section 3.2, ''Test with load'', Section 4, ''Testing Facilities, Section 5, ''Measurements'', Section 6, ''General'', Section 7, ''Type of loss'', Section 8, ''Efficiency and Power Factor''; Section 10 ''Temperature Tests'', Annex A, Section A.3 ''Determination of Motor Efficiency'', Annex A, Section A.4 ''Explanatory notes for form 3, test data'';

(ii) CSA C747–09, Section 1.6 ''Scope'', Section 3 ''Definitions'', Section 5, ''General test requirements'', and Section 6 ''Test method'';

(iii) IEC 60034–2–1:2014 Method 2–1–1A, Section 3 ''Terms and definitions'', Section 4 ''Symbols and abbreviations'', Section 5 ''Basic requirements'', and Section 6.1.2 ''Method 2–1–1A—Direct measurement of input and output'' (except Section 6.1.2.2, ''Test Procedure''). The supply voltage shall be in accordance with section 7.2 of IEC 60034–1:2010 (incorporated by reference, see § 431.443). The measured resistance at the end of the thermal test shall be determined in a similar way to the extrapolation procedure described in section 8.6.2.3.3 of IEC 60034–1:2010, using the shortest possible time instead of the time interval specified in Table 5 therein, and extrapolating to zero. The measuring instruments for electrical quantities shall have the equivalent of an accuracy class of 0,2 in case of a direct test and 0,5 in case of an indirect test in accordance with section 5.2 of IEC 60051–1:2016 (incorporated by reference, see § 431.443).

(A) *Additional IEC 60034–2–1:2014 Method 2–1–1A Torque Measurement Instructions*.

If using IEC 60034–2–1:2014 Method 2–1–1A to measure motor performance, follow the instructions in paragraph (b)(2)(iii)(B) of this section, instead of section 6.1.2.2 of IEC 60034–2–1:2014;

(B) Couple the machine under test to a load machine. Measure torque using an in-line, shaft-coupled, rotating torque transducer or stationary, stator reaction torque transducer. Operate the machine under test at the rated load until thermal equilibrium is achieved (rate of change 1 K or less per half hour). Record U, I, Pel, n, T, θc.

(3) *Polyphase small electric motors of less than or equal to 1 horsepower (0.75 kW)*. For polyphase small electric motors with 1 horsepower or less, use one of the following methods:

(i) IEEE 112–2017 Test Method A, Section 3, ''General'', Section 4, ''Measurements'', Section 5, ''Machine losses and tests for losses'', Section 6.1, ''General'', Section 6.3, ''Efficiency test method A—Input-output'', Section 9.2, ''Form A—Method A'', and Section 9.3, ''Form A2—Method A calculations'';

(ii) CSA C747–09, Section 1.6 ''Scope'', Section 3 ''Definitions'', Section 5, ''General test requirements'', and Section 6 ''Test method'';

(iii) IEC 60034–2–1:2014 Method 2–1–1A, Section 3 ''Terms and definitions'', Section 4 ''Symbols and abbreviations'', Section 5 ''Basic requirements'', and Section 6.1.2 ''Method 2–1–1A—Direct measurement of input and output'' (except Section 6.1.2.2, ''Test Procedure''). The supply voltage shall be in accordance with section 7.2 of IEC 60034–1:2010. The measured resistance at the end of the thermal test shall be determined in a similar way to the extrapolation procedure described in section 8.6.2.3.3 of IEC 60034–1:2010 using the shortest possible time instead of the time interval specified in Table 5 therein, and extrapolating to zero. The measuring instruments for electrical quantities shall have the equivalent of an accuracy class of 0,2 in case of a direct test and 0,5 in case of an indirect test in accordance with section 5.2 of IEC 60051–1:2016.

(A) *Additional IEC 60034–2–1:2014 Method 2–1–1A Torque Measurement Instructions*.

If using IEC 60034–2–1:2014 Method 2–1–1A to measure motor performance, follow the instructions in paragraph (b)(3)(iii)(B) of this section, instead of section 6.1.2.2 of IEC 60034–2–1:2014;

(B) Couple the machine under test to load machine. Measure torque using an in-line shaft-coupled, rotating torque transducer or stationary, stator reaction torque transducer. Operate the machine under test at the rated load until thermal equilibrium is achieved (rate of change 1 K or less per half hour). Record U, I, Pel, n, T, θc.

(4) *Polyphase small electric motors of greater than 1 horsepower (0.75 kW)*. For polyphase small electric motors exceeding 1 horsepower, use one of the following methods:

(i) IEEE 112–2017 Test Method B, Section 3, ''General''; Section 4, ''Measurements''; Section 5, ''Machine losses and tests for losses'', Section 6.1, ''General'', Section 6.4, ''Efficiency test method B—Input-output with loss segregation'', Section 9.4, ''Form B—Method B'', and Section 9.5, ''Form B2—Method B calculations''; or

(ii) CSA C390–10, Section 1.3, ''Scope'', Section 3.1, ''Definitions'', Section 5, ''General test requirements—Measurements'', Section 7, ''Test method'', Table 1, ''Resistance measurement time delay, Annex B, ''Linear regression analysis'', and Annex C, ''Procedure for correction of dynamometer torque readings''; or

(iii) IEC 60034–2–1:2014 Method 2–1–1B Section 3 ''Terms and definitions'', Section 4 ''Symbols and abbreviations'', Section 5 ''Basic requirements'', Section 6.1.3 ''Method 2–1–1B—Summation of losses, additional load losses according to the method of residual losses.'', and Annex D, ''Test report template for 2–1–1B. The supply voltage shall be in accordance with section 7.2 of IEC 60034–1:2010. The measured resistance at the end of the thermal test shall be determined in a similar way to the extrapolation procedure described in section 8.6.2.3.3 of IEC 60034–1:2010 using the shortest possible time instead of the time interval specified in Table 5 therein, and extrapolating to zero. The measuring instruments for electrical quantities shall have the equivalent of an accuracy class of 0,2 in case of a direct test and 0,5 in case of an indirect test in accordance with section 5.2 of IEC 60051–1:2016.

[86 FR 23, Jan. 4, 2021]

§ 431.445 Determination of small electric motor efficiency.

(a) *Scope*. When a party determines the energy efficiency of a small electric motor to comply with an obligation imposed on it by or pursuant to Part A–1 of Title III of EPCA, 42 U.S.C. 6311–6317, this section applies.

(b) *Provisions applicable to all small electric motors*—(1) *General requirements*. The average full-load efficiency of each basic model of small electric motor must be determined either by testing in accordance with § 431.444 of this subpart, or by application of an alternative efficiency determination method (AEDM) that meets the requirements of paragraphs (a)(2) and (3) of this section, provided, however, that an AEDM may be used to determine the average full-load efficiency of one or more of a manufacturer's basic models only if the average full-load efficiency of at least five of its other basic models is determined through testing.

(2) *Alternative efficiency determination method.* An AEDM applied to a basic model must be:

(i) Derived from a mathematical model that represents the mechanical and electrical characteristics of that basic model, and

(ii) Based on engineering or statistical analysis, computer simulation or modeling, or other analytic evaluation of performance data.

(3) *Substantiation of an alternative efficiency determination method.* Before an AEDM is used, its accuracy and reliability must be substantiated as follows:

(i) The AEDM must be applied to at least five basic models that have been tested in accordance with § 431.444; and

(ii) The predicted total power loss for each such basic model, calculated by applying the AEDM, must be within plus or minus 10 percent of the mean total power loss determined from the testing of that basic model.

(4) *Subsequent verification of an AEDM.* (i) Each manufacturer that has used an AEDM under this section shall have available for inspection by the Department of Energy records showing the method or methods used; the mathematical model, the engineering or statistical analysis, computer simulation or modeling, and other analytic evaluation of performance data on which the AEDM is based; complete test data, product information, and related information that the manufacturer has generated or acquired pursuant to paragraph (a)(3) of this section; and the calculations used to determine the efficiency and total power losses of each basic model to which the AEDM was applied.

(ii) If requested by the Department, the manufacturer shall conduct simulations to predict the performance of particular basic models of small electric motors specified by the Department, analyses of previous simulations conducted by the manufacturer, sample testing of basic models selected by the Department, or a combination of the foregoing.

(5) *Use of a certification program.* (i) A manufacturer may use a certification program, that DOE has classified as nationally recognized under § 431.447, to certify the average full-load efficiency of a basic model of small electric motor, and issue a certificate of conformity for the small electric motor.

(ii) For each basic model for which a certification program is not used as described in paragraph (b)(5)(i) of this section, any testing of a motor to determine its energy efficiency must be carried out in accordance with paragraph (c) of this section.

(c) *Additional testing requirements applicable when a certification program is not used*—(1) *Selection of basic models for testing.* (i) Basic models must be selected for testing in accordance with the following criteria:

(A) Two of the basic models must be among the five basic models that have the highest unit volumes of production by the manufacturer in the prior year, or during the prior 12 calendar month period beginning in 2015, whichever is later, and comply with the standards set forth in § 431.446;

(B) The basic models should be of different horsepowers without duplication;

(C) At least one basic model should be selected from each of the frame number series for which the manufacturer is seeking compliance; and

(D) Each basic model should have the lowest average full-load efficiency among the basic models with the same rating (''rating'' as used here has the same meaning as it has in the definition of ''basic model'').

(ii) In any instance where it is impossible for a manufacturer to select basic models for testing in accordance with all of these criteria, the criteria shall be given priority in the order in which they are listed. Within the limits imposed by the criteria, basic models shall be selected randomly.

(2) *Selection of units for testing within a basic model.* For each basic model selected for testing,[1] a sample of units shall be selected at random and tested. The sample shall be comprised of production units of the basic model, or units that are representative of such production units. The sample size shall be no fewer than five units, except when fewer than five units of a basic model would be produced over a reasonable period of time (approximately 180 days). In such cases, each unit produced shall be tested.

(3) *Applying results of testing.* When applying the test results to determine whether a motor complies with the required average efficiency level:

The average full-load efficiency of the sample, $\bar{X}$ which is defined by

$$\overline{X} = \frac{1}{n}\sum_{i=1}^{n} X_i$$

where X_i is the measured full-load efficiency of unit i and n is the number of units tested, shall satisfy the condition:

$$\overline{X} \geq \frac{100}{1 + 1.05\left(\frac{100}{RE} - 1\right)}$$

where RE is the required average full-load efficiency.

[74 FR 32072, July 7, 2009, as amended at 77 FR 26638, May 4, 2012]

ENERGY CONSERVATION STANDARDS

§431.446 Small electric motors energy conservation standards and their effective dates.

(a) Each small electric motor manufactured (alone or as a component of another piece of non-covered equipment) after March 9, 2015, or in the case of a small electric motor which requires listing or certification by a nationally recognized safety testing laboratory, after March 9, 2017, shall have an average full load efficiency of not less than the following:

[1] Components of similar design may be substituted without requiring additional testing if the represented measures of energy consumption continue to satisfy the applicable sampling provision.

Motor horsepower/standard kilowatt equivalent	Average full load efficiency		
	Polyphase		
	Open motors (number of poles)		
	6	4	2
0.25/0.18	67.5	69.5	65.6
0.33/0.25	71.4	73.4	69.5
0.5/0.37	75.3	78.2	73.4
0.75/0.55	81.7	81.1	76.8
1/0.75	82.5	83.5	77.0
1.5/1.1	83.8	86.5	84.0
2/1.5	N/A	86.5	85.5
3/2.2	N/A	86.9	85.5

Motor horsepower/standard kilowatt equivalent	Average full load efficiency		
	Capacitor-start capacitor-run and capacitor-start induction-run		
	Open motors (number of poles)		
	6	4	2
0.25/0.18	62.2	68.5	66.6
0.33/0.25	66.6	72.4	70.5
0.5/0.37	76.2	76.2	72.4
0.75/0.55	80.2	81.8	76.2
1/0.75	81.1	82.6	80.4
1.5/1.1	N/A	83.8	81.5
2/1.5	N/A	84.5	82.9
3/2.2	N/A	N/A	84.1

(b) For purposes of determining the required minimum average full load efficiency of an electric motor that has a horsepower or kilowatt rating between two horsepower or two kilowatt ratings listed in any table of efficiency standards in paragraph (a) of this section, each such motor shall be deemed to have a listed horsepower or kilowatt rating, determined as follows:

(1) A horsepower at or above the midpoint between the two consecutive horsepower ratings shall be rounded up to the higher of the two horsepower ratings;

(2) A horsepower below the midpoint between the two consecutive horsepower ratings shall be rounded down to the lower of the two horsepower ratings; or

(3) A kilowatt rating shall be directly converted from kilowatts to horsepower using the formula 1 kilowatt = (1/0.746) hp, without calculating beyond three significant decimal places, and the resulting horsepower shall be rounded in accordance with paragraphs (b)(1) or (b)(2) of this section, whichever applies.

[75 FR 10947, Mar. 9, 2010; 75 FR 17036, Apr. 5, 2010]

§ 431.447 Department of Energy recognition of nationally recognized certification programs.

(a) *Petition.* For a certification program to be classified by the Department of Energy as being nationally recognized in the United States (''nationally recognized''), the organization operating the program must submit a petition to the Department requesting such classification, in accordance with paragraph (c) of this section and § 431.448. The petition must demonstrate that the program meets the criteria in paragraph (b) of this section.

(b) *Evaluation criteria.* For a certification program to be classified by the Department as nationally recognized, it must meet the following criteria:

(1) It must have satisfactory standards and procedures for conducting and administering a certification system, including periodic follow up activities to assure that basic models of small electric motors continue to conform to the efficiency levels for which they were certified, and for granting a certificate of conformity.

(2) It must be independent of small electric motor manufacturers, importers, distributors, private labelers or vendors. It cannot be affiliated with, have financial ties with, be controlled by, or be under common control with any such entity.

(3) It must be qualified to operate a certification system in a highly competent manner.

(4) It must be expert in the content and application of the test procedures and methodologies in IEEE 112–2017 Test Method A, IEEE 112–2017 Test Method B, IEEE 114–2010, IEC 60034–2–1:2014 Method 2–1–1A, IEC 60034–2–1:2014 Method 2–1–1B, CSA C390–10, or CSA C747–09 (incorporated by reference, see § 431.443) or similar procedures and methodologies for determining the energy efficiency of small electric motors. It must have satisfactory criteria and procedures for the selection and sampling of electric motors tested for energy efficiency.

(c) *Petition format.* Each petition requesting classification as a nationally recognized certification program must contain a narrative statement as to why the program meets the criteria listed in paragraph (b) of this section, must be signed on behalf of the organization operating the program by an authorized representative, and must be accompanied by documentation that supports the narrative statement. The following provides additional guidance as to the specific criteria:

(1) *Standards and procedures.* A copy of the standards and procedures for operating a certification system and for granting a certificate of conformity should accompany the petition.

(2) *Independent status.* The petitioning organization should identify and describe any relationship, direct or indirect, that it or the certification program has with an electric motor manufacturer, importer, distributor, private labeler, vendor, trade association or other such entity, as well as any other relationship it believes might appear to create a conflict of interest for the certification program in operating a certification system for determining the compliance of small electric motors with the applicable energy efficiency standards. It should explain why it believes such relationship would not compromise its independence in operating a certification program.

(3) *Qualifications to operate a certification system.* Experience in operating a certification system should be discussed and substantiated by supporting documents. Of particular relevance would be documentary evidence that establishes experience in the application of guidelines contained in the ISO/IEC Guide 65, General requirements for bodies operating product certification systems, ISO/IEC Guide 27, Guidelines for corrective action to be taken by a certification body in the event of either misapplication of its mark of conformity to a product, or products which bear the mark of the certification body being found to subject persons or property to risk, and ISO/IEC Guide 28, General rules for a model third-party certification system for products, as well as experience in overseeing compliance with the guidelines contained in the ISO/IEC Guide 25, General requirements for the competence of calibration and testing laboratories.

(4) *Expertise in small electric motor test procedures.* The petition should set forth the program's experience, as applicable, with the test procedures and methodologies in, IEEE 112–2017 Test Method A, IEEE 112–2017 Test Method B, IEEE 114–2010, IEC 60034–2–1:2014 Method 2–1–1A, IEC 60034–2–1:2014 Method 2–1–1B, CSA C390–10, and CSA C747–09 (incorporated by reference, see §431.443) and with similar procedures and methodologies. This part of the petition should include items such as, but not limited to, a description of prior projects and qualifications of staff members. Of particular relevance would be documentary evidence that establishes experience in applying guidelines contained in the ISO/IEC Guide 25, General Requirements for the Competence of Calibration and Testing Laboratories to energy efficiency testing for electric motors.

(5) The ISO/IEC Guides referenced in paragraphs (c)(3) and (c)(4) of this section are not incorporated by reference, but are for information and guidance only. International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, CP 56, CH–1211 Geneva 20, Switzerland/International Electrotechnical Commission, 3, rue de Varembé, P.O. Box 131, CH–1211 Geneva 20, Switzerland.

(d) *Disposition.* The Department will evaluate the petition in accordance with §431.448, and will determine whether the applicant meets the criteria in paragraph (b) of this section for classification as a nationally recognized certification program.

[77 FR 26639, May 4, 2012, as amended at 86 FR 25, Jan. 4, 2021]

§431.448 Procedures for recognition and withdrawal of recognition of certification programs.

(a) *Filing of petition.* Any petition submitted to the Department pursuant to §431.447(a), shall be entitled "Petition for Recognition" ("Petition") and must be submitted, in triplicate to the Assistant Secretary for Energy Efficiency and Renewable Energy, U.S. Department of Energy, Forrestal Building, 1000 Independence Avenue SW., Washington, DC 20585–0121. In accordance with the provisions set forth in 10 CFR 1004.11, any request for confidential treatment of any information contained in such a Petition or in supporting documentation must be accompanied by a copy of the Petition or supporting documentation from which the information claimed to be confidential has been deleted.

(b) *Public notice and solicitation of comments.* DOE shall publish in the FEDERAL REGISTER the Petition from which confidential information, as determined by DOE, has been deleted in accordance with 10 CFR 1004.11 and shall solicit comments, data and information on whether the Petition should be granted. The Department shall also make available for inspection and copying the Petition's supporting documentation from which confidential information, as determined by DOE, has been deleted in accordance with 10 CFR 1004.11. Any person submitting written comments to DOE with respect to a Petition shall also send a copy of such comments to the petitioner.

(c) *Responsive statement by the petitioner.* A petitioner may, within 10 working days of receipt of a copy of any comments submitted in accordance with paragraph (b) of this section, respond to such comments in a written statement submitted to the Assistant Secretary for Energy Efficiency and Renewable Energy. A petitioner may address more than one set of comments in a single responsive statement.

(d) *Public announcement of interim determination and solicitation of comments.* The Assistant Secretary for Energy Efficiency and Renewable Energy shall issue an interim determination on the Petition as soon as is practicable following receipt and review of the Petition and other applicable documents, including, but not limited to, comments and responses to comments. The petitioner shall be notified in writing of the interim determination. DOE shall also publish in the FEDERAL REGISTER the interim determination and shall solicit comments, data and information with respect to that interim determination. Written comments and responsive statements may be submitted as provided in paragraphs (b) and (c) of this section.

(e) *Public announcement of final determination.* The Assistant Secretary for

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Energy Efficiency and Renewable Energy shall, as soon as practicable, following receipt and review of comments and responsive statements on the interim determination publish in the FEDERAL REGISTER a notice of final determination on the Petition.

(f) *Additional information.* The Department may, at any time during the recognition process, request additional relevant information or conduct an investigation concerning the Petition. The Department's determination on a Petition may be based solely on the Petition and supporting documents, or may also be based on such additional information as the Department deems appropriate.

(g) *Withdrawal of recognition*—(1) *Withdrawal by the Department.* If the Department believes that a certification program that has been recognized under § 431.447 is failing to meet the criteria of paragraph (b) of the section under which it is recognized, the Department will so advise such entity and request that it take appropriate corrective action. The Department will give the entity an opportunity to respond. If after receiving such response, or no response, the Department believes satisfactory corrective action has not been made, the Department will withdraw its recognition from that entity.

(2) *Voluntary withdrawal.* A certification program may withdraw itself from recognition by the Department by advising the Department in writing of such withdrawal. It must also advise those that use it (for a certification organization, the manufacturers) of such withdrawal.

(3) *Notice of withdrawal of recognition.* The Department will publish in the FEDERAL REGISTER a notice of any withdrawal of recognition that occurs pursuant to this paragraph (g).

[77 FR 26639, May 4, 2012]

Subpart Y—Pumps

SOURCE: 81 FR 4145, Jan. 25, 2016, unless otherwise noted.

§ 431.461 Purpose and scope.

This subpart contains definitions, test procedures, and energy conservation requirements for pumps, pursuant to Part A–1 of Title III of the Energy Policy and Conservation Act, as amended, 42 U.S.C. 6311–6317.

§ 431.462 Definitions.

The following definitions are applicable to this subpart, including appendices A and B. In cases where there is a conflict, the language of the definitions adopted in this section takes precedence over any descriptions or definitions found in the 2014 version of ANSI/HI Standard 1.1–1.2, "Rotodynamic (Centrifugal) Pumps For Nomenclature And Definitions" (ANSI/HI 1.1–1.2–2014; incorporated by reference, see § 431.463), or the 2014 version of ANSI/HI Standard 2.1–2.2, "Rotodynamic (Vertical) Pumps For Nomenclature And Definitions" (ANSI/HI 2.1–2.2–2014; incorporated by reference, see § 431.463). In cases where definitions reference design intent, DOE will consider marketing materials, labels and certifications, and equipment design to determine design intent.

Adaptive pressure control means a pressure control that senses the head requirements in the system in which it is installed and adjusts the pump control curve accordingly.

Bare pump means a pump excluding mechanical equipment, driver, and controls.

Basic model means all units of a given class of pump manufactured by one manufacturer, having the same primary energy source, and having essentially identical electrical, physical, and functional (or hydraulic) characteristics that affect energy consumption, energy efficiency, water consumption, or water efficiency; and, in addition, for pumps that are subject to the standards specified in § 431.465(b), the following provisions also apply:

(1) All variations in numbers of stages of bare RSV and ST pumps must be considered a single basic model;

(2) Pump models for which the bare pump differs in impeller diameter, or impeller trim, may be considered a single basic model; and

(3) Pump models for which the bare pump differs in number of stages or impeller diameter and which are sold with motors (or motors and controls) of

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varying horsepower may only be considered a single basic model if:

(i) For ESCC, ESFM, IL, and RSV pumps, each motor offered in the basic model has a nominal full load motor efficiency rated at the Federal minimum (see the current table for NEMA Design B motors at § 431.25) or the same number of bands above the Federal minimum for each respective motor horsepower (see Table 3 of appendix A to subpart Y of this part); or

(ii) For ST pumps, each motor offered in the basic model has a full load motor efficiency at the default nominal full load submersible motor efficiency shown in Table 2 of appendix A to subpart Y of this part or the same number of bands above the default nominal full load submersible motor efficiency for each respective motor horsepower (see Table 3 of appendix A to subpart Y of this part).

Basket strainer means a perforated or otherwise porous receptacle, mounted within a housing on the suction side of a pump, that prevents solid debris from entering a pump. The basket strainer receptacle is capable of passing spherical solids of 1 mm in diameter, and can be removed by hand or using only simple tools (*e.g.*, screwdriver, pliers, open-ended wrench).

Best efficiency point (BEP) means the pump hydraulic power operating point (consisting of both flow and head conditions) that results in the maximum efficiency.

Bowl diameter means the maximum dimension of an imaginary straight line passing through and in the plane of the circular shape of the intermediate bowl of the bare pump that is perpendicular to the pump shaft and that intersects the outermost circular shape of the intermediate bowl of the bare pump at both of its ends, where the intermediate bowl is as defined in ANSI/HI 2.1–2.2–2014.

Circulator-less-volute means a circulator pump distributed in commerce without a volute and for which a paired volute is also distributed in commerce. Whether a paired volute is distributed in commerce will be determined based on published data, marketing literature, and other publicly available information.

Circulator pump means is a pump that is either a wet rotor circulator pumps; a dry rotor, two-piece circulator pump; or a dry rotor, three-piece circulator pump. A circulator pump may be distributed in commerce with or without a volute.

Clean water pump means a pump that is designed for use in pumping water with a maximum non-absorbent free solid content of 0.016 pounds per cubic foot, and with a maximum dissolved solid content of 3.1 pounds per cubic foot, provided that the total gas content of the water does not exceed the saturation volume, and disregarding any additives necessary to prevent the water from freezing at a minimum of 14 °F.

Close-coupled pump means a pump in which the motor shaft also serves as the impeller shaft for the bare pump.

Continuous control means a control that adjusts the speed of the pump driver continuously over the driver operating speed range in response to incremental changes in the required pump flow, head, or power output.

Control means any device that can be used to operate the driver. Examples include, but are not limited to, continuous or non-continuous controls, schedule-based controls, on/off switches, and float switches.

Dedicated-purpose pool pump comprises self-priming pool filter pumps, non-self-priming pool filter pumps, waterfall pumps, pressure cleaner booster pumps, integral sand-filter pool pumps, integral-cartridge filter pool pumps, storable electric spa pumps, and rigid electric spa pumps.

Dedicated-purpose pool pump motor total horsepower means the product of the dedicated-purpose pool pump nominal motor horsepower and the dedicated-purpose pool pump service factor of a motor used on a dedicated-purpose pool pump based on the maximum continuous duty motor power output rating allowable for the motor's nameplate ambient rating and insulation class. (Dedicated-purpose pool pump motor total horsepower is also referred to in the industry as service factor horsepower or motor capacity.)

Dedicated-purpose pool pump service factor means a multiplier applied to the rated horsepower of a pump motor to

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indicate the percent above nameplate horsepower at which the motor can operate continuously without exceeding its allowable insulation class temperature limit.

Designed and marketed means that the equipment is designed to fulfill the indicated application and, when distributed in commerce, is designated and marketed for that application, with the designation on the packaging and any publicly available documents (*e.g.*, product literature, catalogs, and packaging labels).

Driver means the machine providing mechanical input to drive a bare pump directly or through the use of mechanical equipment. Examples include, but are not limited to, an electric motor, internal combustion engine, or gas/steam turbine.

Dry rotor pump means a pump in which the motor rotor is not immersed in the pumped fluid.

Dry rotor, three-piece circulator pump means:

(1) A single stage, rotodynamic, single-axis flow, mechanically-coupled, dry rotor pump that:

(i) Has a rated hydraulic power less than or equal to 5 hp at the best efficiency point at full impeller diameter,

(ii) Is distributed in commerce with a horizontal motor, and

(iii) Discharges the pumped liquid through a volute in a plane perpendicular to the shaft.

(2) Examples include, but are not limited to, pumps generally referred to in industry as CP3.

Dry rotor, two-piece circulator pump means:

(1) A single stage, rotodynamic, single-axis flow, close-coupled, dry rotor pump that:

(i) Has a rated hydraulic power less than or equal to 5 hp at best efficiency point at full impeller diameter,

(ii) Is distributed in commerce with a horizontal motor, and

(iii) Discharges the pumped liquid through a volute in a plane perpendicular to the shaft.

(2) Examples include, but are not limited to, pumps generally referred to in industry as CP2.

End suction close-coupled (ESCC) pump means a close-coupled, dry rotor, end suction pump that has a shaft input power greater than or equal to 1 hp and less than or equal to 200 hp at BEP and full impeller diameter and that is not a dedicated-purpose pool pump. Examples include, but are not limited to, pumps within the specified horsepower range that comply with ANSI/HI nomenclature OH7, as described in ANSI/HI 1.1–1.2–2014.

End suction frame mounted/own bearings (ESFM) pump means a mechanically-coupled, dry rotor, end suction pump that has a shaft input power greater than or equal to 1 hp and less than or equal to 200 hp at BEP and full impeller diameter and that is not a dedicated-purpose pool pump. Examples include, but are not limited to, pumps within the specified horsepower range that comply with ANSI/HI nomenclature OH0 and OH1, as described in ANSI/HI 1.1–1.2–2014.

End suction pump means a single-stage, rotodynamic pump in which the liquid enters the bare pump in a direction parallel to the impeller shaft and on the side opposite the bare pump's driver-end. The liquid is discharged through a volute in a plane perpendicular to the shaft.

External input signal control means a variable speed drive that adjusts the speed of the driver in response to an input signal from an external logic and/or user interface.

Fire pump means a pump that is compliant with NFPA 20–2016 (incorporated by reference, see § 431.463), ''Standard for the Installation of Stationary Pumps for Fire Protection,'' and is either:

(1) UL listed under ANSI/UL 448–2013 (incorporated by reference, see § 431.463), ''Standard for Safety Centrifugal Stationary Pumps for Fire-Protection Service,'' or

(2) FM Global (FM) approved under the January 2015 edition of FM Class Number 1319, ''Approval Standard for Centrifugal Fire Pumps (Horizontal, End Suction Type),'' (incorporated by reference, see § 431.463).

Freeze protection control means a pool pump control that, at a certain ambient temperature, turns on the dedicated-purpose pool pump to circulate water for a period of time to prevent the pool and water in plumbing from freezing.

Full impeller diameter means the maximum diameter impeller with which a given pump basic model is distributed in commerce.

Header pump means a circulator pump distributed in commerce without a volute and for which a paired volute is not distributed in commerce. Whether a paired volute is distributed in commerce will be determined based on published data, marketing literature, and other publicly available information.

Horizontal motor means a motor, for which the motor shaft position when functioning under operating conditions specified in manufacturer literature, includes a horizontal position.

In-line (IL) pump means a pump that is either a twin-head pump or a single-stage, single-axis flow, dry rotor, rotodynamic pump that has a shaft input power greater than or equal to 1 hp and less than or equal to 200 hp at BEP and full impeller diameter, in which liquid is discharged through a volute in a plane perpendicular to the shaft. Such pumps do not include pumps that are mechanically coupled or close-coupled, have a pump power output that is less than or equal to 5 hp at BEP at full impeller diameter, and are distributed in commerce with a horizontal motor. Examples of in-line pumps include, but are not limited to, pumps within the specified horsepower range that comply with ANSI/HI nomenclature OH3, OH4, or OH5, as described in ANSI/HI 1.1–1.2–2014.

Integral means a part of the device that cannot be removed without compromising the device's function or destroying the physical integrity of the unit.

Integral cartridge-filter pool pump means a pump that requires a removable cartridge filter, installed on the suction side of the pump, for operation; and the cartridge filter cannot be bypassed.

Integral sand-filter pool pump means a pump distributed in commerce with a sand filter that cannot be bypassed.

Magnet driven pump means a pump in which the bare pump is isolated from the motor via a containment shell and torque is transmitted from the motor to the bare pump via magnetic force. The motor shaft is not physically coupled to the impeller or impeller shaft.

Manual speed control means a control (variable speed drive and user interface) that adjusts the speed of the driver based on manual user input.

Mechanical equipment means any component of a pump that transfers energy from the driver to the bare pump.

Mechanically-coupled pump means a pump in which the bare pump has its own impeller shaft and bearings and so does not rely on the motor shaft to serve as the impeller shaft.

Multi-speed dedicated-purpose pool pump means a dedicated-purpose pool pump that is capable of operating at more than two discrete, pre-determined operating speeds separated by speed increments greater than 100 rpm, where the lowest speed is less than or equal to half of the maximum operating speed and greater than zero, and must be distributed in commerce with an on-board pool pump control (*i.e.*, variable speed drive and user interface or programmable switch) that changes the speed in response to pre-programmed user preferences and allows the user to select the duration of each speed and/or the on/off times.

Non-continuous control means a control that adjusts the speed of a driver to one of a discrete number of non-continuous preset operating speeds, and does not respond to incremental reductions in the required pump flow, head, or power output.

Non-self-priming pool filter pump means a pool filter pump that is not certified under NSF/ANSI 50–2015 (incorporated by reference, see § 431.463) to be self-priming and is not capable of re-priming to a vertical lift of at least 5.0 feet with a true priming time less than or equal to 10.0 minutes, when tested in accordance with section F of appendix B or C of this subpart, and is not a waterfall pump.

On-demand circulator pump means a circulator pump that is distributed in commerce with an integral control that:

(1) Initiates water circulation based on receiving a signal from the action of a user [of a fixture or appliance] or sensing the presence of a user of a fixture and cannot initiate water circulation based on other inputs, such as

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water temperature or a pre-set schedule.

(2) Automatically terminates water circulation once hot water has reached the pump or desired fixture.

(3) Does not allow the pump to operate when the temperature in the pipe exceeds 104 °F or for more than 5 minutes continuously.

Pool filter pump means an end suction pump that:

(1) Either:

(i) Includes an integrated basket strainer; or

(ii) Does not include an integrated basket strainer, but requires a basket strainer for operation, as stated in manufacturer literature provided with the pump; and

(2) May be distributed in commerce connected to, or packaged with, a sand filter, removable cartridge filter, or other filtration accessory, so long as the filtration accessory are connected with consumer-removable connections that allow the filtration accessory to be bypassed.

Pool pump timer means a pool pump control that automatically turns off a dedicated-purpose pool pump after a run-time of no longer than 10 hours.

Pressure cleaner booster pump means an end suction, dry rotor pump designed and marketed for pressure-side pool cleaner applications, and which may be UL listed under ANSI/UL 1081–2016 (incorporated by reference, see § 431.463).

Pressure control means a control (variable speed drive and integrated logic) that automatically adjusts the speed of the driver in response to pressure.

Prime-assist pump means a pump that:

(1) Is designed to lift liquid that originates below the centerline of the pump inlet;

(2) Requires no manual intervention to prime or re-prime from a dry-start condition; and

(3) Includes a device, such as a vacuum pump or air compressor and venturi eductor, to remove air from the suction line in order to automatically perform the prime or re-prime function at any point during the pump's operating cycle.

Pump means equipment designed to move liquids (which may include entrained gases, free solids, and totally dissolved solids) by physical or mechanical action and includes a bare pump and, if included by the manufacturer at the time of sale, mechanical equipment, driver, and controls.

Radially split, multi-stage, vertical, in-line diffuser casing (RSV) pump means a vertically suspended, multi-stage, single axis flow, dry rotor, rotodynamic pump:

(1) That has a shaft input power greater than or equal to 1 hp and less than or equal to 200 hp at BEP and full impeller diameter and at the number of stages required for testing and

(2) In which liquid is discharged in a place perpendicular to the impeller shaft; and

(3) For which each stage (or bowl) consists of an impeller and diffuser;

(4) For which no external part of such a pump is designed to be submerged in the pumped liquid; and

(5) Examples include, but are not limited to, pumps complying with ANSI/HI nomenclature VS8, as described in ANSI/HI 2.1–2.2–2014.

Removable cartridge filter means a filter component with fixed dimensions that captures and removes suspended particles from water flowing through the unit. The removable cartridge filter is not capable of passing spherical solids of 1 mm in diameter or greater, and can be removed from the filter housing by hand or using only simple tools (*e.g.*, screwdrivers, pliers, open-ended wrench).

Rigid electric spa pump means an end suction pump that does not contain an integrated basket strainer or require a basket strainer for operation as stated in manufacturer literature provided with the pump and that meets the following three criteria:

(1) Is assembled with four through bolts that hold the motor rear endplate, rear bearing, rotor, front bearing, front endplate, and the bare pump together as an integral unit;

(2) Is constructed with buttress threads at the inlet and discharge of the bare pump; and

(3) Uses a casing or volute and connections constructed of a non-metallic material.

Rotodynamic pump means a pump in which energy is continuously imparted to the pumped fluid by means of a rotating impeller, propeller, or rotor.

Sand filter means a device designed to filter water through sand or an alternate sand-type media.

Self-priming pool filter pump means a pool filter pump that is certified under NSF/ANSI 50–2015 (incorporated by reference, see § 431.463) to be self-priming or is capable of re-priming to a vertical lift of at least 5.0 feet with a true priming time less than or equal to 10.0 minutes, when tested in accordance with section F of appendix B or C of this subpart, and is not a waterfall pump.

Self-priming pump means a pump that either is a self-priming pool filter pump or a pump that:

(1) Is designed to lift liquid that originates below the centerline of the pump inlet;

(2) Contains at least one internal recirculation passage; and

(3) Requires a manual filling of the pump casing prior to initial start-up, but is able to re-prime after the initial start-up without the use of external vacuum sources, manual filling, or a foot valve.

Single axis flow pump means a pump in which the liquid inlet of the bare pump is on the same axis as the liquid discharge of the bare pump.

Single-speed dedicated-purpose pool pump means a dedicated-purpose pool pump that is capable of operating at only one speed.

Storable electric spa pump means a pump that is distributed in commerce with one or more of the following:

(1) An integral heater; and

(2) An integral air pump.

Submersible pump means a pump that is designed to be operated with the motor and bare pump fully submerged in the pumped liquid.

Submersible turbine (ST) pump means a single-stage or multi-stage, dry rotor, rotodynamic pump that is designed to be operated with the motor and stage(s) fully submerged in the pumped liquid; that has a shaft input power greater than or equal to 1 hp and less than or equal to 200 hp at BEP and full impeller diameter and at the number of stages required for testing; and in which each stage of this pump consists of an impeller and diffuser, and liquid enters and exits each stage of the bare pump in a direction parallel to the impeller shaft. Examples include, but are not limited to, pumps within the specified horsepower range that comply with ANSI/HI nomenclature VS0, as described in ANSI/HI 2.1–2.2–2014.

Temperature control means a control (variable speed drive and integrated logic) that automatically adjusts the speed of the driver continuously over the driver operating speed range in response to temperature.

Twin head pump means a dry rotor, single-axis flow, rotodynamic pump that contains two impeller assemblies, which both share a common casing, inlet, and discharge, and each of which

(1) Contains an impeller, impeller shaft (or motor shaft in the case of close-coupled pumps), shaft seal or packing, driver (if present), and mechanical equipment (if present);

(2) Has a shaft input power that is greater than or equal to 1 hp and less than or equal to 200 hp at best efficiency point (BEP) and full impeller diameter;

(3) Has the same primary energy source (if sold with a driver) and the same electrical, physical, and functional characteristics that affect energy consumption or energy efficiency;

(4) Is mounted in its own volute; and

(5) Discharges liquid through its volute and the common discharge in a plane perpendicular to the impeller shaft.

Two-speed dedicated-purpose pool pump means a dedicated-purpose pool pump that is capable of operating at only two different pre-determined operating speeds, where the low operating speed is less than or equal to half of the maximum operating speed and greater than zero, and must be distributed in commerce either:

(1) With a pool pump control (*e.g.*, variable speed drive and user interface or switch) that is capable of changing the speed in response to user preferences; or

(2) Without a pool pump control that has the capability to change speed in response to user preferences, but is unable to operate without the presence of such a pool pump control.

Variable-speed dedicated-purpose pool pump means a dedicated-purpose pool pump that is capable of operating at a variety of user-determined speeds, where all the speeds are separated by at most 100 rpm increments over the operating range and the lowest operating speed is less than or equal to one-third of the maximum operating speed and greater than zero. Such a pump must include a variable speed drive and be distributed in commerce either:

(1) With a user interface that changes the speed in response to pre-programmed user preferences and allows the user to select the duration of each speed and/or the on/off times; or

(2) Without a user interface that changes the speed in response to pre-programmed user preferences and allows the user to select the duration of each speed and/or the on/off times, but is unable to operate without the presence of a user interface.

Variable speed drive means equipment capable of varying the speed of the motor.

Waterfall pump means a pool filter pump with a certified maximum head less than or equal to 30.0 feet, and a maximum speed less than or equal to 1,800 rpm.

Wet rotor circulator pump means a single stage, rotodynamic, close-coupled, wet rotor pump. Examples include, but are not limited to, pumps generally referred to in industry as CP1.

[81 FR 4145, Jan. 25, 2016, as amended at 82 FR 5742, Jan. 18, 2017; 82 FR 36920, Aug. 7, 2017; 87 FR 57298, Sept. 19, 2022]

§ 431.463 Materials incorporated by reference.

(a) *General.* Certain material is incorporated by reference into this subpart with the approval of the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. To enforce any edition other than that specified in this section, the U.S. Department of Energy (DOE) must publish a document in the FEDERAL REGISTER and the material must be available to the public. All approved incorporation by reference (IBR) material is available for inspection at DOE and at the National Archives and Records Administration (NARA). Contact DOE at: the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Program, Sixth Floor, 950 L'Enfant Plaza SW, Washington, DC 20024, (202) 586–9127, *Buildings@ee.doe.gov, www.energy.gov/eere/buildings/building-technologies-office.* For information on the availability of this material at NARA, email: *fr.inspection@nara.gov,* or go to: *www.archives.gov/federal-register/cfr/ibr-locations.html.* The material may be obtained from the sources in the following paragraphs:

(b) *CSA.* Canadian Standards Association, 5060 Spectrum Way, Suite 100, Mississauga, Ontario, L4W 5N6, Canada, (800) 463–6727. *www.csagroup.org.*

(1) CSA C747–2009 (Reaffirmed 2014), (''CSA C747–2009 (RA 2014)''), ''Energy efficiency test methods for small motors,'' CSA reaffirmed 2014, IBR approved for appendices B and C to this subpart, as follows:

(i) Section 1, ''Scope'';

(ii) Section 3, ''Definitions'';

(iii) Section 5, ''General Test Requirements''; and

(iv) Section 6, ''Test Method.''

(2) [Reserved]

(c) *FM.* FM Global, 1151 Boston-Providence Turnpike, P.O. Box 9102, Norwood, MA 02062, (781) 762–4300. *www.fmglobal.com.*

(1) FM Class Number 1319, ''Approval Standard for Centrifugal Fire Pumps (Horizontal, End Suction Type),'' January 2015, IBR approved for § 431.462.

(2) [Reserved]

(d) *HI.* Hydraulic Institute, 6 Campus Drive, First Floor North, Parsippany, NJ 07054–4406, 973–267–9700. *www.Pumps.org.*

(1) ANSI/HI 1.1–1.2–2014, (''ANSI/HI 1.1–1.2–2014''), ''American National Standard for Rotodynamic Centrifugal Pumps for Nomenclature and Definitions,'' approved October 30, 2014, section 1.1, ''Types and nomenclature,'' and section 1.2.9, ''Rotodynamic pump icons,'' IBR approved for § 431.462.

(2) ANSI/HI 2.1–2.2–2014, (''ANSI/HI 2.1–2.2–2014''), ''American National Standard for Rotodynamic Vertical Pumps of Radial, Mixed, and Axial Flow Types for Nomenclature and Definitions,'' approved April 8, 2014, section 2.1, ''Types and nomenclature,'' IBR approved for § 431.462.

(3) HI 40.6–2014, (''HI 40.6–2014''), ''Methods for Rotodynamic Pump Efficiency Testing,'' (except section

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40.6.5.3, ''Test report;'' Appendix A, section A.7, ''Testing at temperatures exceeding 30 °C (86 °F);'' and Appendix B, ''Reporting of test results (normative);'') copyright 2014, IBR approved for appendix A to subpart Y of part 431.

(4) HI 40.6–2014, (''HI 40.6–2014–B''), ''Methods for Rotodynamic Pump Efficiency Testing'' (except sections 40.6.4.1 ''Vertically suspended pumps'', 40.6.4.2 ''Submersible pumps'', 40.6.5.3 ''Test report'', 40.6.5.5 ''Test conditions'', 40.6.5.5.2 ''Speed of rotation during test'', and 40.6.6.1 ''Translation of test results to rated speed of rotation'', Appendix A ''Test arrangements (normative)'': A.7 ''Testing at temperatures exceeding 30 °C (86 °F)'', and Appendix B, ''Reporting of test results (normative)''), copyright 2014, IBR approved for appendices B and C to this subpart.

(5) HI 40.6–2021, *Hydraulic Institute Standard for Methods for Rotodynamic Pump Efficiency Testing*, approved February 17, 2021; IBR approved for appendix D to this subpart.

(6) HI 41.5–2022, *Hydraulic Institute Program Guideline for Circulator Pump Energy Rating Program*, approved June 16, 2022; IBR approved for appendix D to this subpart.

(e) *IEEE*. Institute of Electrical and Electronics Engineers, Inc., 45 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855–1331, (732) 981–0060. *http://www.ieee.org*.

(1) IEEE Std 113–1985, (''IEEE 113–1985''), ''IEEE Guide: Test Procedures for Direct-Current Machines,'' copyright 1985, IBR approved for appendices B and C to this subpart, as follows:

(i) Section 3, Electrical Measurements and Power Sources for all Test Procedures:

(A) Section 3.1, ''Instrument Selection Factors'';

(B) Section 3.4 ''Power Measurement''; and

(C) Section 3.5 ''Power Sources'';

(ii) Section 4, Preliminary Tests:

(A) Section 4.1, Reference Conditions, Section 4.1.2, ''Ambient Air''; and

(B) Section 4.1, Reference Conditions, Section 4.1.4 ''Direction of Rotation''; and

(iii) Section 5, Performance Determination:

(A) Section 5.4, Efficiency, Section 5.4.1, ''Reference Conditions''; and

(B) Section 5.4.3, Direct Measurements of Input and Output, Section 5.4.3.2 ''Dynomometer or Torquemeter Method.''

(2) IEEE Std 114–2010, (''IEEE 114–2010''), ''IEEE Standard Test Procedure for Single-Phase Induction Motors,'' approved September 30, 2010, IBR approved for appendices B and C to this subpart, as follows:

(i) Section 3, ''General tests'', Section 3.2, ''Tests with load'';

(ii) Section 4 ''Testing facilities''; and

(iii) Section 5, ''Measurements'':

(A) Section 5.2 ''Mechanical measurements'';

(B) Section 5.3 ''Temperature measurements''; and

(iv) Section 6 ''Tests.''

(f) *NFPA*. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169–7471, (617) 770–3000. *www.nfpa.org*.

(1) NFPA 20, (''NFPA 20–2016''), ''Standard for the Installation of Stationary Pumps for Fire Protection,'' 2016 Edition, approved June 15, 2015, IBR approved for § 431.462.

(2) [Reserved]

(g) *NSF*. NSF International. 789 N. Dixboro Road, Ann Arbor, MI 48105, (743) 769–8010. *www.nsf.org*.

(1) NSF/ANSI 50–2015, ''Equipment for Swimming Pools, Spas, Hot Tubs and Other Recreational Water Facilities,'' Annex C, ''(normative Test methods for the evaluation of centrifugal pumps,'' Section C.3, ''Self-priming capability,'' ANSI approved January 26, 2015, IBR approved for § 431.462 and appendices B and C to this subpart.

(2) [Reserved]

(h) *UL*. UL, 333 Pfingsten Road, Northbrook, IL 60062, (847) 272–8800. ul.com.

(1) UL 448, (''ANSI/UL 448–2013''), ''Standard for Safety Centrifugal Stationary Pumps for Fire-Protection Service,'' 10th Edition, June 8, 2007, including revisions through July 12, 2013, IBR approved for § 431.462.

(2) UL 1081, (''ANSI/UL 1081–2016''), ''Standard for Swimming Pool Pumps, Filters, and Chlorinators,'' 7th Edition,

ANSI approved October 21, 2016, IBR approved for § 431.462.

[81 FR 4145, Jan. 25, 2016, as amended at 82 FR 36920, Aug. 7, 2017; 87 FR 57299, Sept. 19, 2022]

§ 431.464 Test procedure for the measurement of energy efficiency, energy consumption, and other performance factors of pumps.

(a) *General pumps*—(1) *Scope.* This paragraph (a) provides the test procedures for determining the constant and variable load pump energy index for:

(i) The following categories of clean water pumps:

(A) End suction close-coupled (ESCC);

(B) End suction frame mounted/own bearings (ESFM);

(C) In-line (IL);

(D) Radially split, multi-stage, vertical, in-line casing diffuser (RSV); and

(E) Submersible turbine (ST) pumps.

(ii) With the following characteristics:

(A) Flow rate of 25 gpm or greater at BEP and full impeller diameter;

(B) Maximum head of 459 feet at BEP and full impeller diameter and the number of stages required for testing (see section 1.2.2 of appendix A of this subpart);

(C) Design temperature range from 14 to 248 °F;

(D) Designed to operate with either:

(*1*) A 2- or 4-pole induction motor; or

(*2*) A non-induction motor with a speed of rotation operating range that includes speeds of rotation between 2,880 and 4,320 revolutions per minute (rpm) and/or 1,440 and 2,160 rpm, and in either case, the driver and impeller must rotate at the same speed;

(E) For ST pumps, a 6-inch or smaller bowl diameter; and

(F) For ESCC and ESFM pumps, a specific speed less than or equal to 5,000 when calculated using U.S. customary units.

(iii) Except for the following pumps:

(A) Fire pumps;

(B) Self-priming pumps;

(C) Prime-assist pumps;

(D) Magnet driven pumps;

(E) Pumps designed to be used in a nuclear facility subject to 10 CFR part 50, ‘‘Domestic Licensing of Production and Utilization Facilities’’; and

(F) Pumps meeting the design and construction requirements set forth in Military Specifications: MIL–P–17639F, ‘‘Pumps, Centrifugal, Miscellaneous Service, Naval Shipboard Use’’ (as amended); MIL–P–17881D, ‘‘Pumps, Centrifugal, Boiler Feed, (Multi-Stage)’’ (as amended); MIL–P–17840C, ‘‘Pumps, Centrifugal, Close-Coupled, Navy Standard (For Surface Ship Application)’’ (as amended); MIL–P–18682D, ‘‘Pump, Centrifugal, Main Condenser Circulating, Naval Shipboard’’ (as amended); and MIL–P–18472G, ‘‘Pumps, Centrifugal, Condensate, Feed Booster, Waste Heat Boiler, And Distilling Plant’’ (as amended). Military specifications and standards are available for review at *http://everyspec.com/MIL-SPECS.*

(2) *Testing and calculations.* Determine the applicable constant load pump energy index (PEI_{CL}) or variable load pump energy index (PEI_{VL}) using the test procedure set forth in appendix A of this subpart.

(b) *Dedicated-purpose pool pumps*—(1) *Scope.* This paragraph (b) provides the test procedures for determining the weighted energy factor (WEF), rated hydraulic horsepower, dedicated-purpose pool pump nominal motor horsepower, dedicated-purpose pool pump motor total horsepower, dedicated-purpose pool pump service factor, and other pump performance parameters for:

(i) The following varieties of dedicated-purpose pool pumps:

(A) Self-priming pool filter pumps;

(B) Non-self-priming pool filter pumps;

(C) Waterfall pumps; and

(D) Pressure cleaner booster pumps;

(ii) Served by single-phase or polyphase input power;

(iii) Except for:

(A) Submersible pumps; and

(B) Self-priming and non-self-priming pool filter pumps with hydraulic output power greater than or equal to 2.5 horsepower.

(2) *Testing and calculations.* Determine the weighted energy factor (WEF) using the test procedure set forth in appendix B or appendix C of this subpart, as applicable.

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(c) *Circulator pumps*—(1) *Scope*. This paragraph (c) provides the test procedures for determining the circulator energy index for circulator pumps that are also clean water pumps, including on-demand circulator pumps and circulators-less-volute, and excluding submersible pumps and header pumps.

(2) *Testing and calculations*. Determine the circulator energy index (CEI) using the test procedure set forth in appendix D of this subpart Y.

[82 FR 36923, Aug. 7, 2017, as amended at 87 FR 57299, Sept. 19, 2022]

§ 431.465 Pumps energy conservation standards and their compliance dates.

(a) For the purposes of paragraph (b) of this section, "PEI_{CL}" means the constant load pump energy index and "PEI_{VL}" means the variable load pump energy index, both as determined in accordance with the test procedure in § 431.464. For the purposes of paragraph (c) of this section, "BEP" means the best efficiency point as determined in accordance with the test procedure in § 431.464.

(b) Each pump that is manufactured starting on January 27, 2020 and that:

(1) Is in one of the equipment classes listed in the table in paragraph (b)(4) of this section;

(2) Meets the definition of a clean water pump in § 431.462;

(3) Is not listed in paragraph (c) of this section; and

(4) Conforms to the characteristics listed in paragraph (d) of this section must have a PEI_{CL} or PEI_{VL} rating of not more than 1.00 using the appropriate C-value in the table in this paragraph (b)(4):

Equipment class [1]	Maximum PEI [2]	C-value [3]
ESCC.1800.CL	1.00	128.47
ESCC.3600.CL	1.00	130.42
ESCC.1800.VL	1.00	128.47
ESCC.3600.VL	1.00	130.42
ESFM.1800.CL	1.00	128.85
ESFM.3600.CL	1.00	130.99
ESFM.1800.VL	1.00	128.85
ESFM.3600.VL	1.00	130.99
IL.1800.CL	1.00	129.30
IL.3600.CL	1.00	133.84
IL.1800.VL	1.00	129.30
IL.3600.VL	1.00	133.84
RSV.1800.CL	1.00	129.63
RSV.3600.CL	1.00	133.20
RSV.1800.VL	1.00	129.63
RSV.3600.VL	1.00	133.20
ST.1800.CL	1.00	138.78
ST.3600.CL	1.00	134.85
ST.1800.VL	1.00	138.78
ST.3600.VL	1.00	134.85

[1] Equipment class designations consist of a combination (in sequential order separated by periods) of: (1) An equipment family (ESCC = end suction close-coupled, ESFM = end suction frame mounted/own bearing, IL = in-line, RSV = radially split, multi-stage, vertical, in-line diffuser casing, ST = submersible turbine; all as defined in § 431.462); (2) nominal speed of rotation (1800 = 1800 rpm, 3600 = 3600 rpm); and (3) an operating mode (CL = constant load, VL = variable load). Determination of the operating mode is determined using the test procedure in appendix A to this subpart.

[2] For equipment classes ending in .CL, the relevant PEI is PEI_{CL}. For equipment classes ending in .VL, the relevant PEI is PEI_{VL}.

[3] The C-values shown in this table must be used in the equation for PER_{STD} when calculating PEI_{CL} or PEI_{VL}, as described in section II.B of appendix A to this subpart.

(c) The energy efficiency standards in paragraph (b) of this section do not apply to the following pumps:

(1) Fire pumps;

(2) Self-priming pumps;

(3) Prime-assist pumps;

(4) Magnet driven pumps;

(5) Pumps designed to be used in a nuclear facility subject to 10 CFR part 50, "Domestic Licensing of Production and Utilization Facilities";

(6) Pumps meeting the design and construction requirements set forth in Military Specification MIL–P–17639F, "Pumps, Centrifugal, Miscellaneous Service, Naval Shipboard Use" (as amended); MIL–P–17881D, "Pumps, Centrifugal, Boiler Feed, (Multi-Stage)" (as amended); MIL–P–17840C, "Pumps, Centrifugal, Close-Coupled, Navy Standard (For Surface Ship Application)" (as amended); MIL–P–18682D, "Pump, Centrifugal, Main Condenser Circulating, Naval Shipboard" (as amended); MIL–P–18472G, "Pumps, Centrifugal, Condensate, Feed Booster, Waste Heat Boiler, And Distilling Plant" (as amended). Military specifications and standards are available for review at *http://everyspec.com/MIL-SPECS*.

(d) The energy conservation standards in paragraph (b) of this section apply only to pumps that have the following characteristics:

(1) Flow rate of 25 gpm or greater at BEP at full impeller diameter;

(2) Maximum head of 459 feet at BEP at full impeller diameter and the number of stages required for testing;

(3) Design temperature range from 14 to 248 °F;

(4) Designed to operate with either:

(i) A 2- or 4-pole induction motor; or

(ii) A non-induction motor with a speed of rotation operating range that includes speeds of rotation between 2,880 and 4,320 revolutions per minute and/or 1,440 and 2,160 revolutions per minute; and

(iii) In either case, the driver and impeller must rotate at the same speed;

(5) For ST pumps, a 6-inch or smaller bowl diameter; and

(6) For ESCC and ESFM pumps, specific speed less than or equal to 5,000 when calculated using U.S. customary units.

(e) For the purposes of paragraph (f) of this section, "WEF" means the weighted energy factor and "hhp" means the rated hydraulic horsepower, as determined in accordance with the test procedure in § 431.464(b) and applicable sampling plans in § 429.59 of this chapter.

(f) Each dedicated-purpose pool pump that is not a submersible pump and is manufactured starting on July 19, 2021 must have a WEF rating that is not less than the value calculated from the following table:

Equipment class		Minimum allowable WEF score [kgal/kWh]	Minimum allowable WEF score [kgal/kWh]
Dedicated-purpose pool pump variety	hhp Applicability	Motor phase	
Self-priming pool filter pumps	0.711 hp ≤hhp <2.5 hp.	Single	WEF = −2.30 * ln (hhp) + 6.59.
Self-priming pool filter pumps	hhp <0.711 hp	Single	WEF = 5.55, for hhp ≤0.13 hp −1.30 * ln (hhp) + 2.90, for hhp >0.13 hp.
Non-self-priming pool filter pumps.	hhp <2.5 hp	Any	WEF = 4.60, for hhp ≤0.13 hp −0.85 * ln (hhp) + 2.87, for hhp >0.13 hp.
Pressure cleaner booster pumps.	Any	Any	WEF = 0.42.

(g) Each integral cartridge filter pool pump and integral sand filter pool pump that is manufactured starting on July 19, 2021 must be distributed in commerce with a pool pump timer that is either integral to the pump or a separate component that is shipped with the pump.

(h) For all dedicated-purpose pool pumps distributed in commerce with freeze protection controls, the pump must be shipped with freeze protection disabled or with the following default, user-adjustable settings:

(1) The default dry-bulb air temperature setting is no greater than 40 °F;

(2) The default run time setting shall be no greater than 1 hour (before the temperature is rechecked); and

(3) The default motor speed shall not be more than ½ of the maximum available speed.

[81 FR 4431, Jan. 26, 2016, as amended at 82 FR 5742, Jan. 18, 2017]

§ 431.466 Pumps labeling requirements.

(a) *General pumps*. For the pumps described in § 431.464(a), the following requirements apply to units manufactured on the same date that compliance is required with any applicable standards prescribed in § 431.465.

(1) *Pump nameplate*—(i) *Required information*. The permanent nameplate must be marked clearly with the following information:

(A) For bare pumps and pumps sold with electric motors but not continuous or non-continuous controls, the rated pump energy index—constant load (PEI_{CL}), and for pumps sold with motors and continuous or non-continuous controls, the rated pump energy index—variable load (PEI_{VL});

(B) The bare pump model number; and

(C) If transferred directly to an end-user, the unit's impeller diameter, as distributed in commerce. Otherwise, a space must be provided for the impeller diameter to be filled in.

(ii) *Display of required information*. All orientation, spacing, type sizes, typefaces, and line widths to display this required information must be the same as or similar to the display of the other performance data on the pump's permanent nameplate. The PEI_{CL} or PEI_{VL}, as appropriate to a given pump model, must be identified in the form ‘‘PEI_{CL} _______’’ or ‘‘PEI_{VL} _______.’’ The model number must be in one of the following forms: ‘‘Model _______’’ or ‘‘Model number _______’’ or ‘‘Model No. _______.’’ The unit's impeller diameter must be in the form ‘‘Imp. Dia. _______(in.).’’

(2) *Disclosure of efficiency information in marketing materials.* (i) The same information that must appear on a pump's permanent nameplate pursuant to paragraph (a)(1)(i) of this section, must also be prominently displayed:

(A) On each page of a catalog that lists the pump; and

(B) In other materials used to market the pump.

(ii) [Reserved]

(b) *Dedicated-purpose pool pumps.* For the pumps described in § 431.464(b), the following requirements apply on the same date that compliance is required with any applicable standards prescribed in § 431.465.

(1) *Pump nameplate*—(i) *Required information.* The permanent nameplate must be marked clearly with the following information:

(A) The weighted energy factor (WEF); and

(B) The dedicated-purpose pool pump motor total horsepower.

(ii) *Display of required information.* All orientation, spacing, type sizes, typefaces, and line widths to display this required information must be the same as or similar to the display of the other performance data on the pump's permanent nameplate.

(A) The WEF must be identified in the form ‘‘WEF _______.’’

(B) The dedicated-purpose pool pump motor total horsepower must be identified in one of the following forms: ‘‘Dedicated-purpose pool pump motor total horsepower ________,’’ ‘‘DPPP motor total horsepower ________,’’ ‘‘motor total horsepower ________,’’ ‘‘motor THP ________,’’ or ‘‘THP ________.’’

(2) [Reserved]

[82 FR 36923, Aug. 7, 2017]

APPENDIX A TO SUBPART Y OF PART 431—UNIFORM TEST METHOD FOR THE MEASUREMENT OF ENERGY CONSUMPTION OF PUMPS

NOTE: Starting on July 25, 2016, any representations made with respect to the energy use or efficiency of pumps subject to testing pursuant to 10 CFR 431.464(a) must be made in accordance with the results of testing pursuant to this appendix.

I. TEST PROCEDURE FOR PUMPS

A. *General.* To determine the constant load pump energy index (PEI_{CL}) for bare pumps and pumps sold with electric motors or the variable load pump energy index (PEI_{VL}) for pumps sold with electric motors and continuous or non-continuous controls, perform testing in accordance with HI 40.6–2014, except section 40.6.5.3, ‘‘Test report;’’ section A.7, ‘‘Testing at temperatures exceeding 30 °C (86 °F);’’ and appendix B, ‘‘Reporting of test results;’’ (incorporated by reference, see § 431.463) with the modifications and additions as noted throughout the provisions below. Where HI 40.6–2014 refers to ‘‘pump,’’ the term refers to the ‘‘bare pump,’’ as defined in § 431.462. Also, for the purposes of applying this appendix, the term ‘‘volume per unit time,’’ as defined in section 40.6.2, ‘‘Terms and definitions,’’ of HI 40.6–2014 shall be deemed to be synonymous with the term ‘‘flow rate’’ used throughout that standard and this appendix. In addition, the specifications of section 40.6.4.1 of HI 40.6–2014 do not apply to ST pumps and the performance of ST bare pumps considers the bowl performance only.

A.1 Scope. Section II of this appendix is applicable to all pumps and describes how to calculate the pump energy index (section II.A) based on the pump energy rating for the minimally compliant reference pump (PER_{STD}; section II.B) and the constant load pump energy rating (PER_{CL}) or variable load pump energy rating (PER_{VL}) determined in accordance with one of sections III through VII of this appendix, based on the configuration in which the pump is distributed in commerce and the applicable testing method specified in sections III through VII and as described in Table 1 of this appendix.

TABLE 1—APPLICABILITY OF CALCULATION-BASED AND TESTING-BASED TEST PROCEDURE OPTIONS BASED ON PUMP CONFIGURATION

Pump configuration	Pump sub-configuration	Applicable test methods
Bare Pump	Bare Pump OR Pump + Single-Phase Induction Motor OR Pump + Driver Other Than Electric Motor	Section III: Test Procedure for Bare Pumps.
Pump + Motor *	Pump + Polyphase Motor Covered by DOE's Electric Motor Energy Conservation Standards **. OR Pump + Submersible Motor	Section IV: Testing-Based Approach for Pumps Sold with Motors OR Section V: Calculation-Based Approach for Pumps Sold with Motors.
	Pump + Motor Not Covered by DOE's Electric Motor Energy Conservation Standards (Except Submersible Motors) ** ***.	Section IV: Testing-Based Approach for Pumps Sold with Motors.
Pump + Motor + Continuous Controls. OR Pump + Motor + Non-Continuous Controls.	Pump + Polyphase Motor Covered by DOE's Electric Motor Energy Conservation Standards** + Continuous Control. OR Pump + Submersible Motor + Continuous Control.	Section VI: Testing-Based Approach for Pumps Sold with Motors and Controls OR Section VII: Calculation-Based Approach for Pumps Sold with Motors Controls.
	Pump + Polyphase Motor Covered by DOE's Electric Motor Energy Conservation Standards** + Non-Continuous Control. OR Pump + Submersible Motor + Non-Continuous Control.	Section VI: Testing-Based Approach for Pumps Sold with Motors and Controls.
	Pump + Motor Not Covered by DOE's Electric Motor Energy Conservation Standards (Except Submersible Motors) ** *** + Continuous or Non-Continuous Controls.	Section VI: Testing-Based Approach for Pumps Sold with Motors and Controls.

* Also applies if unit is sold with controls other than continuous or non-continuous controls (*e.g.,* ON/OFF switches).
** All references to "Motors Covered by DOE's Electric Motor Energy Conservation Standards" refer to those listed at § 431.25(g) of this chapter.
*** Includes pumps sold with single-phase induction motors.

A.2 Section III of this appendix addresses the test procedure applicable to bare pumps. This test procedure also applies to pumps sold with drivers other than motors and pumps sold with single-phase induction motors.

A.3 Section IV of this appendix addresses the testing-based approach for pumps sold with motors, which is applicable to all pumps sold with electric motors, including single-phase induction motors. This test procedure also applies to pumps sold with controls other than continuous or non-continuous controls (*e.g.*, on/off switches).

A.4 Section V of this appendix addresses the calculation-based approach for pumps sold with motors, which applies to:

(1) Pumps sold with polyphase electric motors regulated by DOE's energy conservation standards for electric motors at § 431.25(g), and

(2) Pumps sold with submersible motors.

A.5 Section VI of this appendix addresses the testing-based approach for pumps sold with motors and controls, which is applicable to all pumps sold with electric motors (including single-phase induction motors) and continuous or non-continuous controls.

A.6 Section VII of this appendix discusses the calculation-based approach for pumps sold with motors and controls, which applies to:

(1) Pumps sold with polyphase electric motors regulated by DOE's energy conservation standards for electric motors at § 431.25(g) and continuous controls and

(2) Pumps sold with submersible motors and continuous controls.

B. *Measurement Equipment*. For the purposes of measuring pump power input, driver power input to the motor or controls, and pump power output, the equipment specified in HI 40.6–2014 Appendix C (incorporated by reference, see § 431.463) necessary to measure head, speed of rotation, flow rate, temperature, torque, and electrical power must be used and must comply with the stated accuracy requirements in HI 40.6–2014 Table 40.6.3.2.3 except as noted in sections III.B, IV.B, V.B, VI.B, and VII.B of this appendix. When more than one instrument is used to measure a given parameter, the combined accuracy, calculated as the root sum of squares of individual instrument accuracies, must meet the specified accuracy requirements.

C. *Test Conditions*. Conduct testing at full impeller diameter in accordance with the test conditions, stabilization requirements, and specifications of HI 40.6–2014 (incorporated by reference, see § 431.463) section 40.6.3, "Pump efficiency testing;" section 40.6.4, "Considerations when determining the efficiency of a pump;" section 40.6.5.4 (including appendix A), "Test arrangements;" and section 40.6.5.5, "Test conditions.". For ST pumps, head measurements must be based on the bowl assembly total head as described in section A.5 of 40.6–2014 and the pump power input or driver power input, as applicable, must be based on the measured input power to the driver or bare pump, respectively; section 40.6.4.1, "vertically suspended pumps," does not apply to ST pumps.

C.1 Nominal Speed of Rotation. Determine the nominal speed of rotation based on the range of speeds of rotation at which the pump is designed to operate, in accordance with sections I.C.1.1, I.C.1.2, I.C.1.3, I.C.1.4, or I.C.1.5 of this appendix, as applicable. When determining the range of speeds at which the pump is designed to operate, DOE will refer to published data, marketing literature, and other publicly-available information about the pump model and motor, as applicable.

C.1.1 For pumps sold without motors, select the nominal speed of rotation based on the speed for which the pump is designed. For bare pumps designed for speeds of rotation including 2,880 to 4,320 revolutions per minute (rpm), the nominal speed of rotation shall be 3,600 rpm. For bare pumps designed for speeds of rotation including 1,440 to 2,160 rpm, the nominal speed of rotation shall be 1,800 rpm.

C.1.2 For pumps sold with 4-pole induction motors, the nominal speed of rotation shall be 1,800 rpm.

C.1.3 For pumps sold with 2-pole induction motors, the nominal speed of rotation shall be 3,600 rpm.

C.1.4 For pumps sold with non-induction motors where the operating range of the pump and motor includes speeds of rotation between 2,880 and 4,320 rpm, the nominal speed of rotation shall be 3,600 rpm.

C.1.5 For pumps sold with non-induction motors where the operating range of the pump and motor includes speeds of rotation between 1,440 and 2,160 rpm, the nominal speed of rotation shall be 1,800 rpm.

C.2 Multi-stage Pumps. For RSV and ST pumps, perform testing on the pump with three stages for RSV pumps and nine stages for ST pumps. If the basic model of pump being tested is only available with fewer than the required number of stages, test the pump with the maximum number of stages with which the basic model is distributed in commerce in the United States. If the basic model of pump being tested is only available with greater than the required number of stages, test the pump with the lowest number of stages with which the basic model is distributed in commerce in the United States. If the basic model of pump being tested is available with both fewer and greater than the required number of stages, but not the required number of stages, test the pump with the number of stages closest to the required number of stages. If both the next lower and next higher number of stages are equivalently close to the required number of stages, test the pump with the next higher number of stages.

C.3 Twin Head Pumps. For twin head pumps, perform testing on an equivalent single impeller IL pump, constructed by incorporating one of the driver and impeller assemblies of the twin head pump being rated into an adequate, IL style, single impeller volute and casing. An adequate, IL style, single impeller volute and casing means a volute and casing for which any physical and functional characteristics that affect energy consumption and energy efficiency are the same to their corresponding characteristics for a single impeller in the twin head pump volute and casing.

D. Data Collection and Analysis

D.1 Damping Devices. Use of damping devices, as described in section 40.6.3.2.2 of HI 40.6 – 2014 (incorporated by reference, see § 431.463), are only permitted to integrate up to the data collection interval used during testing.

D.2 Stabilization. Record data at any tested load point only under stabilized conditions, as defined in HI 40.6–2014 section 40.6.5.5.1 (incorporated by reference, see § 431.463), where a minimum of two measurements are used to determine stabilization.

D.3 Calculations and Rounding. Normalize all measured data to the nominal speed of rotation of 3,600 or 1,800 rpm based on the nominal speed of rotation selected for the pump in section I.C.1 of this appendix, in accordance with the procedures specified in section 40.6.6.1.1 of HI 40.6–2014 (incorporated by reference, see § 431.463). Except for the "expected BEP flow rate," all terms and quantities refer to values determined in accordance with the procedures set forth in this appendix for the rated pump. Perform all calculations using raw measured values without rounding. Round PER_{CL} and PER_{VL} to three significant digits, and round PEI_{CL}, and PEI_{VL} values, as applicable, to the hundredths place (*i.e.*, 0.01).

D.4 Pumps with BEP at Run Out.

Test pumps for which the expected BEP corresponds to a volume rate of flow that is within 20 percent of the expected maximum flow rate at which the pump is designed to operate continuously or safely (*i.e.*, pumps with BEP at run-out) in accordance with the test procedure specified in this appendix, but with the following exceptions:

(1) Use the following seven flow points for determination of BEP in sections III.D, IV.D, V.D, VI.D, and VII.D of this appendix instead

of those specified in those sections: 40, 50, 60, 70, 80, 90, and 100 percent of the expected.

(2) Use flow points of 60, 70, 80, 90, and 100 percent of the expected maximum flow rate of the pump to determine pump power input or driver power input at the specified load points in section III.E.1.1, IV.E.1, V.E.1.1, VI.E.1, and VII.E.1.1 of this appendix instead of those specified in those sections.

(3) To determine of PER_{CL} and PER_{STD}, use load points of 65, 90, and 100 percent of the BEP flow rate determined with the modified flow points specified in this section I.D.4 of this appendix instead of 75, 100, and 110 percent of BEP flow.

II. CALCULATION OF THE PUMP ENERGY INDEX

A. Determine the PEI of each tested pump based on the configuration in which it is sold, as follows:

A.1. For pumps rated as bare pumps or pumps sold with motors, determine the PEI_{CL} using the following equation:

$$PEI_{CL} = \frac{PER_{CL}}{PER_{STD}}$$

Where:

PEI_{CL} = the pump energy index for a constant load (hp),

PER_{CL} = the pump energy rating for a constant load (hp), determined in accordance with either section III (for bare pumps, pumps sold with single-phase induction motors, and pumps sold with drivers other than electric motors), section IV (for pumps sold with motors and rated using the testing-based approach), or section V (for pumps sold with motors and rated using the calculation-based approach) of this appendix, and

PER_{STD} = the PER_{CL} for a pump that is minimally compliant with DOE's energy conservation standards with the same flow and specific speed characteristics as the tested pump (hp), as determined in accordance with section II.B of this appendix.

A.2 For pumps rated as pumps sold with motors and continuous controls or non-continuous controls, determine the PEI_{VL} using the following equation:

$$PEI_{VL} = \frac{PER_{VL}}{PER_{STD}}$$

Where:

PEI_{VL} = the pump energy index for a variable load,

PER_{VL} = the pump energy rating for a variable load (hp) determined in accordance with section VI (for pumps sold with motors and continuous or non-continuous controls rated using the testing-based approach) or section VII of this appendix (for pumps sold with motors and continuous controls rated using the calculation-based approach), and

PER_{STD} = the PER_{CL} for a pump that is minimally compliant with DOE's energy conservation standards with the same flow and specific speed characteristics as the tested pump (hp), as determined in accordance with section II.B of this appendix.

B. Determine the pump energy rating for the minimally compliant reference pump (PER_{STD}), according to the following equation:

$$PER_{STD} = \sum_{i=75\%,100\%,110\%} \omega_i P_i^{in,m}$$

Where:

PER_{STD} = the PER_{CL} for a pump that is minimally compliant with DOE's energy conservation standards with the same flow and specific speed characteristics as the tested pump (hp),

ω_i = 0.3333,

$P_i^{in,m}$ = calculated driver power input to the motor at load point i for the minimally compliant pump (hp), calculated in accordance with section II.B.1of this appendix, and

i = load point corresponding to 75, 100, or 110 percent of the BEP flow rate.

B.1. Determine the driver power input at each load point corresponding to 75, 100, or 110 percent of the BEP flow rate as follows:

$$P_i^{in,m} = P_i + L_i$$

Where:

$P_i^{in,m}$ = driver power input to the motor at load point i (hp),

P_i = pump power input to the bare pump at load point i (hp), calculated in accordance with section II.B.1.1 of this appendix,

L_i = the part load motor losses at load point i (hp), calculated in accordance with section II.B.1.2 of this appendix, and

i = load point corresponding to 75, 100, or 110 percent of the BEP flow rate.

B.1.1. Determine the pump power input to the minimally compliant pump at each load point corresponding to 75, 100, or 110 percent of the BEP flow rate as follows:

$$P_i = \frac{P_{u,i}}{\alpha_i \times \left(\eta_{pump,STD} / 100 \right)}$$

Where:

P_i = pump power input to the bare pump at load point i (hp),

α_i = 0.947 for 75 percent of the BEP flow rate, 1.000 for 100 percent of the BEP flow rate, and 0.985 for 110 percent of the BEP flow rate;

$P_{u,i}$ = the pump power output at load point i of the tested pump (hp), as determined in accordance with section II.B.1.1.2 of this appendix;

$\eta_{pump,STD}$ = the minimally compliant pump efficiency (%), calculated in accordance with section II.B.1.1.1 of this appendix; and

i = load point corresponding to 75, 100, or 110 percent of the BEP flow rate.

B.1.1.1 Calculate the minimally compliant pump efficiency based on the following equation:

$\eta_{pump,STD} = -0.8500 \times \ln(Q_{100\neq})^2 - 0.3800 \times \ln(Ns) \times \ln(Q_{100\neq}) - 11.480 \times \ln(Ns)^2 + 17.800 \times \ln(Q_{100\neq}) + 179.80 \times \ln(Ns) - (C + 555.60$

Where:

$\eta_{pump,STD}$ = minimally compliant pump efficiency (%),

$Q_{100\neq}$ = the BEP flow rate of the tested pump at full impeller and nominal speed of rotation (gpm),

Ns = specific speed of the tested pump determined in accordance with section II.B.1.1.1.1 of this appendix, and

C = the appropriate C-value for the category and nominal speed of rotation of the tested pump, as listed at § 431.466.

B.1.1.1.1 Determine the specific speed of the rated pump using the following equation:

$$N_s = \frac{n_{sp} \times \sqrt{Q_{100\%}}}{(H_{100\%}/S)^{0.75}}$$

Where:

Ns = specific speed,

n_{sp} = the nominal speed of rotation (rpm),

$Q_{100\neq}$ = the measured BEP flow rate of the tested pump at full impeller and nominal speed of rotation (gpm),

$H_{100\neq}$ = pump total head at 100 percent of the BEP flow rate of the tested pump at full impeller and nominal speed of rotation (ft), and

S = the number of stages with which the pump is being rated.

B.1.1.2 Determine the pump power output at each load point corresponding to 75, 100, or 110 percent of the BEP flow rate using the following equation:

$$P_{u,i} = \frac{Q_i \times H_i \times SG}{3956}$$

Where:

$P_{u,i}$ = the measured pump power output at load point i of the tested pump (hp),

Q_i = the measured flow rate at load point i of the tested pump (gpm),

H_i = pump total head at load point i of the tested pump (ft),

SG = the specific gravity of water at specified test conditions, which is equivalent to 1.00, and

i = load point corresponding to 75, 100, or 110 percent of the BEP flow rate.

B.1.2 Determine the motor part load losses at each load point corresponding to 75, 100, or 110 percent of the BEP flow rate as follows:

$L_i = L_{full} \times y_i$

Where:

L_i = part load motor losses at load point i (hp),

L_{full} = motor losses at full load (hp), as determined in accordance with section II.B.1.2.1 of this appendix,

y_i = part load loss factor at load point i determined in accordance with section II.B.1.2.2 of this appendix, and

i = load point corresponding to 75, 100, or 110 percent of the BEP flow rate.

B.1.2.1 Determine the full load motor losses using the appropriate motor efficiency value and horsepower as shown in the following equation:

$$L_{full} = \frac{MotorHP}{\left[\eta_{motor,full}/100\right]} - MotorHP$$

Where:

L_{full} = motor losses at full load (hp),

MotorHP = the motor horsepower as determined in accordance with section II.B.1.2.1.1 of this appendix (hp), and

$\eta_{motor,full}$ = the default nominal full load motor efficiency as determined in accordance with section II.B.1.2.1.2 of this appendix (%).

B.1.2.1.1 Determine the motor horsepower as follows:

• For bare pumps other than ST pumps, the motor horsepower is determined as the horsepower rating listed in Table 2 of this appendix that is either equivalent to, or the next highest horsepower greater than, the pump power input to the bare pump at 120 percent of the BEP flow rate of the tested pump.

• For ST bare pumps, the motor horsepower is determined as the horsepower rating listed in Table 2 of this appendix that, is either equivalent to, or the next highest horsepower greater than, the pump power input to the bare pump at 120 percent of the BEP flow rate of the tested pump divided by a service factor of 1.15.

• For pumps sold with motors, pumps sold with motors and continuous controls, or pumps sold with motors and non-continuous controls, the motor horsepower is the rated horsepower of the motor with which the pump is being tested.

B.1.2.1.2 Determine the default nominal full load motor efficiency as described in section II.B.1.2.1.2.1 of this appendix for pumps other than ST pumps or II.B.1.2.1.2.2 of this appendix for ST pumps.

B.1.2.1.2.1. For pumps other than ST pumps, the default nominal full load motor

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efficiency is the minimum of the nominal full load motor efficiency standards (open or enclosed) from the table containing the current energy conservation standards for NEMA Design B motors at § 431.25, with the number of poles relevant to the speed at which the pump is being tested (see section I.C.1 of this appendix) and the motor horsepower determined in section II.B.1.2.1.1 of this appendix.

B.1.2.1.2.2. For ST pumps, the default nominal full load motor efficiency is the default nominal full load submersible motor efficiency listed in Table 2 of this appendix, with the number of poles relevant to the speed at which the pump is being tested (see section I.C.1 of this appendix) and the motor horsepower determined in section II.B.1.2.1.1 of this appendix.

B.1.2.2 Determine the part load loss factor at each load point corresponding to 75, 100, or 110 percent of the BEP flow rate as follows:

$$y_i = -0.4508 \times \left(\frac{P_i}{MotorHP}\right)^3 + 1.2399 \times \left(\frac{P_i}{MotorHP}\right)^2 - 0.4301 \times \left(\frac{P_i}{MotorHP}\right) + 0.6410$$

Where:

y_i = the part load loss factor at load point i,

P_i = pump power input to the bare pump at load point i (hp),

MotorHP = the motor horsepower (hp), as determined in accordance with section II.B.1.2.1.1 of this appendix,

i = load point corresponding to 75, 100, or 110 percent of the BEP flow rate, and

$\frac{P_i}{MotorHP} \leq 1.000$; if $\frac{P_i}{MotorHP} > 1.000$, then set $\frac{P_i}{MotorHP} = 1.000$ in the equation in this section II.B.1.2.2 to calculate the part load loss factor at each load point i.

III. Test Procedure for Bare Pumps

A. *Scope*. This section III applies only to:

(1) Bare pumps,

(2) Pumps sold with drivers other than electric motors, and

(3) Pumps sold with single-phase induction motors.

B. *Measurement Equipment*. The requirements regarding measurement equipment presented in section I.B of this appendix apply to this section III, and in addition, when testing pumps using a calibrated motor:

(1) Electrical measurement equipment must be capable of measuring true RMS current, true RMS voltage, and real power up to the 40th harmonic of fundamental supply source frequency, and

(2) Any instruments used to measure a particular parameter specified in paragraph (1) must have a combined accuracy of ±2.0 percent of the measured value at the fundamental supply source frequency, where combined accuracy is the root sum of squares of individual instrument accuracies.

C. *Test Conditions*. The requirements regarding test conditions presented in section I.C of this appendix apply to this section III. When testing pumps using a calibrated motor the following conditions also apply to the mains power supplied to the motor:

(1) Maintain the voltage within ±5 percent of the rated value of the motor,

(2) Maintain the frequency within ±1 percent of the rated value of the motor,

(3) Maintain the voltage unbalance of the power supply within ±3 percent of the rated values of the motor, and

(2) Maintain total harmonic distortion below 12 percent throughout the test.

D. *Testing BEP for the Pump*. Determine the best efficiency point (BEP) of the pump as follows:

D.1. Adjust the flow by throttling the pump without changing the speed of rotation of the pump and conduct the test at a minimum of the following seven flow points: 40, 60, 75, 90, 100, 110, and 120 percent of the expected BEP flow rate of the pump at the nominal speed of rotation, as specified in HI 40.6–2014, except section 40.6.5.3, section A.7, and appendix B (incorporated by reference, see § 431.463).

D.2. Determine the BEP flow rate as the flow rate at the operating point of maximum pump efficiency on the pump efficiency curve, as determined in accordance with section 40.6.6.3 of HI 40.6–2014 (incorporated by reference, see §431.463), where the pump efficiency is the ratio of the pump power output divided by the pump power input, as specified in Table 40.6.2.1 of HI 40.6–2014, disregarding the calculations provided in section 40.6.6.2.

E. *Calculating the Constant Load Pump Energy Rating*. Determine the PER_{CL} of each tested pump using the following equation:

$$PER_{CL} = \sum_{i=75\%,100\%,110\%} \omega_i P_i^{in,m}$$

Where:

PER_{CL} = the pump energy rating for a constant load (hp),

ω_i = 0.3333,

$P_i^{in,m}$ = calculated driver power input to the motor at load point i (hp), as determined in accordance with section III.E.1 of this appendix, and

i = load point corresponding to 75, 100, or 110 percent of the BEP flow rate.

E.1 Determine the driver power input at each load point corresponding to 75, 100, or 110 percent of the BEP flow rate as follows:

$$P_i^{in,m} = P_i + L_i$$

Where:

$P_i^{in,m}$ = driver power input to the motor at load point i (hp),

P_i = pump power input to the bare pump at load point i (hp), as determined in section III.E.1.1 of this appendix,

L_i = the part load motor losses at load point i (hp), as determined in accordance with section III.E.1.2 of this appendix, and

i = load point corresponding to 75, 100, or 110 percent of the BEP flow rate.

E.1.1 Determine the pump power input at 75, 100, 110, and 120 percent of the BEP flow rate by employing a least squares regression to determine a linear relationship between the pump power input at the nominal speed of rotation of the pump and the measured flow rate at the following load points: 60, 75, 90, 100, 110, and 120 percent of the expected BEP flow rate. Use the linear relationship to determine the pump power input at the nominal speed of rotation for the load points of 75, 100, 110, and 120 percent of the BEP flow rate.

E.1.2 Determine the motor part load losses at each load point corresponding to 75, 100, or 110 percent of the BEP flow rate as follows:

$L_i = L_{full} \times y_i$

Where:

L_i = motor losses at load point i (hp),

L_{full} = motor losses at full load (hp), as determined in accordance with section III.E.1.2.1 of this appendix,

y_i = loss factor at load point i as determined in accordance with section III.E.1.2.2 of this appendix, and

i = load point corresponding to 75, 100, or 110 percent of the BEP flow rate.

E.1.2.1 Determine the full load motor losses using the appropriate motor efficiency value and horsepower as shown in the following equation:

$$L_{full} = \frac{MotorHP}{\left[{\eta_{motor,full}}/{100}\right]} - MotorHP$$

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Where:

L_{full} = motor losses at full load (hp);

MotorHP = the motor horsepower (hp), as determined in accordance with section II.E.1.2.1.1 of this appendix, and

$\eta_{motor,full}$ = the default nominal full load motor efficiency (%), as determined in accordance with section III.E.1.2.1.2 of this appendix.

E.1.2.1.1 Determine the motor horsepower as follows:

- For bare pumps other than ST pumps, determine the motor horsepower by selecting the horsepower rating listed in Table 2 of this appendix that is either equivalent to, or the next highest horsepower greater than, the pump power input to the bare pump at 120 percent of the BEP flow rate of the tested pump.
- For ST bare pumps, determine the motor horsepower by selecting the horsepower rating listed in Table 2 of this appendix that, is either equivalent to, or the next highest horsepower greater than, the pump power input to the bare pump at 120 percent of the BEP flow rate of the tested pump divided by a service factor of 1.15.
- For pumps sold with motors, pumps sold with motors and continuous controls, or pumps sold with motors and non-continuous controls, the motor horsepower is the rated horsepower of the motor with which the pump is being tested.

E.1.2.1.2 Determine the default nominal full load motor efficiency as described in section III.E.1.2.1.2.1 of this appendix for pumps other than ST pumps or III.E.1.2.1.2.2. of this appendix for ST pumps.

E.1.2.1.2.1. For pumps other than ST pumps, the default nominal full load motor efficiency is the minimum of the nominal full load motor efficiency standards (open or enclosed) from the table containing the current energy conservation standards for NEMA Design B motors at §431.25, with the number of poles relevant to the speed at which the pump is being tested (see section I.C.1 of this appendix) and the motor horsepower determined in section III.E.1.2.1.1 of this appendix.

E.1.2.1.2.2. For ST pumps, the default nominal full load motor efficiency is the default nominal full load submersible motor efficiency listed in Table 2 of this appendix, with the number of poles relevant to the speed at which the pump is being tested (see section I.C.1 of this appendix) and the motor horsepower determined in section III.E.1.2.1.1 of this appendix;

E.1.2.2 Determine the loss factor at each load point corresponding to 75, 100, or 110 percent of the BEP flow rate as follows:

$$y_i = -0.4508 \times \left(\frac{P_i}{MotorHP}\right)^3 + 1.2399 \times \left(\frac{P_i}{MotorHP}\right)^2 - 0.4301 \times \left(\frac{P_i}{MotorHP}\right) + 0.6410$$

Where:

y_i = the part load loss factor at load point i,

P_i = pump power input to the bare pump at load point i (hp), as determined in accordance with section III.E.1.1 of this appendix,

MotorHP = as determined in accordance with section III.E.1.2.1 of this appendix (hp),

i = load point corresponding to 75, 100, or 110 percent of the BEP flow rate, and

$\frac{P_i}{MotorHP} \leq 1.000$; if $\frac{P_i}{MotorHP} > 1.000$, then set $\frac{P_i}{MotorHP} = 1.000$ in the equation in this section III.E.1.2.2 of this appendix to calculate the part load loss factor at each load point i.

IV. Testing-Based Approach for Pumps Sold With Motors

A. *Scope*. This section IV applies only to pumps sold with electric motors, including single-phase induction motors.

B. *Measurement Equipment*. The requirements regarding measurement equipment presented in section I.B of this appendix apply to this section IV, and in addition, the electrical measurement equipment must:

(1) Be capable of measuring true RMS current, true RMS voltage, and real power up to the 40th harmonic of fundamental supply source frequency, and

(2) For all instruments used to measure a given parameter, have a combined accuracy of ±2.0 percent of the measured value at the

fundamental supply source frequency, where combined accuracy is the root sum of squares of individual instrument accuracies.

C. *Test Conditions*. The requirements regarding test conditions presented in section I.C of this appendix apply to this section IV. The following conditions also apply to the mains power supplied to the motor:

(1) Maintain the voltage within ±5 percent of the rated value of the motor,

(2) Maintain the frequency within ±1 percent of the rated value of the motor,

(3) Maintain the voltage unbalance of the power supply within ±3 percent of the rated values of the motor, and

(4) Maintain total harmonic distortion below 12 percent throughout the test.

D. *Testing BEP for the Pump*. Determine the BEP of the pump as follows:

D.1 Adjust the flow by throttling the pump without changing the speed of rotation of the pump to a minimum of seven flow points: 40, 60, 75, 90, 100, 110, and 120 percent of the expected BEP flow rate of the pump at the nominal speed of rotation, as specified in HI 40.6–2014, except section 40.6.5.3, section A.7, and appendix B (incorporated by reference, see § 431.463).

D.2. Determine the BEP flow rate as the flow rate at the operating point of maximum overall efficiency on the pump efficiency curve, as determined in accordance with section 40.6.6.3 of HI 40.6–2014 (incorporated by reference, see § 431.463), where the overall efficiency is the ratio of the pump power output divided by the driver power input, as specified in Table 40.6.2.1 of HI 40.6–2014, disregarding the calculations provided in section 40.6.6.2.

E. *Calculating the Constant Load Pump Energy Rating*. Determine the PER_{CL} of each tested pump using the following equation:

$$PER_{CL} = \sum_{i=75\%,100\%,110\%} \omega_i P_i^{in,m}$$

Where:

PER_{CL} = the pump energy rating for a constant load (hp),

ω_i = 0.3333,

P_i^{in} = measured driver power input to the motor at load point i (hp) for the tested pump as determined in accordance with section IV.E.1 of this appendix, and

i = load point corresponding to 75, 100, or 110 percent of the BEP flow rate.

E.1 Determine the driver power input at 75, 100, and 110 percent of the BEP flow rate by employing a least squares regression to determine a linear relationship between the driver power input at the nominal speed of rotation of the pump and the measured flow rate at the following load points: 60, 75, 90, 100, 110, and 120 percent of the expected BEP flow rate. Use the linear relationship to determine the driver power input at the nominal speed of rotation for the load points of 75, 100, and 110 percent of the BEP flow rate.

V. Calculation-Based Approach for Pumps Sold With Motors

A. *Scope*. This section V can only be used in lieu of the test method in section IV of this appendix to calculate the index for pumps sold with motors listed in section V.A.1 or V.A.2 of this appendix.

A.1 Pumps sold with motors subject to DOE's energy conservation standards for polyphase electric motors at § 431.25(g), and

A.2. Pumps sold with submersible motors.

A.3. Pumps sold with motors not listed in sections V.A.1 or V.A.2 of this appendix cannot use this section V and must apply the test method in section IV of this appendix.

B. *Measurement Equipment*. The requirements regarding measurement equipment presented in section I.B of this appendix apply to this section V, and in addition, when testing pumps using a calibrated motor electrical measurement equipment must:

(1) Be capable of measuring true RMS current, true RMS voltage, and real power up to the 40th harmonic of fundamental supply source frequency, and

(2) For all instruments used to measure a given parameter, have a combined accuracy of ±2.0 percent of the measured value at the fundamental supply source frequency, where combined accuracy is the root sum of squares of individual instrument accuracies.

C. *Test Conditions*. The requirements regarding test conditions presented in section I.C of this appendix apply to this section V. When testing pumps using a calibrated motor the following conditions also apply to the mains power supplied to the motor:

(1) Maintain the voltage within ±5 percent of the rated value of the motor,

(2) Maintain the frequency within ±1 percent of the rated value of the motor,

(3) Maintain the voltage unbalance of the power supply within ±3 percent of the rated values of the motor, and

(4) Maintain total harmonic distortion below 12 percent throughout the test.

D. *Testing BEP for the Bare Pump*. Determine the best efficiency point (BEP) of the pump as follows:

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D.1 Adjust the flow by throttling the pump without changing the speed of rotation of the pump to a minimum of seven flow points: 40, 60, 75, 90, 100, 110, and 120 percent of the expected BEP flow rate of the pump at the nominal speed of rotation, as specified in HI 40.6–2014, except section 40.6.5.3, section A.7, and appendix B (incorporated by reference, see § 431.463).

D.2. Determine the BEP flow rate as the flow rate at the operating point of maximum pump efficiency on the pump efficiency curve, as determined in accordance with section 40.6.6.3 of HI 40.6–2014 (incorporated by reference, see § 431.463), where pump efficiency is the ratio of the pump power output divided by the pump power input, as specified in Table 40.6.2.1 of HI 40.6–2014 and the calculations provided in section 40.6.6.2 are to be disregarded.

E. *Calculating the Constant Load Pump Energy Rating*. Determine the PER_{CL} of each tested pump using the following equation:

$$PER_{CL} = \sum_{i=75\%,100\%,110\%} \omega_i P_i^{in,m}$$

Where:

PER_{CL} = the pump energy rating for a constant load (hp),

ω_i = 0.3333,

$P_i^{in,m}$ = calculated driver power input to the motor at load point i for the tested pump as determined in accordance with section V.E.1 of this appendix (hp), and

i = load point corresponding to 75, 100, or 110 percent of the BEP flow rate.

E.1 Determine the driver power input at each load point corresponding to 75, 100, or 110 percent of the BEP flow rate as follows:

$$P_i^{in,m} = P_i + L_i$$

Where:

$P_i^{in,m}$ = driver power input to the motor at load point i (hp),

P_i = pump power input to the bare pump at load point i, as determined in section V.E.1.1 of this appendix (hp),

L_i = the part load motor losses at load point i as determined in accordance with section V.E.1.2 of this appendix (hp), and

i = load point corresponding to 75, 100, or 110 percent of the BEP flow rate.

E.1.1 Determine the pump power input at 75, 100, 110, and 120 percent of the BEP flow rate by employing a least squares regression to determine a linear relationship between the pump power input at the nominal speed of rotation of the pump and the measured flow rate at the following load points: 60, 75, 90, 100, 110, and 120 percent of the expected BEP flow rate. Use the linear relationship to determine the pump power input at the nominal speed of rotation for the load points of 75, 100, 110, and 120 percent of the BEP flow rate.

E.1.2 Determine the motor part load losses at each load point corresponding to 75, 100, or 110 percent of the BEP flow rate as follows:

$L_i = L_{full} \times Y_i$

Where:

L_i = motor losses at load point i (hp),

L_{full} = motor losses at full load as determined in accordance with section V.E.1.2.1 of this appendix (hp),

y_i = part load loss factor at load point i as determined in accordance with section V.E.1.2.2 of this appendix, and

i = load point corresponding to 75, 100, or 110 percent of the BEP flow rate.

E.1.2.1 Determine the full load motor losses using the appropriate motor efficiency value and horsepower as shown in the following equation:

$$L_{full} = \frac{MotorHP}{\left[{\eta_{motor,full}}/{100}\right]} - MotorHP$$

Where:

L_{full} = motor losses at full load (hp),

MotorHP = the horsepower of the motor with which the pump model is being tested (hp), and

$\eta_{motor,full}$ = the represented nominal full load motor efficiency (*i.e.,* nameplate/DOE-certified value) or default nominal full load submersible motor efficiency as determined in accordance with section V.E.1.2.1.1 of this appendix (%).

E.1.2.1.1 For pumps sold with motors other than submersible motors, determine the represented nominal full load motor efficiency as described in section V.E.1.2.1.1.1 of this appendix. For pumps sold with submersible motors determine the default nominal full load submersible motor efficiency as described in section V.E.1.2.1.1.2 of this appendix.

E.1.2.1.1.1. For pumps sold with motors other than submersible motors, the represented nominal full load motor efficiency is that of the motor with which the given pump model is being tested, as determined in accordance with the DOE test procedure for electric motors at § 431.16 and applicable representation procedures in parts 429 and 430.

E.1.2.1.1.2. For pumps sold with submersible motors, the default nominal full load submersible motor efficiency is that listed in Table 2 of this appendix, with the number of poles relevant to the speed at which the pump is being tested (see section I.C.1 of this appendix) and the motor horsepower of the pump being tested.

E.1.2.2 Determine the loss factor at each load point corresponding to 75, 100, or 110 percent of the BEP flow rate as follows:

$$y_i = -0.4508 \times \left(\frac{P_i}{\text{MotorHP}}\right)^3 + 1.2399 \times \left(\frac{P_i}{\text{MotorHP}}\right)^2 - 0.4301 \times \left(\frac{P_i}{\text{MotorHP}}\right) + 0.6410$$

Where:

y_i = the part load loss factor at load point i,

P_i = the pump power input to the bare pump at load point i as determined in accordance with section V.E.1.1 of this appendix (hp),

MotorHP = the horsepower of the motor with which the pump model is being tested (hp),

i = load point corresponding to 75, 100, or 110 percent of the BEP flow rate, and

i = load point corresponding to 75, 100, or 110 percent of the BEP flow rate, and

$\frac{P_i}{\text{MotorHP}} \leq 1.000$; if $\frac{P_i}{\text{MotorHP}} > 1.000$ then set $\frac{P_i}{\text{MotorHP}} = 1.000$ in the equation in this section V.E.1.2.2 of this appendix to calculate the part load loss factor at each load point i.

in the equation in this section V.E.1.2.2. of this appendix to calculate the part load loss factor at each load point

VI. Testing-Based Approach for Pumps Sold with Motors and Controls

A. *Scope.* This section VI applies only to pumps sold with electric motors, including single-phase induction motors, and continuous or non-continuous controls. For the purposes of this section VI, all references to ''driver input power'' in this section VI or HI 40.6–2014 (incorporated by reference, see § 431.463) refer to the input power to the continuous or non-continuous controls.

B. *Measurement Equipment.* The requirements regarding measurement equipment presented in section I.B of this appendix apply to this section VI, and in addition electrical measurement equipment must:

(1) Be capable of measuring true RMS current, true RMS voltage, and real power up to the 40th harmonic of fundamental supply source frequency, and

(2) For all instruments used to measure a given parameter, have a combined accuracy of ±2.0 percent of the measured value at the fundamental supply source frequency, where combined accuracy is the root sum of squares of individual instrument accuracies.

C. *Test Conditions.* The requirements regarding test conditions presented in section I.C of this appendix apply to this section VI. The following conditions also apply to the mains power supplied to the continuous or non-continuous control:

(1) Maintain the voltage within ±5 percent of the rated value of the motor,

(2) Maintain the frequency within ±1 percent of the rated value of the motor,

(3) Maintain the voltage unbalance of the power supply within ±3 percent of the rated values of the motor, and

(4) Maintain total harmonic distortion below 12 percent throughout the test.

D. *Testing BEP for the Pump*. Determine the BEP of the pump as follows:

D.1. Adjust the flow by throttling the pump without changing the speed of rotation of the pump to a minimum of seven flow points: 40, 60, 75, 90, 100, 110, and 120 percent of the expected BEP flow rate of the pump at the nominal speed of rotation, as specified in HI 40.6–2014, except section 40.6.5.3, section A.7, and appendix B (incorporated by reference, see § 431.463).

D.2. Determine the BEP flow rate as the flow rate at the operating point of maximum overall efficiency on the pump efficiency curve, as determined in accordance with section 40.6.6.3 of HI 40.6–2014 (incorporated by reference, see § 431.463), where overall efficiency is the ratio of the pump power output divided by the driver power input, as specified in Table 40.6.2.1 of HI 40.6–2014 and the calculations provided in section 40.6.6.2 are to be disregarded.

E. *Calculating the Variable Load Pump Energy Rating*. Determine the PER_{VL} of each tested pump using the following equation:

$$PER_{VL} = \sum_{i=25\%,50\%75\%,100\%} \omega_i P_i^{in,c}$$

Where:

PER_{VL} = the pump energy rating for a variable load (hp);
ω_i = 0.25;
$P_i^{in,c}$ = the normalized driver power input to continuous or non-continuous controls at load point i for the tested pump as determined in accordance with section VI.E.1 of this appendix; and
i = load point corresponding 25, 50, 75, or 100 percent of the BEP flow rate.

E.1. Determine the driver power input at 100 percent of the measured BEP flow rate of the tested pump by employing a least squares regression to determine a linear relationship between the measured driver power input at the nominal speed of rotation of the pump and the measured flow rate, using the following load points: 60, 75, 90, 100, 110, and 120 percent of the expected BEP flow rate. Use the linear relationship to determine the driver power input at the nominal speed of rotation for the load point of 100 percent of the measured BEP flow rate of the tested pump.

E.2 Determine the driver power input at 25, 50, and 75 percent of the BEP flow rate by measuring the driver power input at the load points defined by:

(1) Those flow rates, and

(2) The associated head points calculated according to the following reference system curve equation:

$$H_i = \left(0.80 \times \frac{{Q_i}^2}{{Q_{100\%}}^2} + 0.20\right) \times H_{100\%}$$

Where:

H_i = pump total head at load point i (ft),
$H_{100\neq}$ = pump total head at 100 percent of the BEP flow rate and nominal speed of rotation (ft),
Q_i = flow rate at load point i (gpm),
$Q_{100\neq}$ = flow rate at 100 percent of the BEP flow rate and nominal speed of rotation (gpm), and
i = load point corresponding to 25, 50, or 75 percent of the measured BEP flow rate of the tested pump.

E.2.1. For pumps sold with motors and continuous controls, the specific head and flow points must be achieved within 10 percent of the calculated values and the measured driver power input must be corrected to the exact intended head and flow conditions using the following equation:

$$P_i^{in,c} = \left(\frac{H_{sp,i}}{H_{M,j}}\right)\left(\frac{Q_{sp,i}}{Q_{M,j}}\right)P_{M,j}^{in,c}$$

Where:

$P_i^{in,c}$ = the corrected driver power input to the continuous or non-continuous controls at load point i (hp),

$H_{sp,i}$ = the specified total system head at load point i based on the reference system curve (ft),

$H_{M,j}$ = the measured total system head at load point j (ft),

$Q_{sp,i}$ = the specified total system flow rate at load point i based on the reference system curve (gpm),

$Q_{M,j}$ = the measured total system flow rate at load point j (gpm),

$P_{M,j}^{in,c}$ = the measured normalized driver power input to the continuous or non-continuous controls at load point j (hp),

i = specified load point at 25, 50, 75, or 100 percent of BEP flow, and

j = measured load point corresponding to specified load point i.

E.2.2. For pumps sold with motors and non-continuous controls, the head associated with each of the specified flow points shall be no lower than 10 percent below that defined by the reference system curve equation in section VI.E.2 of this appendix. Only the measured flow points must be achieved within 10 percent of the calculated values. Correct for flow and head as described in section VI.E.2.1, except do not correct measured head values that are higher than the reference system curve at the same flow rate; only correct flow rate and head values lower than the reference system curve at the same flow rate. For head values higher than the system curve, use the measured head points directly to calculate PEI_{VL}.

VII. CALCULATION-BASED APPROACH FOR PUMPS SOLD WITH MOTORS AND CONTROLS

A. *Scope*. This section VII can only be used in lieu of the test method in section VI of this appendix to calculate the index for pumps listed in section VII.A.1 or VII.A.2 of this appendix.

A.1. Pumps sold with motors regulated by DOE's energy conservation standards for polyphase NEMA Design B electric motors at §431.25(g) and continuous controls, and

A.2. Pumps sold with submersible motors and continuous controls.

A.3. Pumps sold with motors not listed in VII.A.1 or VII.A.2 of this appendix and pumps sold without continuous controls, including pumps sold with non-continuous controls, cannot use this section and must apply the test method in section VI of this appendix.

B. *Measurement Equipment*. The requirements regarding measurement equipment presented in section I.B of this appendix apply to this section VII, and in addition, when testing pumps using a calibrated motor electrical measurement equipment must:

(1) Be capable of measuring true RMS current, true RMS voltage, and real power up to the 40th harmonic of fundamental supply source frequency, and

(2) For all instruments used to measure a given parameter, have a combined accuracy of ±2.0 percent of the measured value at the fundamental supply source frequency, where combined accuracy is the root sum of squares of individual instrument accuracies.

C. *Test Conditions*. The requirements regarding test conditions presented in section I.C of this appendix apply to this section VII. When testing pumps using a calibrated motor the following conditions also apply to the mains power supplied to the motor:

(1) Maintain the voltage within ±5 percent of the rated value of the motor,

(2) Maintain the frequency within ±1 percent of the rated value of the motor,

(3) Maintain the voltage unbalance of the power supply within ±3 percent of the rated values of the motor, and

(4) Maintain total harmonic distortion below 12 percent throughout the test.

D. *Testing BEP for the Bare Pump*. Determine the BEP of the pump as follows:

D.1. Adjust the flow by throttling the pump without changing the speed of rotation of the pump to a minimum of seven flow points: 40, 60, 75, 90, 100, 110, and 120 percent of the expected BEP flow rate of the pump at the nominal speed of rotation, as specified in HI 40.6–2014, except section 40.6.5.3, section A.7, and appendix B (incorporated by reference, see §431.463).

D.2. Determine the BEP flow rate as the flow rate at the operating point of maximum pump efficiency on the pump efficiency curve, as determined in accordance with section 40.6.6.3 of HI 40.6–2014 (incorporated by reference, see §431.463), where pump efficiency is the ratio of the pump power output divided by the pump power input, as specified in Table 40.6.2.1 of HI 40.6–2014 and the calculations provided in section 40.6.6.2 are to be disregarded.

E. *Calculating the Variable Load Pump Energy Rating*. Determine the PER_{VL} of each tested pump using the following equation:

$$PER_{VL} = \sum_{i=25\%,50\%,75\%,100\%} \omega_i P_i^{in,c}$$

Where:

PER_{VL} = the pump energy rating for a variable load (hp);

ω_i = 0.25;

$P_i^{in,c}$ = the calculated driver power input to the continuous or non-continuous controls at load point i for the tested pump as determined in accordance with section VII.E.1 of this appendix; and

i = load point corresponding to 25, 50, 75, or 100 percent of the BEP flow rate.

E.1 Determine the driver power input at each load point corresponding to 25, 50, 75, or 100 percent of the BEP flow rate as follows:

$$P_i^{in,c} = P_i + L_i$$

Where:

$P_i^{in,c}$ = driver power input at to the continuous or non-continuous controls at load point i (hp),

P_i = pump power input to the bare pump at load point i as determined in accordance with section VII.E.1.1 of this appendix (hp),

L_i = the part load motor and control losses at load point i as determined in accordance with section VII.E.1.2 of this appendix (hp), and

i = load point corresponding to 25, 50, 75, or 100 percent of the BEP flow rate.

E.1.1 Determine the pump power input at 100 percent of the measured BEP flow rate of the tested pump by employing a least squares regression to determine a linear relationship between the measured pump power input at the nominal speed of rotation and the measured flow rate at the following load points: 60, 75, 90, 100, 110, and 120 percent of the expected BEP flow rate. Use the linear relationship to determine the pump power input at the nominal speed of rotation for the load point of 100 percent of the BEP flow rate.

E.1.1.1 Determine the pump power input at 25, 50, and 75 percent of the BEP flow rate based on the measured pump power input at 100 percent of the BEP flow rate and using with the following equation:

$$P_i = \left(0.80 \times \frac{Q_i^{\ 3}}{Q_{100\%}^{\ 3}} + 0.20 \times \frac{Q_i}{Q_{100\%}}\right) \times P_{100\%}$$

Where:

P_i = pump power input at load point i (hp);

$P_{100\neq}$ = pump power input at 100 percent of the BEP flow rate and nominal speed of rotation (hp);

Q_i = flow rate at load point i (gpm);

$Q_{100\neq}$ = flow rate at 100 percent of the BEP flow rate and nominal speed of rotation (gpm); and

i = load point corresponding to 25, 50, or 75 percent of the measured BEP flow rate of the tested pump.

E.1.2 Calculate the motor and control part load losses at each load point corresponding to 25, 50, 75, and 100 percent of the BEP flow rate as follows:

$L_i = L_{full} \times z_i$

Where:

L_i = motor and control losses at load point i (hp),

L_{full} = motor losses at full load as determined in accordance with section VII.E.1.2.1 of this appendix (hp),

z_i = part load loss factor at load point i as determined in accordance with section VII.E.1.2.2 of this appendix, and

i = load point corresponding to 25, 50, 75, or 100 percent of the BEP flow rate.

E.1.2.1 Determine the full load motor losses using the appropriate motor efficiency value and horsepower as shown in the following equation:

$$L_{full} = \frac{MotorHP}{\left[\eta_{motor,full}/_{100}\right]} - MotorHP$$

Where:

L_{full} = motor losses at full load (hp),

MotorHP = the horsepower of the motor with which the pump model is being tested (hp), and

$\eta_{motor,full}$ = the represented nominal full load motor efficiency (*i.e.,* nameplate/DOE-certified value) or default nominal full load submersible motor efficiency as determined in accordance with section VII.E.1.2.1.1 of this appendix (%).

E.1.2.1.1 For pumps sold with motors other than submersible motors, determine the represented nominal full load motor efficiency as described in section VII.E.1.2.1.1.1 of this appendix. For pumps sold with submersible motors, determine the default nominal full load submersible motor efficiency as described in section VII.E.1.2.1.1.2 of this appendix.

E.1.2.1.1.1 For pumps sold with motors other than submersible motors, the represented nominal full load motor efficiency is that of the motor with which the given pump model is being tested, as determined in accordance with the DOE test procedure for electric motors at § 431.16 and applicable representation procedures in parts 429 and 430.

E.1.2.1.1.2 For pumps sold with submersible motors, the default nominal full load submersible motor efficiency is that listed in Table 2 of this appendix, with the number of poles relevant to the speed at which the pump is being tested (see section I.C.1 of this appendix) and the motor horsepower of the pump being tested.

E.1.2.2 For load points corresponding to 25, 50, 75, and 100 percent of the BEP flow rate, determine the part load loss factor at each load point as follows:

$$z_i = a \times \left(\frac{P_i}{MotorHP}\right)^2 + b \times \left(\frac{P_i}{MotorHP}\right) + c$$

Where:

z_i = the motor and control part load loss factor at load point i,

a,b,c = coefficients listed in Table 4 of this appendix based on the horsepower of the motor with which the pump is being tested,

P_i = the pump power input to the bare pump at load point i, as determined in accordance with section VII.E.1.1 of this appendix (hp),

MotorHP = the horsepower of the motor with which the pump is being tested (hp),

i = load point corresponding to 25, 50, 75, or 100 percent of the BEP flow rate, and

$\frac{P_i}{MotorHP} \leq 1.000$; if $\frac{P_i}{MotorHP} > 1.000$ then set $\frac{P_i}{MotorHP} = 1.000$ in the equation in this section VII.E.1.2.2 of this appendix to calculate the part load loss factor at load point i.

TABLE 2—DEFAULT NOMINAL FULL LOAD SUBMERSIBLE MOTOR EFFICIENCY BY MOTOR HORSEPOWER AND POLE

Motor horsepower (hp)	Default nominal full load submersible motor efficiency	
	2 poles	4 poles
1	55	68
1.5	66	70
2	68	70
3	70	75.5
5	74	75.5
7.5	68	74
10	70	74
15	72	75.5
20	72	77
25	74	78.5
30	77	80
40	78.5	81.5
50	80	82.5
60	81.5	84
75	81.5	85.5
100	81.5	84
125	84	84
150	84	85.5
200	85.5	86.5
250	86.5	86.5

TABLE 3—NOMINAL FULL LOAD MOTOR EFFICIENCY VALUES

Nominal full load motor efficiency*
50.5
52.5
55.0
57.5
59.5
62.0
64.0
66.0
68.0
70.0
72.0
74.0
75.5
77.0
78.5
80.0
81.5
82.5
84.0
85.5
86.5
87.5
88.5
89.5
90.2
91.0
91.7
92.4
93.0
93.6
94.1
94.5
95.0
95.4
95.8
96.2
96.5
96.8
97.1
97.4
97.6
97.8
98.0
98.2
98.4
98.5
98.6
98.7
98.8
98.9
99.0

* **Note:** Each consecutive incremental value of nominal efficiency represents one band.

TABLE 4—MOTOR AND CONTROL PART LOAD LOSS FACTOR EQUATION COEFFICIENTS FOR SECTION VII.E.1.2.2 OF THIS APPENDIX A

Motor horsepower (hp)	Coefficients for Motor and Control Part Load Loss Factor (z_i)		
	a	b	c
≤5	− 0.4658	1.4965	0.5303
>5 and ≤20	− 1.3198	2.9551	0.1052
>20 and ≤50	− 1.5122	3.0777	0.1847
>50	− 0.8914	2.8846	0.2625

[81 FR 4145, Jan. 25, 2016, as amended at 82 FR 36924, Aug. 7, 2017]

APPENDIX B TO SUBPART Y OF PART 431—UNIFORM TEST METHOD FOR THE MEASUREMENT OF ENERGY EFFICIENCY OF DEDICATED-PURPOSE POOL PUMPS

NOTE: On February 5, 2018 but before July 19, 2021, any representations made with respect to the energy use or efficiency of dedicated-purpose pool pumps subject to testing pursuant to 10 CFR 431.464(b) must be made in accordance with the results of testing pursuant to this appendix. Any optional representations of energy factor (EF) must be accompanied by a representation of weighted energy factor (WEF).

I. TEST PROCEDURE FOR DEDICATED-PURPOSE POOL PUMPS

A. General

A.1 Test Method. To determine the weighted energy factor (WEF) for dedicated-purpose pool pumps, perform ''wire-to-water'' testing in accordance with HI 40.6–2014–B, except section 40.6.4.1, ''Vertically suspended pumps''; section 40.6.4.2, ''Submersible pumps''; section 40.6.5.3, ''Test report''; section 40.6.5.5, ''Test conditions''; section 40.6.5.5.2, ''Speed of rotation during testing''; section 40.6.6.1, ''Translation of test results to rated speed of rotation''; section 40.6.6.2, ''Pump efficiency''; section 40.6.6.3, ''Performance curve''; section A.7, ''Testing at temperatures exceeding 30 °C (86 °F)''; and appendix B, ''Reporting of test results''; (incorporated by reference, see § 431.463) with the modifications and additions as noted throughout the provisions below. Do not use the test points specified in section 40.6.5.5.1, ''Test procedure'' of HI 40.6–2014–B and instead use those test points specified in section D.3 of this appendix for the applicable dedicated-purpose pool pump variety and speed configuration. When determining overall efficiency, best efficiency point, or other applicable pump energy performance information, section 40.6.5.5.1, ''Test procedure''; section 40.6.6.2, ''Pump efficiency''; and section 40.6.6.3, ''Performance curve'' must be used, as applicable. For the purposes of applying this appendix, the term ''volume per unit time,'' as defined in section 40.6.2, ''Terms and definitions,'' of HI 40.6–2014–B shall be deemed to be synonymous with the term ''flow rate'' used throughout that standard and this appendix.

A.2. Calculations and Rounding. All terms and quantities refer to values determined in accordance with the procedures set forth in this appendix for the rated pump. Perform all calculations using raw measured values without rounding. Round WEF, EF, maximum head, vertical lift, and true priming time values to the tenths place (*i.e.*, 0.1) and rated hydraulic horsepower to the thousandths place (*i.e.*, 0.001). Round all other reported values to the hundredths place unless otherwise specified.

B. Measurement Equipment

B.1 For the purposes of measuring flow rate, speed of rotation, temperature, and pump power output, the equipment specified in HI 40.6–2014–B Appendix C (incorporated by reference, see § 431.463) necessary to measure head, speed of rotation, flow rate, and temperature must be used and must comply with the stated accuracy requirements in HI 40.6–2014–B Table 40.6.3.2.3, except as specified in section B.1.1 and B.1.2 of this appendix. When more than one instrument is used to measure a given parameter, the combined accuracy, calculated as the root sum of squares of individual instrument accuracies, must meet the specified accuracy requirements.

B.1.1 Electrical measurement equipment for determining the driver power input to the motor or controls must be capable of measuring true root mean squared (RMS) current, true RMS voltage, and real power up to the 40th harmonic of fundamental supply source frequency, and have a combined accuracy of ±2.0 percent of the measured value at the fundamental supply source frequency.

B.1.2 Instruments for measuring distance (*e.g.*, height above the reference plane or water level) must be accurate to and have a resolution of at least ±0.1 inch.

B.2 Calibration. Calibration requirements for instrumentation are specified in appendix D of HI 40.6–2014–B (incorporated by reference, see § 431.463). Historical calibration data may be used to justify time periods up to three times longer than those specified in table D.1 of HI 40.6–2014–B provided the supporting historical data shows maintenance of calibration of the given instrument up to the selected extended calibration interval on at least two unique occasions, based on the interval specified in HI 40.6–2014–B.

C. Test Conditions and Tolerances

C.1 Pump Specifications. Conduct testing at full impeller diameter in accordance with the test conditions, stabilization requirements, and specifications of HI 40.6–2014–B section 40.6.3, ''Pump efficiency testing''; section 40.6.4, ''Considerations when determining the efficiency of a pump''; section 40.6.5.4 (including appendix A), ''Test arrangements''; and section 40.6.5.5, ''Test conditions'' (incorporated by reference, see § 431.463).

C.2 Power Supply Requirements. The following conditions also apply to the mains power supplied to the DPPP motor or controls, if any:

(1) Maintain the voltage within ±5 percent of the rated value of the motor,

(2) Maintain the frequency within ±1 percent of the rated value of the motor,

(3) Maintain the voltage unbalance of the power supply within ±3 percent of the value with which the motor was rated, and

(4) Maintain total harmonic distortion below 12 percent throughout the test.

C.3 Test Conditions. Testing must be carried out with water that is between 50 and 107 °F with less than or equal to 15 nephelometric turbidity units (NTU).

C.4 Tolerances. For waterfall pumps, multi-speed self-priming and non-self-priming pool filter pumps, and variable-speed self-priming and non-self-priming pool filter pumps all measured load points must be within ±2.5 percent of the specified head value and comply with any specified flow values or thresholds. For all other dedicated-purpose pool pumps, all measured load points must be within the greater of ±2.5 percent of the specified flow rate values or ±0.5 gpm and comply with any specified head values or thresholds.

D. Data Collection and Stabilization

D.1 Damping Devices. Use of damping devices, as described in section 40.6.3.2.2 of HI 40.6–2014–B (incorporated by reference, see § 431.463), are only permitted to integrate up to the data collection interval used during testing.

D.2 Stabilization. Record data at any tested load point only under stabilized conditions, as defined in HI 40.6–2014–B section 40.6.5.5.1 (incorporated by reference, see § 431.463), where a minimum of two measurements are used to determine stabilization.

D.3 Test Points. Measure the flow rate in gpm, pump total head in ft, the driver power input in W, and the speed of rotation in rpm at each load point specified in Table 1 of this appendix for each DPPP variety and speed configuration:

TABLE 1—LOAD POINTS (i) AND WEIGHTS (w_i) FOR EACH DPPP VARIETY AND SPEED CONFIGURATION

DPPP varieties	Speed configuration(s)	Number of load points (n)	Load point (i)	Test points		
				Flow rate (Q) (GPM)	Head (H) (ft)	Speed (rpm)
Self-Priming Pool Filter Pumps And Non-Self-Priming Pool Filter Pumps.	Single-speed dedicated-purpose pool pumps and all self-priming and non-self-priming pool filter pumps not meeting the definition of two-*, multi-, or variable-speed dedicated-purpose pool pump.	1	High	Q_{high} (gpm) = $Q_{max\_speed}@_C$ **	H = 0.0082 × Q_{high}^2	Maximum speed
	Two-speed dedicated-purpose pool pumps *.	2	Low	Q_{low} (gpm) = Flow rate associated with specified head and speed that is not below: • 31.1 gpm if rated hydraulic horsepower is >0.75 or • 24.7 gpm if rated hydraulic horsepower is ≤0.75	H = 0.0082 × Q_{low}^2	Lowest speed capable of meeting the specified flow and head values, if any ***.
			High	Q_{high} (gpm) = $Q_{max\_speed}@_C$ **	H = 0.0082 × Q_{high}^2	Maximum speed.
	Multi-speed and variable-speed dedicated-purpose pool pumps.	2	Low	Q_{low} (gpm) = • If rated hydraulic horsepower is >0.75, then Q_{low} ≥ 31.1 gpm • If rated hydraulic horsepower is ≤0.75, then Q_{low} ≥24.7 gpm	H = 0.0082 × Q_{low}^2	Lowest speed capable of meeting the specified flow and head values.
			High	Q_{high} (gpm) ≥0.8 × $Q_{max\_speed}@_C$ **	H = 0.0082 × Q_{high}^2	Lowest speed capable of meeting the specified flow and head values.
Waterfall Pumps.	Single-speed dedicated-purpose pool pumps.	1	High	Q_{low} (gpm) = Flow corresponding to specified head	17.0 ft	Maximum speed.

TABLE 1—LOAD POINTS (i) AND WEIGHTS (w_i) FOR EACH DPPP VARIETY AND SPEED CONFIGURATION—Continued

DPPP varieties	Speed configuration(s)	Number of load points (n)	Load point (i)	Test points		
				Flow rate (Q) (GPM)	Head (H) (ft)	Speed (rpm)
Pressure Cleaner Booster Pumps.	Any	1	High	10.0 gpm	≥60.0 ft	Lowest speed capable of meeting the specified flow and head values.

* In order to apply the test points for two-speed self-priming and non-self-priming pool filter pumps, self-priming pool filter pumps that are greater than or equal to 0.711 rated hydraulic horsepower that are two-speed dedicated-purpose pool pumps must also be distributed in commerce either: (1) With a pool pump control (variable speed drive and user interface or switch) that changes the speed in response to pre-programmed user preferences and allows the user to select the duration of each speed and/or the on/off times or (2) without a pool pump control that has such capability, but without which the pump is unable to operate. Two-speed self-priming pool filter pumps greater than or equal to 0.711 rated hydraulic horsepower that do not meet these requirements must be tested using the load point for single-speed self-priming or non-self-priming pool filter pumps, as appropriate.

** $Q_{max\_\_speed}@_C$ = Flow at max speed on curve C (gpm)

*** If a two-speed pump has a low speed that results in a flow rate below the specified values, the low speed of that pump shall not be tested.

E. Calculations

E.1 Determination of Weighted Energy Factor. Determine the WEF as a ratio of the measured flow and driver power input to the dedicated-purpose pool pump in accordance with the following equation:

$$WEF = \frac{\sum_{i=1}^{n}\left(w_i \times \frac{Q_i}{1000} \times 60\right)}{\sum_{i=1}^{n}\left(w_i \times \frac{P_i}{1000}\right)}$$

Where:

WEF = Weighted Energy Factor in kgal/kWh;

w_i = weighting factor at each load point *i*, as specified in section E.2 of this appendix;

Q_i = flow at each load point *i*, in gpm;

P_i = driver power input to the motor (or controls, if present) at each load point *i*, in watts;

i = load point(s), defined uniquely for each DPPP variety and speed configuration as specified in section D.3 of this appendix; and

n = number of load point(s), defined uniquely for each DPPP variety and speed configuration as specified in section D.3 of this appendix.

E.2 Weights. When determining WEF, apply the weights specified in Table 2 of this appendix for the applicable load points, DPPP varieties, and speed configurations:

TABLE 2—LOAD POINT WEIGHTS (w_i)

DPPP varieties	Speed configuration(s)	Load point(s) *i*	
		Low flow	High flow
Self-Priming Pool Filter Pumps and Non-Self-Priming Pool Filter Pumps.	Single-speed dedicated-purpose pool pumps and all self-priming and non-self-priming pool filter pumps not meeting the definition of two-,* multi-, or variable-speed dedicated-purpose pool pump.		1.0
	Two-speed dedicated-purpose pool pumps*	0.80	0.20
	Multi-speed and variable-speed dedicated-purpose pool pumps.	0.80	0.20
Waterfall Pumps	Single-speed dedicated-purpose pool pumps		1.0

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TABLE 2—LOAD POINT WEIGHTS (w_i)—Continued

DPPP varieties	Speed configuration(s)	Load point(s) *i*	
		Low flow	High flow
Pressure Cleaner Booster Pump	Any	....	1.0

*In order to apply the test points for two-speed self-priming and non-self-priming pool filter pumps, self-priming pool filter pumps that are greater than or equal to 0.711 rated hydraulic horsepower that are two-speed dedicated-purpose pool pumps must also be distributed in commerce either: (1) With a pool pump control (variable speed drive and user interface or switch) that changes the speed in response to pre-programmed user preferences and allows the user to select the duration of each speed and/or the on/off times or (2) without a pool pump control that has such capability, but without which the pump is unable to operate. Two-speed self-priming pool filter pumps greater than or equal to 0.711 rated hydraulic horsepower that do not meet these requirements must be tested using the load point for single-speed self-priming or non-self-priming pool filter pumps, as appropriate.

E.3 Determination of Horsepower and True Power Factor Metrics

E.3.1 Determine the pump power output at any load point *i* using the following equation:

$$P_{u,i} = \frac{Q_i \times H_i \times SG}{3960}$$

Where:

$P_{u,i}$ = the measured pump power output at load point *i* of the tested pump, in hp;
Q_i = the measured flow rate at load point *i* of the tested pump, in gpm;
H_i = pump total head at load point *i* of the tested pump, in ft; and
SG = the specific gravity of water at specified test conditions, which is equivalent to 1.00.

E.3.1.1 Determine the rated hydraulic horsepower as the pump power output measured on the reference curve at maximum rotating speed and full impeller diameter for the rated pump.

E.3.2 For dedicated-purpose pool pumps with single-phase AC motors or DC motors, determine the dedicated-purpose pool pump nominal motor horsepower as the product of the measured full load speed and torque, adjusted to the appropriate units, as shown in the following equation:

$$P_{nm} = \frac{(T \times n)}{5252}$$

Where:

P_{nm} = the dedicated-purpose pool pump nominal total horsepower at full load, in hp;
T = output torque at full load, in lb-ft; and
n = the motor speed at full load, in rpm.

Full-load speed and torque shall be determined based on the maximum continuous duty motor power output rating allowable for the motor's nameplate ambient rating and insulation class.

E.3.2.1 For single-phase AC motors, determine the measured speed and torque at full load according to either section E.3.2.1.1 or E.3.2.1.2 of this appendix.

E.3.2.1.1 Use the procedures in section 3.2, ''Tests with load''; section 4 ''Testing facilities''; section 5.2 ''Mechanical measurements''; section 5.3 ''Temperature measurements''; and section 6 ''Tests'' of IEEE 114–2010 (incorporated by reference, see § 431.463), or

E.3.2.1.2 Use the applicable procedures in section 5, ''General test requirements'' and section 6, ''Tests'' of CSA C747–2009 (RA 2014); except in section 6.4(b) the conversion factor shall be 5252, only measurements at full load are required in section 6.5, and section 6.6 shall be disregarded (incorporated by reference, see § 431.463).

E.3.2.2 For DC motors, determine the measured speed and torque at full load according to either section E.3.2.2.1 or E.3.2.2.2 of this appendix.

E.3.2.2.1 Use the procedures in section 3.1, ''Instrument Selection Factors''; section 3.4 ''Power Measurement'': Section 3.5 ''Power Sources''; section 4.1.2 ''Ambient Air''; section 4.1.4 ''Direction of Rotation''; section 5.4.1 ''Reference Conditions''; and section

5.4.3.2 ‘‘Dynomometer or Torquemeter Method’’ of IEEE 113–1985 (incorporated by reference, see § 431.463), or

E.3.2.2.2 Use the applicable procedures in section 5, ‘‘General test requirements’’ and section 6, ‘‘Tests’’ of CSA C747–2009 (RA 2014); except in section 6.4(b) the conversion factor shall be 5252, only measurements at full load are required in section 6.5, and section 6.6 shall be disregarded (incorporated by reference, see § 431.463).

E.3.3 For dedicated-purpose pool pumps with single-phase AC motors or DC motors, the dedicated-purpose pool pump service factor is equal to 1.0.

E.3.4 Determine the dedicated-purpose pool pump motor total horsepower according to section E.3.4.1 of this appendix for dedicated-purpose pool pumps with single-phase AC motors or DC motors and section E.3.4.2 of this appendix for dedicated-purpose pool pumps with polyphase AC motors.

E.3.4.1 For dedicated-purpose pool pumps with single-phase AC motors or DC motors, determine the dedicated-purpose pool pump motor total horsepower as the product of the dedicated-purpose pool pump nominal motor horsepower, determined in accordance with section E.3.2 of this appendix, and the dedicated-purpose pool pump service factor, determined in accordance with section E.3.3 of this appendix.

E.3.4.2 For dedicated-purpose pool pumps with polyphase AC induction motors, determine the dedicated-purpose pool pump motor total horsepower as the product of the rated nominal motor horsepower and the rated service factor of the motor.

E.3.5 Determine the true power factor at each applicable load point specified in Table 1 of this appendix for each DPPP variety and speed configuration as a ratio of driver power input to the motor (or controls, if present) (P_i), in watts, divided by the product of the voltage in volts and the current in amps at each load point i, as shown in the following equation:

$$PF_i = \frac{P_i}{V_i \times I_i}$$

Where:

PF_i = true power factor at each load point i, dimensionless;

P_i = driver power input to the motor (or controls, if present) at each load point i, in watts;

V_i = voltage at each load point i, in volts;

I_i = current at each load point i, in amps; and

i = load point(s), defined uniquely for each DPPP variety and speed configuration as specified in section D.3 of this appendix.

E.4 Determination of Maximum Head. Determine the maximum head for self-priming pool filter pumps, non-self-priming pool filter pumps, and waterfall pumps by measuring the head at maximum speed and the minimum flow rate at which the pump is designed to operate continuously or safely, where the minimum flow rate is assumed to be zero unless stated otherwise in the manufacturer literature.

F. Determination of Self-Priming Capability

F.1 Test Method. Determine the vertical lift and true priming time of non-self-priming pool filter pumps and self-priming pool filter pumps that are not already certified as self-priming under NSF/ANSI 50–2015 (incorporated by reference, see § 431.463) by testing such pumps pursuant to section C.3 of appendix C of NSF/ANSI 50–2015, except for the modifications and exceptions listed in the following sections F.1.1 through F.1.5 of this appendix:

F.1.1 Where section C.3.2, ‘‘Apparatus,’’ and section C.3.4, ‘‘Self-priming capability test method,’’ of NSF/ANSI 50–2015 (incorporated by reference, see § 431.463) state that the ‘‘suction line must be essentially as shown in annex C, figure C.1;’’ the phrase ‘‘essentially as shown in Annex C, figure C.1’’ means:

- The centerline of the pump impeller shaft is situated a vertical distance equivalent to the specified vertical lift (VL), calculated in accordance with section F.1.1.1. of this appendix, above the water level of a water tank of sufficient volume as to maintain a constant water surface level for the duration of the test;
- The pump draws water from the water tank with a riser pipe that extends below the water level a distance of at least 3 times the riser pipe diameter (*i.e.*, 3 pipe diameters);
- The suction inlet of the pump is at least 5 pipe diameters from any obstructions, 90° bends, valves, or fittings; and
- The riser pipe is of the same pipe diameter as the pump suction inlet.

F.1.1.1 The vertical lift (VL) must be normalized to 5.0 feet at an atmospheric pressure of 14.7 psia and a water density of 62.4 lb/ft^3 in accordance with the following equation:

$$VL = 5.0ft \times \left(\frac{62.4\, ^{lb}/_{ft^3}}{\rho_{test}}\right) \times \left(\frac{P_{abs,test}}{14.7psia}\right)$$

Where:

VL = vertical lift of the test apparatus from the waterline to the centerline of the pump impeller shaft, in ft;

ρ_{test} = density of test fluid, in lb/ft^3; and

$P_{abs,test}$ = absolute barometric pressure of test apparatus location at centerline of pump impeller shaft, in psia.

F.1.2 The equipment accuracy requirements specified in section B, ''Measurement Equipment,'' of this appendix also apply to this section F, as applicable.

F.1.2.1 All measurements of head (gauge pressure), flow, and water temperature must be taken at the pump suction inlet and all head measurements must be normalized back to the centerline of the pump impeller shaft in accordance with section A.3.1.3.1 of HI 40.6–2014–B (incorporated by reference, see § 431.463).

F.1.3 All tests must be conducted with clear water that meets the requirements adopted in section C.3 of this appendix.

F.1.4 In section C.3.4, ''Self-priming capability test method,'' of NSF/ANSI 50–2015 (incorporated by reference, see § 431.463), ''the elapsed time to steady discharge gauge reading or full discharge flow'' is determined when the changes in head and flow, respectively, are within the tolerance values specified in table 40.6.3.2.2, ''Permissible amplitude of fluctuation as a percentage of mean value of quantity being measured at any test point,'' of HI 40.6–2014–B (incorporated by reference, see § 431.463). The measured priming time (MPT) is determined as the point in time when the stabilized load point is first achieved, not when stabilization is determined. In addition, the true priming time (TPT) is equivalent to the MPT.

F.1.5 The maximum true priming time for each test run must not exceed 10.0 minutes. Disregard section C.3.5 of NSF/ANSI 50–2015 (incorporated by reference, see § 431.463).

G. Optional Testing and Calculations

G.1 Energy Factor. When making representations regarding the EF of dedicated-purpose pool pumps, determine EF on one of four system curves (A, B, C, or D) and at any given speed (*s*) according to the following equation:

$$EF_{X,s} = \frac{\left(\frac{Q_{X,s}}{1,000} \times 60\right)}{\left(\frac{P_{X,s}}{1,000}\right)}$$

Where:

$EF_{X,s}$ = the energy factor on system curve X at speed s in gal/Wh;

X = one of four possible system curves (A, B, C, or D), as defined in section G.1.1 of this appendix;

s = the tested speed, in rpm;

$Q_{X,s}$ = flow rate measured on system curve X at speed s in gpm; and

$P_{X,s}$ = driver power input to the motor (or controls, if present) on system curve X at speed s in watts.

G.1.1 System Curves. The energy factor may be determined at any speed (*s*) and on any of the four system curves A, B, C, and/or D specified in the Table 3:

TABLE 3—SYSTEMS CURVES FOR OPTIONAL EF TEST PROCEDURE

System curve	System curve equation *
A	$H = 0.0167 \times Q^2$
B	$H = 0.0500 \times Q^2$
C	$H = 0.0082 \times Q^2$
D	$H = 0.0044 \times Q^2$

* In the above table, Q refers to the flow rate in gpm and H refers to head in ft.

G.2 Replacement Dedicated-Purpose Pool Pump Motors. To determine the WEF for replacement DPPP motors, test each replacement DPPP motor paired with each dedicated-purpose pool pump bare pump for which the replacement DPPP motor is advertised to be paired, as stated in the manufacturer's literature for that replacement DPPP motor model, according to the testing and calculations described in sections A, B, C, D, and E of this appendix. Alternatively, each replacement DPPP motor may be tested with the most consumptive dedicated-purpose pool pump bare pump for which it is advertised to be paired, as stated in the manufacturer's literature for that replacement DPPP motor model. If a replacement DPPP motor is not advertised to be paired with any specific dedicated-purpose pool pump bare pumps, test with the most consumptive dedicated-purpose pool pump bare pump available.

[82 FR 36924, Aug. 7, 2017]

APPENDIX C TO SUBPART Y OF PART 431—UNIFORM TEST METHOD FOR THE MEASUREMENT OF ENERGY EFFICIENCY OF DEDICATED-PURPOSE POOL PUMPS

NOTE: Any representations made on or after July 19, 2021, with respect to the energy use or efficiency of dedicated-purpose pool pumps subject to testing pursuant to 10 CFR 431.464(b) must be made in accordance with the results of testing pursuant to this appendix.

I. TEST PROCEDURE FOR DEDICATED-PURPOSE POOL PUMPS

A. General

A.1 Test Method. To determine the weighted energy factor (WEF) for dedicated-purpose pool pumps, perform "wire-to-water" testing in accordance with HI 40.6–2014–B, except section 40.6.4.1, "Vertically suspended pumps"; section 40.6.4.2, "Submersible pumps"; section 40.6.5.3, "Test report"; section 40.6.5.5, "Test conditions"; section 40.6.5.5.2, "Speed of rotation during testing"; section 40.6.6.1, "Translation of test results to rated speed of rotation"; section 40.6.6.2, "Pump efficiency"; section 40.6.6.3, "Performance curve"; section A.7, "Testing at temperatures exceeding 30 °C (86 °F)"; and appendix B, "Reporting of test results"; (incorporated by reference, see § 431.463) with the modifications and additions as noted throughout the provisions below. Do not use the test points specified in section 40.6.5.5.1, "Test procedure" of HI 40.6–2014–B and instead use those test points specified in section D.3 of this appendix for the applicable dedicated-purpose pool pump variety and speed configuration. When determining overall efficiency, best efficiency point, or other applicable pump energy performance information, section 40.6.5.5.1, "Test procedure"; section 40.6.6.2, "Pump efficiency"; and section 40.6.6.3, "Performance curve" must be used, as applicable. For the purposes of applying this appendix, the term "volume per unit time," as defined in section 40.6.2, "Terms and definitions," of HI 40.6–2014–B shall be deemed to be synonymous with the term "flow rate" used throughout that standard and this appendix .

A.2 Calculations and Rounding. All terms and quantities refer to values determined in accordance with the procedures set forth in this appendix for the rated pump. Perform all calculations using raw measured values without rounding. Round WEF, maximum head, vertical lift, and true priming time values to the tenths place (*i.e.*, 0.1) and rated hydraulic horsepower to the thousandths place (*i.e.*, 0.001). Round all other reported values to the hundredths place unless otherwise specified.

B. Measurement Equipment

B.1 For the purposes of measuring flow rate, speed of rotation, temperature, and pump power output, the equipment specified in HI 40.6–2014–B Appendix C (incorporated by reference, see § 431.463) necessary to measure head, speed of rotation, flow rate, and temperature must be used and must comply with the stated accuracy requirements in HI 40.6–2014–B Table 40.6.3.2.3, except as specified in sections B.1.1 and B.1.2 of this appendix. When more than one instrument is used to measure a given parameter, the combined accuracy, calculated as the root sum of squares of individual instrument accuracies, must meet the specified accuracy requirements.

B.1.1 Electrical measurement equipment for determining the driver power input to the motor or controls must be capable of measuring true root mean squared (RMS) current, true RMS voltage, and real power up to the 40th harmonic of fundamental supply source frequency, and have a combined accuracy of ±2.0 percent of the measured value at the fundamental supply source frequency.

B.1.2 Instruments for measuring distance (*e.g.*, height above the reference plane or water level) must be accurate to and have a resolution of at least ±0.1 inch.

B.2 Calibration. Calibration requirements for instrumentation are specified in appendix D of HI 40.6–2014–B (incorporated by reference, see § 431.463). Historical calibration data may be used to justify time periods up to three times longer than those specified in table D.1 of HI 40.6–2014–B provided the supporting historical data shows maintenance of calibration of the given instrument up to the selected extended calibration interval on at least two unique occasions, based on the interval specified in HI 40.6–2014–B.

C. Test Conditions and Tolerances

C.1 Pump Specifications. Conduct testing at full impeller diameter in accordance with the test conditions, stabilization requirements, and specifications of HI 40.6–2014–B section 40.6.3, ''Pump efficiency testing''; section 40.6.4, ''Considerations when determining the efficiency of a pump''; section 40.6.5.4 (including appendix A), ''Test arrangements''; and section 40.6.5.5, ''Test conditions'' (incorporated by reference, see § 431.463).

C.2 Power Supply Requirements. The following conditions also apply to the mains power supplied to the DPPP motor or controls, if any:

(1) Maintain the voltage within ±5 percent of the rated value of the motor,

(2) Maintain the frequency within ±1 percent of the rated value of the motor,

(3) Maintain the voltage unbalance of the power supply within ±3 percent of the value with which the motor was rated, and

(4) Maintain total harmonic distortion below 12 percent throughout the test.

C.3 Test Conditions. Testing must be carried out with water that is between 50 and 107 °F with less than or equal to 15 nephelometric turbidity units (NTU).

C.4 Tolerances. For waterfall pumps, multi-speed self-priming and non-self-priming pool filter pumps, and variable-speed self-priming and non-self-priming pool filter pumps all measured load points must be within ±2.5 percent of the specified head value and comply with any specified flow values or thresholds. For all other dedicated-purpose pool pumps, all measured load points must be within the greater of ±2.5 percent of the specified flow rate values or ±0.5 gpm and comply with any specified head values or thresholds.

D. Data Collection and Stabilization

D.1 Damping Devices. Use of damping devices, as described in section 40.6.3.2.2 of HI 40.6–2014–B (incorporated by reference, see § 431.463), are only permitted to integrate up to the data collection interval used during testing.

D.2 Stabilization. Record data at any tested load point only under stabilized conditions, as defined in HI 40.6–2014–B section 40.6.5.5.1 (incorporated by reference, see § 431.463), where a minimum of two measurements are used to determine stabilization.

D.3 Test Points. Measure the flow rate in gpm, pump total head in ft, the driver power input in W, and the speed of rotation in rpm at each load point specified in Table 1 of this appendix for each DPPP variety and speed configuration:

TABLE 1—LOAD POINTS (i) AND WEIGHTS (w_i) FOR EACH DPPP VARIETY AND SPEED CONFIGURATION

DPPP varieties	Speed configuration(s)	Number of load points (n)	Load point (i)	Test points		
				Flow rate (Q) (GPM)	Head (H) (ft)	Speed (rpm)
Self-Priming Pool Filter Pumps And Non-Self-Priming Pool Filter Pumps.	Single-speed dedicated-purpose pool pumps and all self-priming and non-self-priming pool filter pumps not meeting the definition of two-*, multi-, or variable-speed dedicated-purpose pool pump.	1	High	Q_{high} (gpm) = $Q_{max\_\_speed@C}$ **	H = 0.0082 × Q_{high}^2	Maximum speed.
	Two-speed dedicated-purpose pool pumps *.	2	Low	Q_{low} (gpm) = Flow rate associated with specified head and speed that is not below: • 31.1 gpm if rated hydraulic horsepower is >0.75 or • 24.7 gpm if rated hydraulic horsepower is ≤0.75	H = 0.0082 × Q_{low}^2	Lowest speed capable of meeting the specified flow and head values, if any. ***
			High	Q_{high} (gpm) = $Q_{max\_\_speed@C}$ **	H = 0.0082 × Q_{low}^2	Maximum speed.
	Multi-speed and variable-speed dedicated-purpose pool pumps.	2	Low	Q_{low} (gpm) = • If rated hydraulic horsepower is >0.75, then Q_{low} ≥31.1 gpm • If rated hydraulic horsepower is ≤0.75, then Q_{low} ≥24.7 gpm	H = 0.0082 × Q_{low}^2	Lowest speed capable of meeting the specified flow and head values.

TABLE 1—LOAD POINTS (i) AND WEIGHTS (w_i) FOR EACH DPPP VARIETY AND SPEED CONFIGURATION—Continued

DPPP varieties	Speed configuration(s)	Number of load points (n)	Load point (i)	Test points: Flow rate (Q) (GPM)	Test points: Head (H) (ft)	Test points: Speed (rpm)
			High	Q_{high} (gpm) ≥0.8 × $Q_{max\_\_speed}@_C$ **	H = 0.0082 × Q_{high}^2	Lowest speed capable of meeting the specified flow and head values.
Waterfall Pumps.	Single-speed dedicated-purpose pool pumps.	1	High	Q_{low} (gpm) = Flow corresponding to specified head	17.0 ft	Maximum speed.
Pressure Cleaner Booster Pumps.	Any	1	High	10.0 gpm	≥60.0 ft	Lowest speed capable of meeting the specified flow and head values.

* In order to apply the test points for two-speed self-priming and non-self-priming pool filter pumps, self-priming pool filter pumps that are greater than or equal to 0.711 rated hydraulic horsepower that are two-speed dedicated-purpose pool pumps must also be distributed in commerce either: (1) With a pool pump control (variable speed drive and user interface or switch) that changes the speed in response to pre-programmed user preferences and allows the user to select the duration of each speed and/or the on/off times or (2) without a pool pump control that has such capability, but without which the pump is unable to operate. Two-speed self-priming pool filter pumps greater than or equal to 0.711 rated hydraulic horsepower that do not meet these requirements must be tested using the load point for single-speed self-priming or non-self-priming pool filter pumps, as appropriate.

** $Q_{max\_\_speed}@_C$ = Flow at max speed on curve C (gpm).

*** If a two-speed pump has a low speed that results in a flow rate below the specified values, the low speed of that pump shall not be tested.

E. Calculations

E.1 Determination of Weighted Energy Factor. Determine the WEF as a ratio of the measured flow and driver power input to the dedicated-purpose pool pump in accordance with the following equation:

$$WEF = \frac{\sum_{i=1}^{n}\left(w_i \times \frac{Q_i}{1000} \times 60\right)}{\sum_{i=1}^{n}\left(w_i \times \frac{P_i}{1000}\right)}$$

Where:

WEF = Weighted Energy Factor in kgal/kWh;
W_i = weighting factor at each load point *i*, as specified in section E.2 of this appendix;
Q_i = flow at each load point *i*, in gpm;
P_i = driver power input to the motor (or controls, if present) at each load point *i*, in watts;
i = load point(s), defined uniquely for each DPPP variety and speed configuration as specified in section D.3 of this appendix; and
n = number of load point(s), defined uniquely for each DPPP variety and speed configuration as specified in section D.3 of this appendix.

E.2 Weights. When determining WEF, apply the weights specified in Table 2 of this appendix for the applicable load points, DPPP varieties, and speed configurations:

TABLE 2—LOAD POINT WEIGHTS (w_i)

DPPP varieties	Speed configuration(s)	Load point(s) *i*: Low flow	Load point(s) *i*: High flow
Self-Priming Pool Filter Pumps and Non-Self-Priming Pool Filter Pumps.	Single-speed dedicated-purpose pool pumps and all self-priming and non-self-priming pool filter pumps not meeting the definition of two-*, multi-, or variable-speed dedicated-purpose pool pump.	....	1.0
	Two-speed dedicated-purpose pool pumps * ..	0.80	0.20
	Multi-speed and variable-speed dedicated-purpose pool pumps.	0.80	0.20

TABLE 2—LOAD POINT WEIGHTS (w_i)—Continued

DPPP varieties	Speed configuration(s)	Load point(s) *i*	
		Low flow	High flow
Waterfall Pumps	Single-speed dedicated-purpose pool pumps		1.0
Pressure Cleaner Booster Pump	Any		1.0

* In order to apply the test points for two-speed self-priming and non-self-priming pool filter pumps, self-priming pool filter pumps that are greater than or equal to 0.711 rated hydraulic horsepower that are two-speed dedicated-purpose pool pumps must also be distributed in commerce either: (1) With a pool pump control (variable speed drive and user interface or switch) that changes the speed in response to pre-programmed user preferences and allows the user to select the duration of each speed and/or the on/off times or (2) without a pool pump control that has such capability, but without which the pump is unable to operate. Two-speed self-priming pool filter pumps greater than or equal to 0.711 rated hydraulic horsepower that do not meet these requirements must be tested using the load point for single-speed self-priming or non-self-priming pool filter pumps, as appropriate.

E.3 Determination of Horsepower and True Power Factor Metrics

E.3.1 Determine the pump power output at any load point *i* using the following equation:

$$P_{u,i} = \frac{Q_i \times H_i \times SG}{3960}$$

Where:

$P_{u,i}$ = the measured pump power output at load point *i* of the tested pump, in hp;
Q_i = the measured flow rate at load point *i* of the tested pump, in gpm;
H_i = pump total head at load point *i* of the tested pump, in ft; and
SG = the specific gravity of water at specified test conditions, which is equivalent to 1.00.

E.3.1.1 Determine the rated hydraulic horsepower as the pump power output measured on the reference curve at maximum rotating speed and full impeller diameter for the rated pump.

E.3.2 For dedicated-purpose pool pumps with single-phase AC motors or DC motors, determine the dedicated-purpose pool pump nominal motor horsepower as the product of the measured full load speed and torque, adjusted to the appropriate units, as shown in the following equation:

$$P_{nm} = \frac{(T \times n)}{5252}$$

Where:

P_{nm} = the dedicated-purpose pool pump nominal total horsepower at full load, in hp;
T = output torque at full load, in lb-ft; and
n = the motor speed at full load, in rpm.

Full-load speed and torque shall be determined based on the maximum continuous duty motor power output rating allowable for the motor's nameplate ambient rating and insulation class.

E.3.2.1 For single-phase AC motors, determine the measured speed and torque at full load according to either section E.3.2.1.1 or E.3.2.1.2 of this appendix.

E.3.2.1.1 Use the procedures in section 3.2, ''Tests with load''; section 4 ''Testing facilities''; section 5.2 ''Mechanical measurements''; section 5.3 ''Temperature measurements''; and section 6 ''Tests'' of IEEE 114–2010 (incorporated by reference, see § 431.463), or

E.3.2.1.2 Use the applicable procedures in section 5, ''General test requirements'' and section 6, ''Tests'' of CSA C747–2009 (RA 2014); except in section 6.4(b) the conversion factor shall be 5252, only measurements at full load are required in section 6.5, and section 6.6 shall be disregarded (incorporated by reference, see § 431.463).

E.3.2.2 For DC motors, determine the measured speed and torque at full load according to either section E.3.2.2.1 or E.3.2.2.2 of this appendix.

E.3.2.2.1 Use the procedures in section 3.1, ''Instrument Selection Factors''; section 3.4 ''Power Measurement'': Section 3.5 ''Power

Sources''; section 4.1.2 ''Ambient Air''; section 4.1.4 ''Direction of Rotation''; section 5.4.1 ''Reference Conditions''; and section 5.4.3.2 ''Dynomometer or Torquemeter Method'' of IEEE 113–1985 (incorporated by reference, see § 431.463), or

E.3.2.2.2 Use the applicable procedures in section 5, ''General test requirements'' and section 6, ''Tests'' of CSA C747–2009 (RA 2014); except in section 6.4(b) the conversion factor shall be 5252, only measurements at full load are required in section 6.5, and section 6.6 shall be disregarded (incorporated by reference, see § 431.463).

E.3.3 For dedicated-purpose pool pumps with single-phase AC motors or DC motors, the dedicated-purpose pool pump service factor is equal to 1.0.

E.3.4 Determine the dedicated-purpose pool pump motor total horsepower according to section E.3.4.1 of this appendix for dedicated-purpose pool pumps with single-phase AC motors or DC motors and section E.3.4.2 of this appendix for dedicated-purpose pool pumps with polyphase AC motors.

E.3.4.1 For dedicated-purpose pool pumps with single-phase AC motors or DC motors, determine the dedicated-purpose pool pump motor total horsepower as the product of the dedicated-purpose pool pump nominal motor horsepower, determined in accordance with section E.3.2 of this appendix, and the dedicated-purpose pool pump service factor, determined in accordance with section E.3.3 of this appendix.

E.3.4.2 For dedicated-purpose pool pumps with polyphase AC induction motors, determine the dedicated-purpose pool pump motor total horsepower as the product of the rated nominal motor horsepower and the rated service factor of the motor.

E.3.5 Determine the true power factor at each applicable load point specified in Table 1 of this appendix for each DPPP variety and speed configuration as a ratio of driver power input to the motor (or controls, if present) (P_i), in watts, divided by the product of the voltage in volts and the current in amps at each load point i, as shown in the following equation:

$$PF_i = \frac{P_i}{V_i \times I_i}$$

Where:

PF_i = true power factor at each load point i, dimensionless;

P_i = driver power input to the motor (or controls, if present) at each load point i, in watts;

V_i = voltage at each load point i, in volts;

I_i = current at each load point i, in amps; and

i = load point(s), defined uniquely for each DPPP variety and speed configuration as specified in section D.3 of this appendix.

E.4 Determination of Maximum Head. Determine the maximum head for self-priming pool filter pumps, non-self-priming pool filter pumps, and waterfall pumps by measuring the head at maximum speed and the minimum flow rate at which the pump is designed to operate continuously or safely, where the minimum flow rate is assumed to be zero unless stated otherwise in the manufacturer literature.

F. Determination of Self-Priming Capability

F.1 Test Method. Determine the vertical lift and true priming time of non-self-priming pool filter pumps and self-priming pool filter pumps that are not already certified as self-priming under NSF/ANSI 50–2015 (incorporated by reference, see § 431.463) by testing such pumps pursuant to section C.3 of appendix C of NSF/ANSI 50–2015, except for the modifications and exceptions listed in the following sections F.1.1 through F.1.5 of this appendix:

F.1.1 Where section C.3.2, ''Apparatus,'' and section C.3.4, ''Self-priming capability test method,'' of NSF/ANSI 50–2015 (incorporated by reference, see § 431.463) state that the ''suction line must be essentially as shown in annex C, figure C.1;'' the phrase ''essentially as shown in Annex C, figure C.1'' means:

(1) The centerline of the pump impeller shaft is situated a vertical distance equivalent to the specified vertical lift (VL), calculated in accordance with section F.1.1.1. of this appendix, above the water level of a water tank of sufficient volume as to maintain a constant water surface level for the duration of the test;

(2) The pump draws water from the water tank with a riser pipe that extends below the water level a distance of at least 3 times the riser pipe diameter (*i.e.*, 3 pipe diameters);

(3) The suction inlet of the pump is at least 5 pipe diameters from any obstructions, 90° bends, valves, or fittings; and

(4) The riser pipe is of the same pipe diameter as the pump suction inlet.

F.1.1.1 The vertical lift (VL) must be normalized to 5.0 feet at an atmospheric pressure of 14.7 psia and a water density of 62.4 lb/ft^3 in accordance with the following equation:

$$VL = 5.0ft \times \left(\frac{62.4 \, {}^{lb}/_{ft^3}}{\rho_{test}} \right) \times \left(\frac{P_{abs,test}}{14.7psia} \right)$$

Where:

VL = vertical lift of the test apparatus from the waterline to the centerline of the pump impeller shaft, in ft;

ρ_{test} = density of test fluid, in lb/ft^3; and

$P_{abs,test}$ = absolute barometric pressure of test apparatus location at centerline of pump impeller shaft, in psia.

F.1.2 The equipment accuracy requirements specified in section B, ''Measurement Equipment,'' of this appendix also apply to this section F, as applicable.

F.1.2.1 All measurements of head (gauge pressure), flow, and water temperature must be taken at the pump suction inlet and all head measurements must be normalized back to the centerline of the pump impeller shaft in accordance with section A.3.1.3.1 of HI 40.6–2014–B (incorporated by reference, see § 431.463).

F.1.3 All tests must be conducted with clear water that meets the requirements adopted in section C.3 of this appendix.

F.1.4 In section C.3.4, ''Self-priming capability test method,'' of NSF/ANSI 50–2015 (incorporated by reference, see § 431.463), ''the elapsed time to steady discharge gauge reading or full discharge flow'' is determined when the changes in head and flow, respectively, are within the tolerance values specified in table 40.6.3.2.2, ''Permissible amplitude of fluctuation as a percentage of mean value of quantity being measured at any test point,'' of HI 40.6–2014–B (incorporated by reference, see § 431.463). The measured priming time (MPT) is determined as the point in time when the stabilized load point is first achieved, not when stabilization is determined. In addition, the true priming time (TPT) is equivalent to the MPT.

F.1.5 The maximum true priming time for each test run must not exceed 10.0 minutes. Disregard section C.3.5 of NSF/ANSI 50–2015 (incorporated by reference, see § 431.463).

G. Optional Testing and Calculations

G.1 Replacement Dedicated-Purpose Pool Pump Motors. To determine the WEF for replacement DPPP motors, test each replacement DPPP motor paired with each dedicated-purpose pool pump bare pump for which the replacement DPPP motor is advertised to be paired, as stated in the manufacturer's literature for that replacement DPPP motor model, according to the testing and calculations described in sections A, B, C, D, and E of this appendix. Alternatively, each replacement DPPP motor may be tested with the most consumptive dedicated-purpose pool pump bare pump for which it is advertised to be paired, as stated in the manufacturer's literature for that replacement DPPP motor model. If a replacement DPPP motor is not advertised to be paired with any specific dedicated-purpose pool pump bare pumps, test with the most consumptive dedicated-purpose pool pump bare pump available.

[82 FR 36924, Aug. 7, 2017]

APPENDIX D TO SUBPART Y OF PART 431—UNIFORM TEST METHOD FOR THE MEASUREMENT OF ENERGY CONSUMPTION OF CIRCULATOR PUMPS

NOTE 1 TO APPENDIX D TO SUBPART Y OF PART 431: Beginning March 20, 2023, any representations made with respect to the energy use or efficiency of circulator pumps subject to testing pursuant to 10 CFR 431.464(c) must be made in accordance with the results of testing pursuant to this appendix.

0. Incorporation by Reference

DOE incorporated by reference in § 431.463 the entire standard for HI 40.6–2021 and for HI 41.5–2022. However, not all provisions of HI 40.6–2021 and HI 41.5–2022 apply to this appendix. If there is any conflict between any industry standard and this appendix, follow the language of the test procedure in this appendix, disregarding the conflicting industry standard language.

0.1 Specifically, the following provisions of HI 40.6–2021 are not applicable:

(a) Section 40.6.4—Considerations when determining the efficiency of certain pumps, Section 40.6.4.1—Vertically suspended pumps

(b) Section 40.6.4—Considerations when determining the efficiency of certain pumps, Section 40.6.4.2—Submersible pumps

(c) Section 40.6.5—Test procedures, Section 40.6.5.3—Test report

(d) Section 40.6.5—Test procedures, Section 40.6.5.5—Test conditions, Section 40.6.5.5.2—Speed of rotation during test

(e) Section 40.6.6—Analysis, Section 40.6.6.1—Translation of the test results to the specified speed of rotation

(f) Section 40.6.6—Analysis, Section 40.6.6.1—Translation of the test results to the specified speed of rotation, Section 40.6.6.1.1—

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Translation of the test results into data based on specified speed of rotation
(g) Appendix B—Reporting of test results
(h) Appendix G—DOE compared to HI 40.6 nomenclature

0.2 Specifically, only the following provisions of HI 41.5–2022 are applicable:

(a) Section 41.5.3.4.1—Determination of CER—Full Speed
(b) Section 41.5.3.4.2—Determination of CER—Pressure Speed Control
(c) Section 41.5.3.4.3—Determination of CER—Temperature Speed Control
(d) Section 41.5.3.4.4.1—Determination of CER—External Input Signal Speed Control Only
(e) Section 41.5.3.4.4.2—Determination of CER—External Input Signal Speed Control Operated With Other Control Methods
(f) Section 41.5.3.4.5—Determination of CER—Manual Speed Control

1. General

To determine the circulator energy index (CEI), testing shall be performed in accordance with HI 40.6–2021, including Appendix E ''Testing Circulator Pumps,'' with the exceptions noted in section 0.1 of this appendix and the modifications and additions as noted throughout the following provisions. For the purposes of applying this appendix, the term ''pump power output,'' as defined in section 40.6.2, ''Terms and definitions,'' of HI 40.6–2021 shall be deemed to be synonymous with the term ''hydraulic horsepower'' used throughout that standard and this appendix.

2. Scope

2.1 This appendix is applicable to all circulator pumps and describes how to calculate the circulator energy index (CEI; section F) based on the pump energy rating for the minimally compliant reference circulator pump (CER_{STD}) and the circulator energy rating (CER) determined in accordance with one of the test methods listed in Table I of this appendix based on a control variety with which the circulator pump is distributed in commerce.

TABLE 1 TO APPENDIX D TO SUBPART Y OF PART 431—APPLICABILITY OF TEST METHODS BASED ON CIRCULATOR PUMP CONFIGURATION AND CONTROL METHOD WITH WHICH CIRCULATOR PUMP IS DISTRIBUTED IN COMMERCE

Circulator pump configuration	Control method with which circulator pump is distributed	Test method to be used for testing and calculation of CER
Circulator Pump + Motor	Circulator pumps at full speed or circulator pumps without pressure, temperature, external input signal, or manual speed control.	HI 41.5–2022 Section 41.5.3.4.1.
Circulator Pump + Motor + Controls.	Circulator pumps with pressure control (including adaptive pressure control).	HI 41.5–2022 Section 41.5.3.4.2.
	Circulator pumps with temperature control	HI 41.5–2022 Section 41.5.3.4.3.
	Circulator pumps with only external input signal control, and which cannot be operated without an external input signal.	HI 41.5–2022 Section 41.5.3.4.4.1.
	Circulator pumps with external input signal control in addition to other control varieties, or which can be operated without an external input signal.	HI 41.5–2022 Section 41.5.3.4.4.2.
	Circulator pumps with manual speed control	HI 41.5–2022 Section 41.5.3.4.5.

2.2 If a given circulator pump model is distributed in commerce with multiple control varieties available, the manufacturer may select a control variety (or varieties) among those available with which to test the circulator pump, including the test method for circulator pumps at full speed or circulator pumps without external input signal, manual, pressure, or temperature controls).

3. Measurement Equipment

For the purposes of measuring flow rate, head, driver power input, and pump power output, the equipment specified in HI 40.6–2021 Appendix C must be used and must comply with the stated accuracy requirements in HI 40.6–2021 Table 40.6.3.2.3. When more than one instrument is used to measure a given parameter, the combined accuracy, calculated as the root sum of squares of individual instrument accuracies, must meet the specified accuracy requirements.

4. Test Conditions

4.1 Pump specifications. Conduct testing in accordance with the test conditions, stabilization requirements, and specifications of HI 40.6–2021 section 40.6.3, ''Pump efficiency testing''; section 40.6.4, ''Considerations when determining the efficiency of a pump,'' including section 40.6.4.4, ''Determination of pump overall efficiency''; section 40.6.5.4 (including Appendix A), ''Test arrangements''; and section 40.6.5.5, ''Test conditions.''

4.2 Twin head circulator pump. To test twin head circulator pumps, one of the two impeller assemblies should be incorporated into an adequate, single impeller volute and casing. An adequate, single impeller volute and casing means a volute and casing for which any physical and functional characteristics that affect energy consumption and energy efficiency are essentially identical to their corresponding characteristics for a single impeller in the twin head circulator pump volute and casing.

4.3 Circulator-less-volute. To determine the CEI for a circulator-less-volute, test each circulator-less-volute with each volute for which the circulator-less-volute is offered for sale or advertised to be paired for that circulator pump model according to the testing and calculations described in the applicable test method listed in Table 1 of this appendix, depending on the variety of control with which the circulator pump model is distributed in commerce. Alternatively, each circulator-less-volute may be tested with the most consumptive volute with which is it offered for sale or advertised to be paired for that circulator pump model.

5. Data Collection and Analysis

5.1 Stabilization. Record data at any test point only under stabilized conditions, as defined in HI 40.6–2021 section 40.6.5.5.1.

5.2 Testing BEP at maximum speed for the circulator pump. Determine the BEP of the circulator pump at maximum speed as specified in Appendix E of HI 40.6–2021 including sections 40.6.5.5.1 and 40.6.6 as modified. Determine the BEP flow rate at maximum speed as the flow rate at the operating point of maximum overall efficiency on the circulator pump curve, as determined in accordance with section 40.6.6.3 of HI 40.6–2021 as modified by Appendix E, where overall efficiency is the ratio of the circulator pump power output divided by the driver power input, as specified in Table 40.6.2.1 of HI 40.6–2021. For the purposes of this test procedure, all references to ''driver power input'' in this appendix or HI 40.6–2021 shall refer to the input power to the controls, or to the motor if no controls are present.

5.3 Rounding. All terms and quantities refer to values determined in accordance with the procedures set forth in this appendix for the rated circulator pump. Perform all calculations using raw measured values without rounding. Round CER to three significant figures. Round CEI to the hundredths decimal place. Round rated hydraulic horsepower to the less precise of the following two values: three significant figures; the fourth decimal place when expressed in units of horsepower.

6. Calculation of CEI

Determine CEI using the following equation:

$$CEI = \frac{\text{CER}}{CER_{STD}}$$

Where:

CEI = the circulator energy index (dimensionless);

CER = the circulator energy rating determined in accordance with Table 1 of this appendix (hp); and

CER_{STD} = the CER for a circulator pump that is minimally compliant with DOE's energy conservation standards with the same hydraulic horsepower as the tested pump, as determined in accordance with the specifications at paragraph (i) of §431.465.

7. Determination of Additional Circulator Performance Parameters

7.1 To determine flow and head at BEP; pump power output (hydraulic horsepower) and driver power input at load points used in the calculation of CEI, including the rated hydraulic horsepower; and any other reported performance parameters, conduct testing according to section 1 of this appendix.

7.2 Determine the rated hydraulic horsepower as the pump power output measured at BEP and full impeller diameter for the rated pump.

7.3 Determine the true power factor at each applicable load point specified in the applicable test method listed in Table 1 of this appendix for each circulator pump control variety as a ratio of driver power input to the motor (or controls, if present) (P_i), in watts, divided by the product of the true RMS voltage in volts and the true RMS current in amps at each load point i, as shown in the following equation:

$$PF_i = \frac{P_i}{V_i \times I_i}$$

Where:

PF_i = true power factor at each load point i, dimensionless;

P_i = driver power input to the motor (or controls, if present) at each load point i, in watts;

V_i = true RMS voltage at each load point i, in volts;

I_i = true RMS current at each load point i, in amps; and

i = load point(s), defined uniquely for each circulator pump control variety as specified in the applicable test method listed in Table 1 of this appendix.

[87 FR 57299, Sept. 19, 2022]

Subpart Z—Dedicated-Purpose Pool Pump Motors

SOURCE: 86 FR 40774, July 29, 2021, unless otherwise noted.

§431.481 Purpose and scope.

(a) *Purpose*. This subpart contains definitions and test procedures requirements for electric motors that are dedicated-purpose pool pump motors, pursuant to Part A–1 of Title III of the Energy Policy and Conservation Act, as amended, 42 U.S.C. 6311–6317. It also identifies materials incorporated by reference in this part. This subpart does not cover other ''electric motors,'' which are addressed in subpart B of this part, nor does it cover ''small electric motors,'' which are addressed in subpart X of this part.

(b) *Scope*. The requirements of this subpart apply to dedicated-purpose pool pump motors, as specified in paragraphs 1.2, 1.3 and 1.4 of UL 1004–10:2020 (incorporated by reference, see §431.482).

(c) *Incorporation by reference*. In §431.482, DOE incorporates by reference entire standards for use in this subpart; however, only the provisions of the document enumerated in an approved section are applicable within §431.482.

§431.482 Materials incorporated by reference.

(a) *General*. Certain material is incorporated by reference into this subpart with the approval of the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. To enforce any edition other than that specified in this section, DOE must publish a document in the FEDERAL REGISTER and the material must be available to the public. Standards can be obtained from the sources in this section. All approved material is available for inspection at the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Program, sixth Floor, 950 L'Enfant Plaza SW, Washington, DC 20024, (202) 586–2945, *https://www.energy.gov/eere/buildings/appliance-and-equipment-standards-program*, and may be obtained from the other sources in this section. It is also available for inspection at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, email: *fedreg.legal@nara.gov*, or go to: *www.archives.gov/federal-register/cfr/ibr-locations.html*.

(b) *CSA*. Canadian Standards Association, Sales Department, 5060 Spectrum Way, Suite 100, Mississauga, Ontario, L4W 5N6, Canada, 1–800–463–6727, or *https://www.csagroup.org/store*.

(1) CSA C747–09 (Reaffirmed 2014) (''CSA C747–09''), ''Energy efficiency test method for small motors'' as revised through August 2016, including Update No. 1; IBR approved for §431.484.

(2) [Reserved]

(c) *UL*. Underwriters Laboratories, 333 Pfingsten Road, Northbrook, IL 60062, (841) 272–8800, or go to *https://www.ul.com*.

(1) UL 1004–10 (1004–10:2020), ''Standard for Safety for Pool Pump Motors,'' First Edition, Dated February 28, 2020; IBR approved for §§431.481 and 431.483.

(2) [Reserved]

§431.483 Definitions.

The definitions applicable to this subpart are defined in Section 2 ''Glossary'' of UL 1004–10:2020 (incorporated by reference, see §431.482).

§431.484 Test procedure.

(a) *Scope*. Pursuant to section 343(a) of EPCA, this section provides the test procedures for measuring the efficiency of dedicated-purpose pool pump motors. (42 U.S.C. 6314) For purposes of this part and EPCA, the test procedures for measuring the efficiency of dedicated-purpose pool pump motors shall be the test procedure specified in paragraph (b) of this section.

(b) *Testing and calculations*. At such time as compliance is required with a labeling requirement or an energy conservation standard, the full-load efficiency of each dedicated-purpose pool pump motor model (inclusive of the drive, if the dedicated-purpose pool pump motor model is placed into commerce with a drive, or is unable to operate without the presence of a drive) is determined in accordance with CSA C747–09, Section 1.6 ''Scope'', Section 3 ''Definitions'', Section 4 ''General requirements'', Section 5, ''General test requirements'', and Section 6 ''Test method'' (incorporated by reference, see §431.482).

PART 433—ENERGY EFFICIENCY STANDARDS FOR THE DESIGN AND CONSTRUCTION OF NEW FEDERAL COMMERCIAL AND MULTI-FAMILY HIGH-RISE RESIDENTIAL BUILDINGS

AUTHORITY: 42 U.S.C. 6831–6832, 6834–6835; 42 U.S.C. 7101 *et seq.*

SOURCE: 71 FR 70281, Dec. 4, 2006, unless otherwise noted.

§433.1 Purpose and scope.

(a) This part establishes an energy efficiency performance standard for the new Federal commercial and multi-family high-rise buildings, for which design for construction began on or after January 3, 2007, as required by section 305(a) of the Energy Conservation and Production Act, as amended (42 U.S.C. 6834(a)).

(b) [Reserved]

(c) This part also establishes green building certification requirements for new Federal buildings that are commercial and multi-family high-rise residential buildings and major renovations to Federal buildings that are commercial and multi-family high-rise residential buildings, for which design for construction began on or after October 14, 2015.

[71 FR 70281, Dec. 4, 2006, as amended at 79 FR 61569, Oct. 14, 2014]

§433.2 Definitions.

For purposes of this part, the following terms, phrases and words are defined as follows:

ANSI means the American National Standards Institute.

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

ASHRAE Baseline Building 2004 means a building that is otherwise identical to the proposed building but is designed to meet, but not exceed, the energy efficiency specifications in ANSI/ASHRAE/IESNA Standard 90.1–2004, Energy Standard for Buildings Except Low-Rise Residential Buildings, January 2004 (incorporated by reference, see §433.3).

ASHRAE Baseline Building 2007 means a building that is otherwise identical to the proposed building but is designed to meet, but not exceed, the energy efficiency specifications in ANSI/ASHRAE/IESNA Standard 90.1–2007, Energy Standard for Buildings Except