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Energy Conservation Program: Test Procedures for Residential Furnace Fans; Final Rule

DEPARTMENT OF ENERGY

10 CFR Parts 429 and 430

[Docket No. EERE–2010–BT–TP–0010]

RIN 1904–AC21

Energy Conservation Program: Test Procedures for Residential Furnace Fans

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

ACTION: Final rule.

SUMMARY: On May 15, 2012, the U.S. Department of Energy (DOE) issued a notice of proposed rulemaking (NOPR) to initiate the rulemaking to establish test procedures for residential furnace fans. On April 2, 2013 DOE issued a supplemental notice of proposed rulemaking (SNOPR) to address interested party comments received on the NOPR. The proposed rulemaking serves as the basis for today's action. DOE is issuing a final rule to establish test procedures for measuring the electrical consumption for electrically-powered devices used in weatherized and non-weatherized gas, oil and electric furnaces and modular blowers to circulate air through ductwork.

DATES: The effective date of this rule is February 3, 2014.

The incorporation by reference of certain publications listed in this rule was approved by the Director of the Federal Register on February 3, 2014.

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

A link to the docket Web page can be found at: *http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/42.* This Web page will contain a link to the docket for this notice on the *regulations.gov* site. The regulations.gov Web page will contain simple instructions on how to access all documents, including public comments, in the docket.

For further information on how to review the docket, contact Ms. Brenda Edwards at (202) 586–2945 or by email: *Brenda.Edwards@ee.doe.gov.*

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SUPPLEMENTARY INFORMATION: This final rule incorporates by reference into part 430 the following industry standards:

(1) ANSI/ASHRAE Standard 103–2007, (Supersedes ANSI/ASHRAE 103–1993), Methods of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers, ASHRAE Standards Committee approved on June 23, 2007, ASHRAE Board of Directors on June 27, 2007, ANSI approved March 25, 2008.

(2) ANSI/ASHRAE 37–2009, Methods of Testing for Rating Electrically Driven Unitary Air-Conditioning and Heat Pump Equipment, ASHRAE Standards Committee approved on June 20, 2009, ASHRAE Board of Directors approved on June 24, 2009; ANSI approved June 25, 2009.

You can purchase copies of ASHRAE standards from the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. 1791 Tullie Circle NE., Atlanta, GA 30329, 404–636–8400, or *www.ashrae.org.*

You can also view copies of these standards at the U.S. Department of Energy, Resource Room of the Building Technologies Program, 950 L'Enfant Plaza SW., 6th Floor, Washington, DC 20024, (202) 586–2945, between 9 a.m. and 4 p.m., Monday through Friday, except Federal holidays.

Table of Contents

I. Authority and Background

Title III of the Energy Policy and Conservation Act of 1975 (42 U.S.C. 6291, *et seq.;* "EPCA" or, "the Act") sets forth a variety of provisions designed to improve energy efficiency. (All references to EPCA refer to the statute as amended through the American Energy Manufacturing Technical Corrections Act (AEMTCA), Pub. L. 112–210 (Dec. 18, 2012)). Part B of title III, which for editorial reasons was redesignated as Part A upon incorporation into the U.S. Code (42 U.S.C. 6291–6309, as codified), establishes the "Energy Conservation Program for Consumer Products Other Than Automobiles." These include products that use electricity for the purposes of circulating air through ductwork, hereinafter referred to as "furnace fans," the subject of today's notice. (42 U.S.C. 6295(f)(4)(D))

Under the Act, this energy conservation program consists essentially of four parts: (1) Testing; (2) labeling; (3) Federal energy conservation standards; and (4) certification and enforcement procedures. The testing requirements consist of test procedures that manufacturers of covered products must use as the basis for certifying to DOE that their products comply with the applicable energy conservation standards adopted pursuant to EPCA and for making representations about the efficiency of those products. (42 U.S.C. 6293(c); 42 U.S.C. 6295(s)) Any representation made after July 2, 2014 for energy consumption of residential furnace fans must be based upon results generated under this test procedure. Upon the compliance date(s) of any energy conservation standard(s) for residential furnace fans, use of the applicable provisions of this test procedure to demonstrate compliance with the energy conservation standard will also be required. Similarly, DOE must use these test procedures in any enforcement action to determine whether covered products comply with these energy conservation standards. (42 U.S.C. 6295(s))

General Test Procedure Rulemaking Process

Under 42 U.S.C. 6293, EPCA sets forth the criteria and procedures DOE must follow when prescribing or amending test procedures for covered products. Under EPCA, ''[a]ny test procedures prescribed or amended under this section shall be reasonably designed to produce test results which measure energy efficiency, energy use, . . . or estimated annual operating cost of a covered product during a representative average use cycle or period of use . . . and shall not be unduly burdensome to conduct.'' (42 U.S.C. 6293(b)(3)) In addition, if DOE determines that a test procedure amendment is warranted, it must publish proposed test procedures and offer the public an opportunity to present oral and written comments on them. (42 U.S.C. 6293(b)(2)) In any rulemaking to amend a test procedure, DOE must determine to what extent, if any, the proposed test procedure would alter the measured energy efficiency of a covered product as determined under the existing test procedure. (42 U.S.C. 6293(e)(1)) If DOE determines that the amended test procedure would alter the measured efficiency of a covered product, DOE must amend the applicable energy conservation standard accordingly. (42 U.S.C. 6293(e)(2))

Energy Conservation Standards and Test Procedures for Furnace Fans

Pursuant to EPCA under 42 U.S.C. 6295(f)(4)(D), DOE is currently conducting a rulemaking to consider new energy conservation standards for furnace fans. EPCA directs DOE to establish test procedures in conjunction with new energy conservation standards, including furnace fans. (42 U.S.C. 6295(o)(3)(A)) DOE does not currently have a test procedure for furnace fans. Hence, to fulfill the statutory requirements, DOE is conducting this test procedure rulemaking for furnace fans concurrently with the energy conservation standards rulemaking for furnace fans. The test procedure established by this final rule includes an energy consumption metric and the methods necessary to measure the energy performance of furnace fans. The energy consumption metric does not account for the electrical energy consumption in standby mode and off mode because consumption of a furnace fan in those modes is already accounted for in the DOE rulemakings for furnaces and central air conditioners (CAC) and heat pumps. 77 FR 76831 (Dec. 31, 2012); 76 FR 65616 (Oct. 24, 2011). Manufacturers will be required to use the energy consumption metric, sampling plans, and testing methods established in this final rule to verify compliance with the new energy conservation standards when they take effect and for making representations of the energy consumption of furnace fans.

On June 3, 2010, DOE published a Notice of Public Meeting and Availability of the Framework Document (the June 2010 Framework Document) to initiate the energy conservation standard rulemaking for furnace fans. 75 FR 31323. In the June 2010 Framework Document, DOE requested feedback from interested parties on many issues related to test methods for evaluating the electrical energy consumption of furnace fans. DOE held the framework public meeting on June 18, 2010. DOE originally scheduled the framework comment period to close on July 6, 2010. However, due to the large number and broad scope of questions and issues raised regarding the June 2010 Framework Document in writing and during the public meeting, DOE published a notice in the **Federal Register** reopening the comment period from July 15, 2010, until July 27, 2010, to allow additional time for interested parties to submit comments. 75 FR 41102 (July 15, 2010).

On May 15, 2012, DOE published a notice of proposed rulemaking in the **Federal Register** to initiate the test procedure rulemaking for furnace fans. 77 FR 28674. In the May 2012 NOPR, DOE proposed an energy consumption metric, fan efficiency rating (FER), and proposed methods to measure the performance of furnace fans based on FER. DOE held a public meeting on the test procedure NOPR on June 15, 2012. The test procedure NOPR comment period closed on September 10, 2012.

In response to the May 2012 NOPR, many interested parties commented that the proposed test procedure was unduly burdensome. The Air-Conditioning, Heating and Refrigeration Institute (AHRI), with support from Goodman Global, Inc. (''Goodman''), Ingersoll Rand, Lennox International, Inc. (''Lennox''), and Morrison Products, Inc. (''Morrison''), proposed an alternative test method that these parties argue would result in accurate and repeatable FER values that are comparable to the FER values resulting from the test procedure proposed in the NOPR, but are obtained at a significantly reduced test burden. (AHRI, No. 16 at p. 3; Goodman, No. 17 at p. 4; Ingersoll Rand, No. 14 at p. 1; Lennox, No. 12 at p. 5; Morrison, No. 21 at p. 3.) On April 2, 2013, DOE published a supplemental notice of proposed rulemaking (SNOPR) in the **Federal Register.** A detailed discussion of AHRI's proposed alternative method and interested parties' comments regarding the burden of the test procedure proposed in the NOPR is provided in the SNOPR. 78 FR 19612 (April 2, 2013) In the April 2013 SNOPR, DOE proposed to adopt a modified version of the test method presented by AHRI as the furnace fan test procedure. DOE agreed that the key concept embodied in the alternative method suggested by AHRI and manufacturers (using the AFUE test set up and temperature rise to determine airflow) may provide accurate and repeatable FER values at a significantly reduced burden to manufacturers.[1] DOE also explained the changes reflected in the test procedure proposed in the SNOPR compared to the test procedure proposed in the NOPR. 78 FR 19606 (Apr. 2, 2013)

II. Summary of the Final Rule

Pursuant to EPCA, this final rule establishes test procedures to enable DOE to develop energy conservation standards to address the electricity used for the purpose of circulating air through duct work. (42 U.S.C. 6295(o)(3)(A) and (f)(4)(D)) The test procedure established by this notice is applicable to circulation fans used in weatherized and non-weatherized gas furnaces, oil furnaces, electric furnaces, and modular blowers. The test procedure is not applicable to any non-ducted products, such as whole-house ventilation systems without ductwork, central air-conditioning (CAC) condensing unit fans, room fans, and furnace draft inducer fans.

DOE aligned the test procedure established by this final rule with the DOE test procedure for furnaces by incorporating by reference specific provisions from an industry standard that is also incorporated by reference in the DOE test procedure for furnaces. DOE's test procedure for furnaces is codified in appendix N of subpart B of part 430 of the code of federal regulations (CFR). The DOE furnace test procedure incorporates by reference American National Standards Institute (ANSI)/American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) 103–1993, *Method of Testing for Annual Fuel Utilization Efficiency of Residential Central*

[1] Temperature rise in this context and for the purposes of this rule is the difference between the inlet and outlet air temperature.

Furnaces and Boilers (ASHRAE 103–1993). This final rule incorporates by reference the definitions, test setup and equipment, and procedures for measuring steady-state combustion efficiency provisions of the 2007 version of ASHRAE 103 (ASHRAE 103–2007). In addition to these provisions, the test procedure established by this final rule includes provisions for apparatuses and procedures for measuring temperature rise, external static pressure, and furnace fan electrical input power. The test procedure established by this final rule also incorporates by reference provisions for measuring temperature and external static pressure from ANSI/ASHRAE 37–2009, *Methods of Testing for Rating Electrically Driven Unitary Air-Conditioning and Heat Pump Equipment* (ASHRAE 37–2009). There are no differences between the 2005 version (which is already incorporated by reference in the CFR) and the 2009 version of the ASHRAE 37 provisions incorporated by reference for this final rule. This final rule also establishes calculations to derive the rating metric, fan energy rating (FER), for each furnace fan basic model based on the results of testing per the test method established by this notice.

FER is the estimated annual electrical energy consumption of the furnace fan normalized by: (a) The estimated total number of annual fan operating hours (1,870); and (b) the airflow in the maximum airflow-control setting. For the purposes of the test procedure established by this final rule, the estimated annual electrical energy consumption is the sum of the furnace fan electrical input power (in Watts), measured separately for multiple airflow-control settings at different external static pressures (ESPs), multiplied by national average operating hours associated with each setting. These ESPs are determined by a reference system, based on operation at maximum airflow, that represents national average ductwork system characteristics.

Table II.1 includes the reference system ESP values by installation type that are specified by the test procedure. In previous rulemaking documents for the furnace fan test procedure and energy conservation standard rulemaking, DOE used the term ''manufactured home furnace'' to be synonymous with ''mobile home furnace'', as defined in the **Federal Register**. 10 CFR 430.2. DOE will use the term ''mobile home'' hereinafter to be consistent with the **Federal Register** definition for ''mobile home furnace.'' All provisions and statements regarding mobile homes and mobile home furnaces are applicable to manufactured homes and manufactured home furnaces.

TABLE II.1—REQUIRED REFERENCE SYSTEM CRITERIA (I.E., ESP AT MAXIMUM AIRFLOW) BY FURNACE FAN INSTALLATION TYPE

Installation type	ESP at maximum airflow (in. wc)
Units with an internal evaporator coil	0.50
Units designed to be paired with an evaporator coil	0.65
Units designed to be installed in a mobile home [2]	0.30

DOE recognizes that some furnace fan basic models may be marketed and designed to be installed in multiple installation types. For example, a non-weatherized, non-condensing gas furnace that can be installed in both mobile homes and non-mobile residences meets the definition for ''units designed to be paired with an evaporator coil'' and ''units designed to be installed in a mobile home.'' In this final rule, DOE is specifying that a manufacturer must test, rate, and certify compliance of the basic model of furnace fan in all of the installation types for which it is marketed and designed. For example, the basic model of furnace fan that is used in a non-weatherized, non-condensing furnace, as described above, that is marketed and designed to be installed in both non-mobile home and mobile home residences will need to be tested and certified as both a non-weatherized, non-condensing gas furnace fan using the ''units designed to be paired with an evaporator coil'' reference system criteria and as a mobile home, non-weatherized, non-condensing gas furnace fan using the ''units designed to be installed in a mobile home'' reference system criteria.

This test procedure requires measurements for the airflow-control settings that correspond to fan operation while performing the cooling function (which DOE finds is predominantly associated with the maximum airflow-control setting), heating function, and constant-circulation function. Table II.2 describes the required airflow-control settings by product type.

TABLE II.2—AIRFLOW-CONTROL SETTINGS AT WHICH MEASUREMENTS ARE REQUIRED FOR EACH PRODUCT TYPE

Product type	Airflow-control setting 1	Airflow-control setting 2	Airflow-control setting 3
Single-stage Heating	Default constant-circulation	Default heat	Absolute maximum.*
Multi-stage or Modulating Heating	Default constant-circulation	Default low heat	Absolute maximum.

* For the purposes of the test procedure established by this notice, ''absolute maximum'' airflow-control setting refers to the airflow-control setting that achieves the maximum attainable airflow at operating conditions specified by this test procedure.

As shown in Table II.2, for products with single-stage heating, the three airflow-control settings to be tested are: The default constant-circulation setting; the default heating setting; and the absolute maximum setting. For products with multi-stage heating or modulating heating, the airflow-control settings to be tested are: the default constant-circulation setting; the default low heating setting; and the absolute maximum setting. The absolute lowest airflow-control setting is used to represent constant circulation if a default constant-circulation setting is not specified. For this test procedure, DOE defines ''default airflow-control settings'' as the airflow-control settings for installed use specified by the manufacturer in the product literature shipped with the product in which the furnace fan is integrated. Manufacturers typically provide detailed instructions for setting the default heating airflow-control setting to ensure that the product in which the furnace fan is integrated operates safely. In instances where a manufacturer specifies multiple airflow-control settings for a given function to account for varying

[2] Mobile home external static pressure is much lower because there is no return air ductwork in mobile homes. Also, the United States Department of Housing and Urban Development (HUD) requirements for manufactured homes stipulate that the ductwork for cooling should be designed for 0.3 in. wc. 24 CFR 3280.715.

installation scenarios, the highest airflow-control setting specified for the given function shall be used for the DOE test procedure. High heat and reduced heat will be considered different functions for multi-stage heating units. Manufacturer installation guides also provide detailed instructions regarding compatible thermostats and how to wire them to achieve the specified default settings.

The Watt measurements for calculating FER are weighted using designated annual operating hours for each function (*i.e.,* cooling, heating, and constant circulation) that represent national average operation. Table II.3 shows the estimated national average operating hours for each function.

TABLE II.3—ESTIMATED NATIONAL AVERAGE OPERATING HOUR VALUES FOR CALCULATING FER

Operating mode	Variable	Single-stage (hours)	Multi-stage or modulating (hours)
Heating	HH	830	830/HCR.
Cooling	CH	640	640.
Constant Circulation	CCH	400	400.

For multi-stage heating or modulating heating products, the specified operating hours for the heating mode are divided by the heating capacity ratio (HCR) to account for variation in time spent in this mode associated with turndown of heating output. The HCR is the ratio of the measured reduced heat input rate to the measured maximum heat input rate.

The FER equation is:

$$FER = \frac{(CH \times E_{Max}) + (HH \times E_{Heat}) + (CCH \times E_{Circ})}{(CH + 830 + CCH) \times Q_{Max}} \times 1000$$

III. Discussion

A. Scope

In the SNOPR, DOE addressed interested party comments on the NOPR regarding the scope of coverage. DOE proposed test procedures for circulation fans that are used in residential furnaces and modular blowers. 78 FR 19609 (Apr. 2, 2013)

AHRI and Morrison Products, Inc. believe that modular blowers should be excluded from the scope of the rulemaking because they are not currently a federally regulated product. They add that, if 42 U.S.C. 6295(f)(4)(D) were intended to cover modular blowers, then there would have been a corresponding change to the definition of furnace or the addition of this product class along with a direction to develop a corresponding test procedure. Additionally, the proposed test procedures in the SNOPR are insufficient for modular blowers and fail to account for the fact that some modular blowers in today's marketplace are not even designed to operate with electric heat resistance kits. (AHRI, No. 0034 at pg. 2; Morrison, No. 0036 at pg. 2) Lennox International, Inc. agrees with DOE's decision not to include fans used in other products, such as split-system central air-conditioning and heat pump air handlers or hydronic air handlers. (Lennox, No. 0031 at p. 1) Additionally, like AHRI, Lennox feels that DOE should not include modular blowers in the scope of coverage because the definition of modular blowers that is contained in the proposed regulation does not support the conclusion that modular blowers and electric furnaces are very similar in design. (Lennox, No. 0031 at p. 2) Furthermore, modular blowers that are not electric furnaces do not currently require AFUE testing. Thus, the test procedure imposes the requirement to run AFUE tests on non-furnaces, which adds additional burden to manufacturers as well as additional testing costs. (Lennox, No. 0031 at p. 2) Goodman Manufacturing Company, L.P. reiterated in comments that DOE's interpretation of the scope in the SNOPR is too broad and in error. Goodman stated that furnace fan electrical power consumption in cooling mode should not be included in the scope of this rule because it is already accounted for by the SEER metric when the furnace fan is used with a split-system air conditioner or split-system heat pump. DOE stated in the SNOPR that EPCA does not impose a limitation on DOE's authority to regulate fan electrical consumption for these products across all operating modes because, in this situation, two different products are being regulated, one the CAC or heat pump product, and one the separate furnace fan product, which may or may not be incorporated into a CAC or heat pump.'' (78 FR at 19612) Goodman commented that DOE's justification in the SNOPR for including furnace fan cooling mode operation ignores the fact that in 100% of applications where a furnace is operated in the cooling mode the furnace is matched with either a central air-conditioner or heat pump product. (Goodman, No. 0037 at pg. 4)

On the other hand, the Northwest Energy Efficiency Alliance (NEEA) and Northwest Power and Conservation Council (NPPC) strongly disagrees with DOE's proposal to exclude hydronic and split system air conditioning and heat pump air handlers from the proposed scope. NPPC/NEEA commented that DOE noted in the SNOPR that ''The NOPR test procedure's proposed scope of applicability included single phase, electrically-powered devices that circulate air through ductwork in HVAC systems with heating input capacities less than 225,000 Btu per hour, cooling capacities less than 65,000 Btu per hour, and airflow capacities less than 3,000 cfm.'' NPPC/NEEA finds this scope to be perfectly acceptable and appropriate, and suggests that there is nothing in this language that would exclude hydronic or central air conditioning and heat pump air handlers. (NPCC/NEEA, No. 0039 at pg. 2) Additionally, NPPC and NEEA note that sold separately, the air handlers used for central air conditioning and heat pump systems are virtually indistinguishable from a modular blower, as DOE defines the latter. NPPC and NEEA argue that they are the same thing, particularly since DOE plans to include modular blowers that can be sold with electric resistance heating kits. (NPCC/NEEA, No. 0039 at pg. 3) Furthermore, NPCC/NEEA state that hydronic air handlers can be properly referred to as ''furnaces'', thus, the need to specify a different test procedure for them, other than the one proposed for gas- or oil-fired furnaces, is not a valid reason for excluding them from coverage in this rulemaking. (NPCC/NEEA, No. 0039 at pg. 3)

Like NPCC/NEEA, the American Gas Association (AGA) supports DOE including furnace fans used in other products, such as split-system central air-conditioning and heat pump air handlers, through-the-wall air handlers, as well as other types of air handlers, but understands that DOE is not addressing these products in this rulemaking but will do so in future rulemakings. (AGA, No. 0040 at pg. 1) The California Investor Owned Utilities (CA IOUs) also believe DOE should include furnace fans that are part of blower-coil and single-packaged central air-conditioners and heat pumps within the scope of the standards rulemaking because the SEER and HSPF do not adequately capture fan energy use. Additionally, CA IOUs encourage DOE to keep hydronic air-handlers within the scope, and to develop a test procedure for this product class. (CA IOUs, No. 0032 at p. 1)

As discussed in the SNOPR, DOE noted that, although the title of this statutory section refers to ''furnaces and boilers,'' the applicable provision at 42 U.S.C. 6295(f)(4)(D) was written using notably broader language than the other provisions within the same section. 78 FR 19606, 19611. Specifically, the applicable statutory provision directs DOE to ''consider and prescribe energy conservation standards or energy use standards for electricity used for purposes of circulating air through duct work.'' Such language could be interpreted as encompassing electrically-powered devices used in any residential HVAC product to circulate air through duct work, not just furnaces, and DOE has received numerous comments on both sides of this issue. At the present time, however, DOE is only establishing test procedures for those circulation fans that are used in residential furnaces and modular blowers (see discussion below). As a result, DOE is not addressing public comments that pertain to fans in other types of HVAC products. The following list describes the furnace fans that DOE is addressing in this rulemaking and those that DOE is not addressing in this rulemaking.

- Products addressed in this rulemaking: furnace fans used in weatherized and non-weatherized gas furnaces, oil furnaces, electric furnaces, and modular blowers.
- Products not addressed in this rulemaking: furnace fans used in other products, such as split-system CAC and heat pump blower-coil units, through-the-wall blower-coil units, small-duct, high-velocity (SDHV) blower-coil units, energy recovery ventilators (ERVs), heat recovery ventilators (HRVs), draft inducer fans, exhaust fans, or hydronic blower-coil units.

The test procedure established by this notice is applicable to modular blowers. All modular blower models of which DOE is aware can be operated in conjunction with an electric resistance heat kit. DOE expects that the number of modular blowers that are not designed to operate with an electric resistance heat kit is de minimis. Consequently, DOE is including modular blowers in the scope of coverage of the test procedure established by this final rule. Manufacturers that produce modular blowers that cannot be operated in conjunction with an electric resistance heat kit will likely have to apply for a waiver from the test procedure. Waiver applications could include a proposed alternative test method that includes provisions for generating measureable heat in the airflow of the product that can be used to calculate airflow per the specified airflow equations. DOE recognizes that testing products that meet the definition of furnace fan, but were previously not subject to DOE's regulatory provisions, requires an investment of time and resources, as Lennox suggests. However, DOE interprets EPCA to require consideration of standards for modular blowers, and DOE does not find the time and resources required to test modular blowers according to the test procedure established by this final rule to be unduly burdensome.

After considering available information and public comments regarding exclusion of fan operation in cooling mode, DOE maintains that the test procedure established by this rule account for the electrical consumption of furnace fans while performing all active mode functions (i.e., heating, cooling, and constant circulation). DOE recognizes that furnace fans are used not just for circulating air through duct work during heating operation, but also for circulating air during cooling and constant-circulation operation. DOE anticipates that higher airflow-control settings are factory-set for cooling operation. Therefore, DOE expects that the electrical energy consumption of a furnace fan is generally higher while performing the cooling function. Additionally, the design of the fan as well as its typical operating characteristics (i.e., ESP levels during operation in different modes) is directly related to the performance requirements in cooling mode. DOE is also concerned that excluding some functions from consideration in rating furnace fan performance would incentivize manufacturers to design fans that are optimized to perform efficiently at the selected rating airflow-control settings but that are not efficient over the broad range of field operating conditions. In DOE's view, in order to obtain a complete assessment of overall performance and a metric that reflects the product's electrical energy consumption during a representative average use cycle, the metric must account for electrical consumption in a set of airflow-control settings that spans all active mode functions. This ensures a more accurate accounting of the benefits of improved furnace fans.

B. Standby and Off Mode

EPCA, as amended by the Energy Independence and Security Act of 2007, Public Law 110–140 (EISA), requires that any final rule for a new or amended energy conservation standard adopted after July 1, 2010, must address standby mode and off mode energy use pursuant to 42 U.S.C. 6295(o). (42 U.S.C. 6295(gg)(3)) In the NOPR and SNOPR, DOE explained that DOE has already fully incorporated standby mode and off mode energy use in the test procedures (or proposed test procedures) for all of the products to which the test procedure established by this notice is applicable. 77 FR 28688 (May 15, 2012) and 78 FR 19619 (April 2, 2013). summarizes the test procedure rulemaking vehicles through which DOE addresses standby mode and off mode energy consumption for the products covered by this rulemaking.

TABLE III.1—RULEMAKING ACTIVITIES ADDRESSING FURNACE FAN STANDBY MODE AND OFF MODE ENERGY CONSUMPTION

HVAC products	DOE rulemaking	DOE rulemaking activity
• Gas Furnaces • Oil-fired Furnaces • Electric Furnaces	Residential Furnaces	• Docket: EERE–2013–BT–TP–0008. • Most Recent Notice: September 13, 2011 NOPR (76 FR 56339).
• Modular Blowers • Weatherized Gas Furnace	Residential Central Air Conditioners and Heat Pumps.	• Docket: EERE–2009–BT–TP–0004. • Most Recent Notice: October 24, 2011 SNOPR (76 FR 65616).

There is no need for DOE to adopt additional test procedure provisions for standby and off mode energy use in the test procedure established by this rulemaking. DOE maintains its position that the standby mode and off mode energy use associated with furnace fans used in products covered by this rulemaking would be measured by the established or proposed test procedures associated with these products.

In the NOPR, DOE proposed to include circulation fans used in hydronic air handlers in the scope of applicability of the test procedure. There are no current DOE test procedures for measurement of electrical energy use in hydronic air handlers, nor is there an ongoing rulemaking to establish such test procedures. Consequently, DOE also proposed in the NOPR to integrate the standby mode and off mode electrical energy consumption measurements with the active mode metric for hydronic air handlers, resulting in an integrated FER (IFER). DOE received a number of comments in response to the NOPR regarding the IFER metric. In the SNOPR, DOE proposed to exclude circulation fans used in hydronic air handlers from the scope of coverage of the test procedure. As discussed in section III.A above, the test procedure established by this final rule excludes circulation fans used in hydronic air handlers.

C. AMCA 210

In the NOPR, DOE proposed a test procedure based on the provisions specified in the American National Standards Institute (ANSI)/Air Movement and Control Association International, Inc. (AMCA) 210–07 | ANSI/American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) 51–07, Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating (AMCA 210). 77 FR 28674 (May 15, 2012) Many interested parties commented on the NOPR that AMCA 210 is not an appropriate reference standard for rating furnace fan performance. (AHRI, No. 16 at p. 3; Goodman, No. 17 at p. 4; Ingersoll Rand, No. 14 at p. 1; Morrison, No. 21 at p. 3.) In the SNOPR, DOE proposed a test procedure that would not adopt provisions from AMCA 210. Consequently, DOE did not address comments received from interested parties on the NOPR regarding AMCA 210 in the SNOPR. Likewise, the test procedure established by this final rule does not include provisions from AMCA 210. Therefore, DOE is not addressing comments received from interested parties on the NOPR regarding AMCA 210 in this notice.

D. Reference System

In the NOPR, DOE proposed to specify a single reference system per product installation type that would be characterized by an ESP value representing national average operating conditions of a residential duct system for a furnace fan operating in the maximum airflow-control setting. 77 FR 28683 (May 15, 2012) In the SNOPR notice, DOE did not address interested parties' comments received in response to the NOPR regarding its proposed reference system requirements. DOE did not alter its proposed reference system requirements in the SNOPR. Hence, interested party comments regarding this topic are summarized and addressed below.

Many interested parties commented that the reference system ESP values should be lower than those proposed in the NOPR. Rheem stated that a single furnace ESP specification at 0.65 in. wc. has not been shown to represent a national average duct system, and ratings should not be based on poor ESP field conditions where installers ignore manufacturers' installation instructions. (Rheem, No. 0025 at pg. 3) AHRI stated that the proposed reference system in the NOPR specifies external static pressures that are too high as compared to the external static pressures in the federal test procedure for furnaces. (AHRI, No. 0023 at pg. 15) Goodman echoed AHRI's comments, stating that they are concerned that FER is based on elevated external static pressures and ignores the fact there are a significant number of applications with lower values. (Goodman, No. 0017 at pg. 2) Goodman added that using elevated static pressure values will only condone higher/increased energy consumption, poor ductwork design and application. (Goodman, No. 0017 at pg. 5) Goodman stated that a survey of its products indicated that watt/cfm is roughly 15% lower at 0.2 in. wc. and 25% lower at 0.4 in. wc. than at the DOE-proposed 0.65 in. wc., suggesting there should be incentive to operate at lower statics to reduce energy. (Goodman, No. 0017 at pg. 6) Morrison stated that by accounting for ESPs that are reported to be fully representative of field conditions in the NOPR, DOE is advocating scenarios that do not comply with the instructions in manufacturers' installation manuals. (Morrison, No. 0021 at pg. 6) Unico, Inc. stated that field pressure measurements are known to be notoriously inaccurate and extremely challenging to collect. (Unico No. 0023 at pg. 94)

Some interested parties recommended that DOE re-evaluate and increase its proposed reference system ESP requirements. NPCC/NEEA commented that DOE's data for manufactured home ESP values, which come primarily from the Northwest, may not be representative of the national average ESP for manufactured home products because of a long history of energy efficiency programs for those products in that region. NPCC/NEEA recommends that DOE collect additional data on field ESP from other regions of the country before settling on ESP values. (NPCC/NEEA, No. 0022 at pg. 6) CA IOU recommended that DOE increase the proposed test ESP based on a recent study for the California Energy Commission [3] for which the resulting average furnace fan cooling mode ESP was 0.85 in. wc. (CA IOU, No. 0020 at pg. 4) The Wisconsin Department of Administration, Division of Energy Services (WI–DOA) stated the reference system ESP should be over 0.55 inches. The WI–DOA provided field measurements for 39 furnace

[3] "Efficiency Characteristics and Opportunities for New California Homes" can be found at *http://www.energy.ca.gov/2012publications/CEC-500-2012-062/CEC-500-2012-062.pdf.*

installations throughout Wisconsin that had ESP values between 0.32 in. wc. and 1.33 in wc. (WI–DOA, No. 0007 at pg. 1)

In a joint comment from ASAP, ACEEE, NRDC, and the National Consumer Law Center (NCLC), hereinafter referred to as ACEEE, *et al.,* efficiency advocates strongly support DOE's proposal to characterize a reference system at external static pressures that mimic field conditions. (ACEEE, *et al.,* No. 0013 at pg. 3) NEEA stated that the range of external static pressures presented by DOE is reasonable based on measured data. (NEEA, No. 0023 at pg. 167) United Technologies (UTC) also agrees with the reference ESP values selected by DOE, but recommends that the reference ESPs should be no higher. (UTC, No. 0010 at pg. 2)

The test procedure established by this final rule specifies the reference system ESP values proposed in the NOPR, which DOE did not modify in the SNOPR. DOE finds that these ESP values are consistent with known field conditions. For the NOPR, DOE gathered field data from available studies and research reports to determine an appropriate ESP value to propose for the reference system for each installation type. DOE compiled over 1300 field ESP measurements from several studies that included furnace fans in single-family and mobile homes in different regions of the country as part of that effort.[4] DOE was not able to acquire nor did DOE receive from interested parties additional data sources for mobile home ESP values on which to base a revision of its previous analysis. However, DOE feels confident in its estimated national average reference system ESP value for these products because the field conditions underlying the values are prescribed by HUD, as explained in footnote Error! Bookmark not defined. in section II. DOE reviewed the CEC study referred to by the CA–IOU and the field measurements provided by WI–DOA. The range and average of the ESP data provided in the CEC study and WI–DOA's measurements are consistent with the rest of the data DOE collected. DOE therefore concludes that this new data supports the reference system ESP levels proposed in the SNOPR and adopted in this final rule (which is above 0.55 in. wc. as WI–DOA recommends for the product installation types included in its study).

DOE expects specifying ESP values that are representative of field conditions will result in ratings that are most representative of field energy use. DOE also expects that the use of manufacturer-recommended ESPs might underestimate furnace fan energy consumption, because the ESP of field-installed HVAC systems typically exceeds the ESP recommended by manufacturers. Like manufacturers, DOE is also concerned about the energy use impact of installations with high static pressures. However, DOE does not expect that a reduction in average field ESPs that approaches the manufacturer-recommended levels is likely to occur, because installing new, larger, and more-efficient ducts in existing homes is generally cost-prohibitive. DOE, like the manufacturers, would prefer that homeowners modify the ductwork to reduce energy use, but DOE has no authority to require larger ducts in this rulemaking. DOE is concerned that a metric based on a low, albeit desirable, static pressure level would not accurately represent actual furnace fan energy consumption. Also, DOE is concerned that a metric based on a low static pressure may lead to excessive energy use by furnace fan designs which do not achieve high efficiency levels when operating at the higher, field static pressures. Adapting the efficiency metric to the field conditions better facilitates meaningful comparisons of furnace fans operating under these conditions.

Interested parties commented on DOE's proposed approach to specify using the maximum airflow-control setting to characterize the required reference system. Goodman believes that because of the large variability of airflow rate provided by most furnaces, the use of a maximum value could potentially mislead the consumer to purchase a product to be applied at less than maximum airflow rate that has a better rating at maximum than another product, even though the other product may have lower energy consumption for a lower airflow rate. (Goodman, No. 0017 at pg. 4) National Resources Canada (NRCan) commented that the NOPR correctly noted that it is not clear from the reports of installed static pressures for residential furnaces if the measurements were taken with furnace control settings configured to provide their maximum air flow when operating in cooling mode. In the absence of clear evidence that field measurements of ESP in cooling mode were actually made with the furnaces adjusted to their highest air flow settings, it is not possible to link field measured ESPs in cooling mode to the maximum air delivery capabilities of the furnace fans. NRCan adds that establishing the reference system ESP using the maximum air flow for which a furnace is capable of operating in cooling mode biases the test and ratings for all other modes towards lower static pressures (which may be lower than field ESP levels for those operating modes). NRCan suggests that one approach that DOE might consider for specification of the reference system would be to use furnace fan control settings that produce an air flow suitable for a cooling system with a capacity that matches the national average cooling system (using a default design air flow rate of say 400 cfm per ton of cooling capacity) in place of using the maximum air flow setting and an unspecified cooling capacity. (NRCan, No. 0011 at pg. 2) Conversely, UTC agrees with DOE's use of a reference ESP that is based on the highest airflow control setting for the fan efficiency rating procedure. (UTC, No. 0010 at pg. 2)

DOE acknowledges the concerns of Goodman and NRCan regarding the impact that requiring measurements in the maximum airflow-control setting has on FER and, in turn, on manufacturer design and consumer purchasing decisions. However, FER is primarily intended for evaluating the national average performance of furnace fans. To best fulfill this intent, FER estimates national average annual energy use. Manufacturers have the option of providing a full account of fan performance in addition to FER in product literature to inform consumers. DOE expects that FER will enable consumers to evaluate relative performance across the entire range of expected field operation because FER is determined based on measurements of furnace fan electrical input power for multiple airflow-control settings at different external static pressures that span the entire range of expected operation. As a result, FER includes and reflects the reduced energy consumption of a product that performs more efficiently at less than maximum airflow compared to a product that performs more efficiently at maximum airflow, as in Goodman's example. DOE disagrees with NRCan that manufacturers are likely to design products with higher maximum airflow-control settings to achieve better FER ratings, because FER includes electrical input power consumption in that setting, which increases as the airflow in that setting increases. In turn, FER may also increase.

[4] DOE has included a list of citations for these studies in the docket for this rulemaking. The ADDRESSES section of this notice provides a link and instructions for accessing the docket. . . . The docket number for this rulemaking is EERE–2010–BT–TP–0010.

DOE recognizes NRCan's concern that DOE assumes that the ESP field measurement data DOE gathered are linked to the maximum airflow-control setting. However, the reports from which DOE gathered ESP field data specified that the ESP measurements were taken in cooling airflow-control settings. As NRCan and other interested parties have confirmed, furnace fans typically operate in the highest of available airflow-control settings for cooling. As mentioned above, DOE did not find or receive from interested parties any additional information upon which to re-evaluate its assumption that field ESP data collected in cooling airflow-control settings is representative of field ESP in maximum airflow-control settings.

DOE also recognizes that specifying the reference system in the maximum airflow-control setting may result in FER measurements taken in lower airflow-control settings at ESP levels that are lower than if a default cooling airflow-control setting were specified for the reference system (as suggested by NRCan). However, DOE expects that specifying the reference system in an airflow-control setting based on national average cooling capacity according to NRCan's suggestion will not address the issues that NRCan raises with the approach outlined by DOE. The NRCan approach will result in airflow-control selections that deviate from the settings ultimately selected at installation if the product is not installed to deliver national average cooling capacity, resulting in similar biases. In addition, some products that are designed for cooling capacities much higher or much lower than the national average may not have airflow-control settings that meet NRCan's national average criteria. Specifying the reference system in the maximum airflow-control setting is more appropriate than the alternative approach presented by NRCan for these reasons. Accordingly, the test procedure established by this notice specifies the reference system in the maximum airflow-control setting.

In the NOPR, DOE proposed to define ESP to mean the difference between the fan total pressure at the air outlet and the total pressure at the air inlet less velocity pressure at the air outlet, which is consistent with the AMCA 210 definition for ESP. In response to the NOPR, Unico and Goodman stated that they support the ASHRAE 37 definition and measurement specifications for external static pressure. ASHRAE 37 defines external static pressure as static pressure measured at the outlet less the static pressure measured at the inlet (or ambient if a return air duct is not used). (Unico, No. 0023 at pg. 40; Goodman, No. 0017 at pg. 6) UTC recommended that DOE use the following definition for ESP: ''The difference between the system inlet and outlet static pressures measured in the attached ducting. In laboratory testing, the inlet may be non-ducted such that the inlet static pressure is zero''. (UTC, No. 0010 at pg. 4) AMCA stated that ''fan static pressure'' is not the static pressure rise through the fan. According to AMCA, the ''Fan static pressure'' is the static pressure rise minus the inlet velocity pressure. (AMCA, No. 0019 at pg. 2) Conversely, NRCan had no issues with the definition of ESP as proposed in the NOPR. (NRCan, No. 0011 at pg. 6; NPCC/NEEA, No. 0022 at pg. 6)

The test procedure established by this final rule adopts the ASHRAE 37 definition of external static pressure as suggested by Unico and Goodman. The definition that UTC recommends is also consistent with the ASHRAE 37 methods for measuring ESP.

Interested parties also commented on using a single-reference system method for representing average residential ducting systems versus a multiple-reference system. UTC agreed with the fan efficiency rating method proposed in the NOPR using a single-reference system method. (UTC No. 0010 at pg. 2) Rheem prefers a single reference system which is consistent with the furnace rating plate and manufacturer's installation instructions, but agreed to the multi-reference system in CSA 823 as a compromise to avoid establishment of a rating based on an unsafe and faulty installation condition. (Rheem, No. 0025 at pg. 8) NPCC/NEEA find the CSA multi-reference system approach and manufacturer-recommended installation ESP values to be inconsistent with field data and a single set of ESP conditions should be specified. (NPCC/NEEA, No. 0022 at pg. 6) Ingersoll Rand supports only one reference system stating that a multi-reference system would not add enough value to warrant double testing. (Ingersoll Rand, No. 0014 at pg. 4) Morrison stated that it is better to have two static pressure levels rather than a single high static pressure level to help consumers and others distinguish between good and bad practice in the field. (Morrison, No. 0023 at pg. 171) Unico recommended a single reference system method because performance data based on multiple reference systems will not improve the quality of decision making on the part of the contractor or consumer. (Unico, No. 0015 at pg. 5) NRCan stated that DOE's assumption that default heating airflow is within 80 to 90 percent of maximum airflow for a given product undermines its conclusion that using multiple reference systems is not justified. NRCan provided example furnaces for which the heating airflow was between 35 and 88 percent of maximum airlfow. (NRCan, No. 0011 at pg. 3)

The test procedure established by this notice specifies one reference system curve for each installation type because DOE cannot set standards based on multiple metrics. Requiring measurements for a second reference system would also increase test burden. For the NOPR, DOE investigated the use of a combined metric based on multiple reference system curves. DOE found that the combined, multiple reference system FER values varied on average by less than 2 percent with a standard deviation of 2 percent compared to the proposed, single reference system FER and did not alter the ranking of furnace fans by FER. 77 FR 28686 (May 15, 2012) In response to the furnace fan framework document, Rheem suggested criteria for a two reference system approach: one reference system at 0.3 in. wc. and another at 0.6 in. wc both in the default heating setting. These reference system criteria are equivalent to those specified in CSA Standard C823–11, Performance of Air Handlers in Residential Space Conditioning Systems. DOE chose to use different criteria that comprised higher ESP values and in the maximum airflow-control setting for its NOPR evaluation of using multiple reference systems. In the NOPR, DOE stated that the reference system criteria it selected for its investigation is approximately equivalent to those suggested by Rheem for products for which the heating airflow is within 80 to 90 percent of maximum airflow. DOE recognizes NRCan's concern that a furnace fan's heating airflow is not always within 80 to 90 percent of maximum airflow. DOE presented this information to explain how its selected criteria for evaluating a multiple reference system approach compared to Rheem's recommended criteria, not as a justification for proposing to specify a single reference system.

In addition, the test method proposed by DOE in the NOPR would require measuring fan performance at enough operating points within each available airflow-control setting to derive performance curves. These curves would allow for calculating fan performance at any operating point in any given airflow-control setting, which would enable the use of multiple reference systems without requiring additional measurements. In the SNOPR, DOE modified its proposed test method to reduce burden. DOE's proposed SNOPR test procedure would only require fan performance to be measured only at operating points consistent with the specified reference system. Requiring measurements for a second reference system would increase the burden of the test method DOE proposed in the SNOPR because additional measurements would be necessary. For these reasons, the test procedure established by this notice does not require multiple reference systems.

In the NOPR, DOE proposed to require measurements at three specific ESP values without any tolerances. 77 FR 28700 (May 15, 2012) Allied Air stated that because systems can become unstable when measuring airflow in the high or low end of the static pressure range, tolerances should be allowed. (Allied Air, No. 0023 at pg. 184) Additionally, UTC recommended that a minimum tolerance of +/−0.05 be allowed for the three ESPs to allow for slight variations in the measurement equipment. (UTC, No. 0010 at pg. 4)

DOE's test experience confirms Allied Air's and UTC's concerns that specific ESP values are difficult to achieve and maintain when measuring airflow. The test procedure established by this notice specifies that products maintain an ESP level between the minimum reference system value and 0.05 in. wc. above that minimum value throughout the stabilization period and at the time that measurements for the maximum airflow-control setting are taken to allow for slight variations.

E. Airflow Equation

In the NOPR, DOE proposed to require measurement of airflow directly using the pressure drop across nozzles according to the procedures in AMCA 210. Interested parties commented on the NOPR that this method would be overly burdensome. AHRI, with the support of a number of manufacturers, proposed a method of calculating airflow based on temperature rise, which would significantly reduce test burden because it can be measured using procedures and a test setup consistent with those used for the DOE test procedure for furnaces (AHRI, No. 16 at p. 3; Goodman, No. 17 at p. 4; Ingersoll Rand, No. 14 at p. 1; Morrison, No. 21 at p. 3). Specifically, AHRI proposed the following equation for calculating airflow (AHRI, No. 26 at p. 23):

$$Q = \frac{AFUE \times Q_{IN}}{1.08 \times \Delta T}$$

Where:

Q = airflow, in cubic feet per minute (CFM),
$AFUE$ = annual fuel utilization efficiency, as determined by the DOE furnace test procedure,
Q_{IN} = fuel energy maximum nameplate input rate at steady-state operation (including any pilot light input), in British Thermal Units per hour (Btu/h),
1.08 = Conversion from airflow and temperature rise to heating rate, and
ΔT = measured temperature rise.

In the SNOPR, DOE proposed to use a modified version of AHRI's proposed equation to calculate airflow. The numerator of AHRI's proposed airflow equation estimates the amount of heat energy produced by the furnace as the nameplate annual fuel utilization efficiency (AFUE) multiplied by the nameplate fuel energy input rate (Q_{IN}). DOE proposed to estimate heat energy differently because nameplate AFUE and Q_{IN} are determined based on measurements taken at the ESP levels required by the DOE furnace test procedure (*i.e.* specified in ASHRAE 103–1993), which are significantly lower than those proposed in the SNOPR of this rule. Specifically, DOE proposed to estimate heat energy as steady-state efficiency ($Effy_{SS}$) less percent jacket losses quantity multiplied by Q_{IN} all measured at the operating conditions proposed in the SNOPR. DOE also proposed to add a term to the numerator to account for the recoverable heat from the fan. DOE expects that its estimate of heat energy improves the accuracy of the equation. DOE proposed the following equation for calculating airflow in the SNOPR. 78 FR 19615 (April 2, 2013)

$$Q = \frac{(Effy_{SS} - L_J) \times Q_{IN} + [(3413 \times E]_{Heat})}{1.08 \times \Delta T}$$

Where:

Q = airflow in CFM,
$Effy_{SS}$ = steady-state efficiency in % as determined according to ASHRAE 103–2007 at the specified operating conditions,
L_J = jacket loss in % as determined according to ASHRAE 103–2007 at specified operating conditions,
Q_{IN} = measured fuel energy input in Btu/h at specified operating conditions based on the fuel's high heating value determined as required in section 8.2.1.3 or 8.2.2.3 of ASHRAE 103–2007,
3413 = conversion of kW to Btu/h;
E_{Heat} = electrical energy to the furnace fan motor in kW that is recovered as useable heat,
1.08 = conversion from airflow and temperature rise to heating rate, and
ΔT = temperature rise measured at specified operating conditions.

AHRI, Lennox, Rheem, and Morrison are concerned that the test procedures specified within the SNOPR would require that a manufacturer test the steady-state efficiency and jacket losses of a furnace at a new and higher external static pressure operating point, causing an undue increase in testing burden. (AHRI, No. 0034 at pg. 3; Lennox, No. 0031 at p. 3; Rheem, No. 0035 at pg. 3; Morrison, No. 0036 at pg. 3) AHRI and Morrison stated that the FER metric is comprised of two distinct furnace operation descriptors—the first is calculated from electrical energy measurements at three separate test conditions and the second is airflow at a single test condition. AHRI, Rheem, and Morrison believe that the airflow component of the FER metric is secondary in importance and is meant to simply provide a frame of reference. They believe that some of DOE's proposed modifications to AHRI's proposed test procedure would increase the testing burden on the industry while adding little or no benefit, and strongly urge that DOE not require furnace manufacturers to measure an additional steady-state efficiency to calculate the FER metric because it would impose an additional testing burden. (AHRI, No. 0034 at pg. 1; Rheem, No. 0035 at pg. 1; Morrison, No. 0036 at pg. 1) Ingersoll Rand stated that if the furnace is running within the allowable rise range, the AFUE can be used in place of the steady-state efficiency and jacket loss in the calculation procedure. (Ingersoll Rand, No. 0038 at pg. 1) AHRI and Morrison believe that using nominal values associated with AFUE (which also accounts for jacket losses) and Q_{IN} to calculate airflow is a conservative approach and will eventually lead to conservative FER values. Additionally, using AFUE and Q_{IN} reduces the testing burden on manufacturers, as compared to measuring steady-state combustion efficiency and determining jacket losses, which could take up to two additional hours for every basic model. (AHRI, No. 0034 at pg. 2; Morrison, No. 0036 at pg. 2) Lennox and Rheem, on the other hand, agree with DOE that using the steady-state combustion efficiency and the measured fuel energy input would provide more accurate air flow calculations, as opposed to using AFUE and nominal fuel energy input. (Lennox, No. 0031 at p. 3; Rheem, No. 0035 at pg. 2) Goodman strongly suggests DOE consider allowing an alternate method of directly measuring airflow using a code tester and ASHRAE 37 ductwork (a method typically used by manufacturers for airflow data published in technical product literature). (Goodman, No. 0037 at pg. 1)

DOE is aware that manufacturers will be required to test products that include furnace fans that have already been tested to comply with other DOE rulemaking requirements (e.g., the residential furnace energy conservation standard). However, EPCA requires DOE to consider standards for furnace fans, and DOE does not find the time and resources required to test furnace fans according to the test procedure established by this final rule to be unduly burdensome.

DOE agrees with interested parties that the SNOPR proposal to measure steady-state efficiency (EffySS), jacket loss (L_J), and fuel energy input (Q_{IN}) instead of using nameplate values of AFUE and Q_{IN} to calculate airflow would result in increased accuracy, but would require additional testing time. In the SNOPR, DOE stated that $Effy_{SS}$ could range from 0 to 6 percentage points higher than AFUE. More recent DOE tests resulted in $Effy_{SS}$ values that ranged from 0 to 4 percentage points higher than AFUE, confirming DOE's previous estimates. DOE agrees with manufacturers' estimates that approximately 2 hours of additional testing time would be required if measured values for $Effy_{SS}$, L_J and Q_{IN} are used to calculate heat energy instead of nameplate AFUE and Q_{IN}. Through testing, DOE finds that as much as 1.5 hours of this additional testing time will be needed for set up of the jacket loss test. The flue or stack gas temperature and carbon dioxide concentration measurements needed to measure steady-state efficiency require less than 10 minutes in DOE's experience. For condensing furnaces, the test procedure proposed in the SNOR would require 30 additional minutes to collect condensate to measure steady-state efficiency. DOE disagrees with AHRI, Rheem, and Morrison that the airflow calculation is secondary in importance and that accuracy should be compromised. However, DOE agrees that time to test should be minimized while maximizing accuracy. The test procedure established by this final rule requires that the airflow used in the FER equation be calculated based on measured values of steady-state efficiency and fuel input energy. However, like the DOE test procedure for furnaces, the test procedure established by this final rule allows manufacturers the option of measuring jacket loss or using a default value of 1 percent. In recent DOE tests, jacket loss measurements ranged from 0.1 to 0.9 percent, with an average of 0.5 percent and a standard deviation of 0.2 percent. Consequently, the difference between measured L_J and the default value can be expected to be less than 1 percent. Manufacturers that opt to use the default jacket loss value of 1 percent will avoid a significant majority of the additional testing time required to calculate airflow, but the expected deviation from measured values is reduced to less than 1 percent with this approach. DOE considers this an acceptable range of accuracy to reduce test burden.

DOE also recognizes that using a code tester and ASHRAE 37 ductwork, as Goodman suggests, could be an alternative test method that provides similar results to the test procedure established by this final rule. However, a test procedure based on this approach would differ significantly from the test procedure established in this notice. An auxiliary fan at the outlet of the airflow chamber may be required to achieve the external static pressures specified by this rule. This method of varying external static pressure is not consistent with the method specified by this final rule, which requires that the same duct restrictions be maintained throughout the test after initial reference system conditions are met. In addition, a test setup that includes a code tester is not typical when currently testing a furnace and would add substantial burden. Instead, DOE tried to harmonize, where possible, the test set up for furnaces and furnace fans. These differences could have significant impacts on the consistency of using a code tester in lieu of the setup and methods specified in this rule. Consequently, DOE is not adopting an alternative method of using a code tester to measure airflow for this rule.

AHRI and Lennox stated that the assumption that the cooling airflow rate can be calculated using the measured temperature rise in the heating mode is not substantiated in the SNOPR. AHRI recommended that the furnace is fired at the maximum airflow rate to calculate Q_{Max}. (AHRI, No. 0034 at pg. 3; Lennox, No. 0031 at p. 3) Additionally, Rheem and Morrison stated that the Q_{Max} value is representative and that the method proposed by AHRI based on firing the furnace at the maximum airflow is sufficiently accurate. (Rheem, No. 0035 at pg. 3; Morrison, No. 0036 at pg. 3) NPCC/NEEA stated that for multi-stage systems, three modes of test are not enough to properly characterize how the system will be used in the field. (NPCC/NEEA, No. 0022 at pg. 5)

DOE disagrees with AHRI, Rheem, Lennox, and Morrison that firing the furnace in the maximum airflow-control setting is always sufficiently accurate. As stated previously, DOE finds that the maximum airflow-control setting is most often designated for cooling. Firing the burner in the maximum airflow-control setting in these instances would not be representative of field use. Also, DOE finds that firing the furnace in a maximum airflow-control setting that is designated only for cooling is not always achievable by third-party testing facilities by interfacing with the product controls. DOE's airflow adjustment approach is a necessity in these cases. For these reasons, the test procedure established in this final rule includes provisions for both product variations: products for which the maximum airflow-control setting is designated for heating, and products for which the maximum airflow-control setting is designated only for cooling. The provisions for products for which the maximum airflow-control setting is designated for heating are provided in section III.M. The provisions for products for which the maximum airflow-control setting is designated only for cooling are as proposed in the SNOPR. 78 FR 19627 (April 2, 2013) In short, the maximum airflow is determined by calculating the airflow according to the equation above for a heating setting and adjusted to the maximum (cooling) setting based on pressure measurements.

In the SNOPR, DOE proposed to calculate airflow based on the temperature rise in the default heat setting for single-stage products and the default low heat setting for multi-stage products. DOE requested comment from interested parties in the SNOPR on whether a more accurate calculation of airflow could be achieved based on temperature rise measured in the maximum heat setting for multi-stage furnaces because temperature rises in the maximum heat setting would be higher. 78 FR 19624 (April 2, 2013)

AHRI, Rheem, Morrison, and Goodman disagree with DOE's assertion that operating a multi-stage furnace at the maximum heat setting results in a higher temperature rise. They went on to state that there are instances where the temperature rise at a reduced heat setting is higher than the temperature rise at the maximum heat setting. (AHRI, No. 0034 at pg. 3; Rheem, No. 0035 at pg. 3; Morrison, No. 0036 at pg. 3; Goodman, No. 0037 at pg. 2)

DOE's review of product literature confirms comments from AHRI, Rheem, Morrison and Goodman that the maximum heat setting does not always result in higher temperature rise. Consequently, the test procedure established in this final rule adopts the provisions proposed in the SNOPR, which require firing at the reduced heat input and associated airflow-control setting to calculate airflow.

In the SNOPR, DOE proposed to calculate airflow based on temperature rise using the equation presented in this section above. DOE's proposed equation included a constant of 1.08 for converting temperature rise and heating rate to airflow. This constant assumes that air has a constant density of 0.075 pounds per cubic foot (lb/ft^3). In the SNOPR, DOE requested comments from interested parties on whether the 1.08 constant should be adjusted by barometric pressure because air density changes with pressure (often due to elevation changes and varying weather conditions). 78 FR 19624 (April 2, 2013)

AHRI, Lennox, Rheem, Morrison, and Goodman agree with DOE that higher elevations would have an impact on temperature rise and calculated airflow. They believe that the maximum test elevation should be 2,000 feet and recommend that furnace fans should not be tested above 2,000 feet without an appropriate adjustment to the test conditions and calculations. (AHRI, No. 0034 at pg. 3; Lennox, No. 0031 at p. 3; Rheem, No. 0035 at pg. 4; Morrison, No. 0036 at pg. 3; Goodman, No. 0037 at pg. 2) AHRI, Lennox, Rheem, Morrison, Goodman, and Ingersoll Rand suggest that DOE consider the use of a 1.08 conversion factor that is adjusted by barometric pressure at test conditions. (AHRI, No. 0034 at pg. 3; Lennox, No. 0031 at p. 3; Rheem, No. 0035 at pg. 3; Morrison, No. 0036 at pg. 3; Goodman, No. 0037 at pg. 1; Ingersoll Rand, No. 0038 at pg. 2)

DOE agrees with AHRI, Lennox, Rheem, Morrison, Goodman, and Ingersoll Rand that the 1.08 conversion factor should be adjusted by barometric pressure at test conditions. The test procedure established by this final rule includes provisions for measuring the humidity ratio and dry bulb temperature of the test room near the inlet to determine the specific volume of test room air in cubic feet per pound of dry air to calculate airflow. As a result, the 1.08 conversion factor is no longer a constant. Instead the constant is a function of the specific volume of test room air in cubic feet per pound of dry air at test conditions. Consequently, the airflow calculation specified by the test procedure established by this final rule is:

$$Q = \frac{(Effy_{SS} - L_J) \times Q_{IN} + [(3413 \times E]_{motor})}{60 \times (0.24 + 0.444 \times W) \times \left(\frac{1}{v_{ai}}\right) \times \Delta T}$$

Where:

Q = airflow in CFM,
$Effy_{SS}$ = steady-state efficiency in % as determined according to ASHRAE 103–2007 at the specified operating conditions,
L_J = jacket loss in % as determined according to ASHRAE 103–2007 at specified operating conditions or a default value of 1%,
Q_{IN} = measured fuel energy input in Btu/h at specified operating conditions based on the fuel's high heating value determined as required in section 8.2.1.3 or 8.2.2.3 of ASHRAE 103–2007,
3413 = conversion of kW to Btu/h;
E_{motor} = electrical energy to the furnace fan motor in the settings for which airflow is being calculated in kW that is recovered as useable heat,
60 = conversion from hours to minutes,
0.24 = specific heat capacity of dry air in Btu/lb°F,
0.44 = specific heat capacity of water vapor in Btu/lb°F,
W = humidity ratio in pounds water vapor per pounds dry air,
v_{air} = specific volume of dry air at specified operating conditions per the equations in the psychrometric chapter in 2001 ASHRAE Handbook—Fundamentals in lb/ft^3
ΔT = temperature rise measured at specified operating conditions.

Test room air properties are required to be measured near the inlet of the product under test to minimize the impacts of test room humidity and temperature gradients. For electric furnaces and modular blowers, $Effy_{SS}$ equals 100, and Q_{IN} is the measured electrical input power to the sub-metered electric resistance heat kit multiplied by 3,413 kW per Btu/h.

F. Duct Specifications and External Static Pressure Measurement

In the NOPR, DOE proposed to use the methods specified in AMCA 210 for rating fans. The proposal called for evaluation of the fan performance at the flows and ESPs associated with a reference system curve by (1) measuring performance at multiple conditions at each airflow-control setting, (2) developing equations to represent the airflow and power input of the fan as a quadratic function of ESP, (3) mathematically determining the ESP associated with the reference system curve for the tested airflow-control setting using the airflow equation, and (4) calculating power input using the developed power input equation. Interested parties commented on the NOPR that the AMCA 210 method would be unduly burdensome and that an acceptable alternative would be to maintain the same duct restrictions throughout the test after initial reference system conditions are met in lieu of the previously proposed methods of making multiple determinations in each airflow-control setting and curve-fitting to identify operating points. Because the AMCA 210 method requires use of a supplemental test facility fan to achieve the desired flow and ESP conditions, this method is not amenable to moving to all of the target flow conditions on the reference system curve simply by changing the speed of the furnace fan under test. In contrast, the test approach suggested by AHRI and other stakeholders and adopted in the SNOPR is amenable to this simplified approach. DOE proposed in the SNOPR to adopt the alternative method suggested by interested parties and to use the provisions in ASHRAE 103–2007 for achieving the specified ESP levels in the maximum airflow-control setting by ''symmetrically restricting the outlet duct''. DOE requested comments from interested parties whether this language was sufficiently instructive or if more details are necessary (such as which materials and procedures to use to restrict the duct). 78 FR 19624 (April 2, 2013)

AHRI, Lennox, Morrison, and Goodman all agree that DOE should not specify the methods for restricting the outlet duct. (AHRI, No. 0034 at pg. 4; Lennox, No. 0031 at p. 3; Morrison, No. 0036 at pg. 4; Goodman, No. 0037 at pg. 2) AHRI and Morrison stated that a symmetrical duct restriction is needed in order to achieve repeatable results, but the manufacturer should be allowed to determine the type of material that would lead to symmetrical restrictions on the outlet duct. (AHRI, No. 0034 at pg. 4; Morrison, No. 0036 at pg. 4) Rheem also stated that a specific duct restriction is needed to assure repeatable test results, and further explained that they have adopted the method of ''symmetrically restricting the outlet of the test duct.'' (Rheem, No. 0035 at pg. 4)

DOE agrees with AHRI, Lennox, Morrison, and Goodman that the proposed requirement to symmetrically restrict the outlet of the test duct to achieve the specified ESP is sufficient. The test procedure established by this final rule includes this provision.

In the SNOPR, DOE proposed to allow manufacturers the option of rating their products with or without a return air duct. 78 FR 19616 (April 2, 2013) AHRI, Lennox, Morrison, and Goodman all agree with DOE's proposal to allow for the optional use of a return air duct. (AHRI, No. 0034 at pg. 4; Lennox, No. 0031 at p. 4; Morrison, No. 0036 at pg. 4; Goodman, No. 0037 at pg. 2) Furthermore, Goodman added that if a return air duct is used, then DOE should specify that the return air pressure tap should be downstream of any bends or turns in the return air duct. (Goodman, No. 0037 at pg. 2) Rheem stated that it follows the duct and plenum arrangements shown in Figure 2 of ASHRAE 103–1993, in which the downflow configuration requires an inlet duct and the upflow and horizontal configurations do not require an inlet duct. (Rheem, No. 0035 at pg. 4) Ingersoll Rand proposed that inlet ducts should be allowed on an optional basis as detailed in ASHRAE 103–2007 with pressure taps 12 inches from the furnace inlet. (Ingersoll Rand, No. 0038 at pg. 2)

DOE agrees with manufacturers that the test procedure established by this final rule should allow for the optional use of a return air duct. The test procedure includes this provision. The test procedure also specifies that pressure taps be placed on all four sides of the duct, 12 inches from the inlet, and downstream of any bends or turns in the return air duct.

In the SNOPR, DOE proposed to adopt the provisions in ASHRAE 37 for measuring external static pressure that specify duct geometry and pressure tap placement. 78 FR 19616 (April 2, 2013)

AHRI and Lennox agree that the DOE test procedures should provide a detailed specification and a diagram for measuring the external static pressure. However, using the provisions in ANSI/ASHRAE Standard 37 may require a duct that is too tall for the ceiling height of a laboratory that is used for testing furnaces. Additionally, in Figure 7a in ANSI/ASHRAE 37–2005, the tap location dimension from the furnace outlet is two times the square root of the duct width times the duct depth, which would put the tap into the 90 degree bend of the duct and cause inaccurate static pressure measurements. (AHRI, No. 0034 at pg. 4; Lennox, No. 0031 at p. 4). AHRI, Rheem, Morrison, and Goodman added that DOE should specify the four tap arrangement in AHSI/ASHRAE Standard 37 with the specification that the pressure taps be placed 18 inches from the furnace outlet. (AHRI, No. 0034 at pg. 4; Rheem, No. 0035 at pg. 5; Morrison, No. 0036 at pg. 4; Goodman, No. 0037 at pg. 2). Furthermore, Rheem stated that the proposed DOE requirement would no longer allow Rheem to make test measurements for AFUE and FER on the same test stand. A horizontal test set up would be required for FER measurement. (Rheem, No. 0035 at pg. 5) Ingersoll Rand proposed that the fan test method specify ASHRAE 103–2007 ducts with static pressure taps on all four sides located 12 inches from furnace outlet. (Ingersoll Rand, No. 0038 at pg. 2)

Through recent testing experience, DOE confirms AHRI's, Lennox's, and Rheem's comments that the ASHRAE 37duct requirements, in some cases, can be incompatible with the ASHRAE 103–2007 setup, and that for larger products, ducts that meet the ASHRAE 37 requirements are too large for typical furnace testing facilities. Consequently, the test procedure established by this final rule adopts the provisions suggested by AHRI, Rheem, Morrison, and Goodman which require ducting dimensions to meet ASHRAE 103 setup requirements with a pressure tap on each of the four faces of the outlet duct, 18 inches from the outlet, and upstream of any bends or turns in the duct.

G. Temperature Measurement Accuracy Requirement

In the SNOPR, DOE proposed to require temperature measurement errors no greater than +/−0.5 degrees Fahrenheit. 78 FR 19617 (April 2, 2013)

AHRI, Lennox, Morrison, and Goodman do not believe that a requirement to have temperature measurement errors no greater than +/−0.5 degrees Fahrenheit is reasonably achievable. AHRI, Morrison, and Goodman recommend that DOE specify an error of +/−0.9 degrees Fahrenheit, per the special limits of error of T-type thermocouples. (AHRI, No. 0034 at pg. 4; Lennox, No. 0031 at p. 4; Morrison, No. 0036 at pg. 4; Goodman, No. 0037 at pg. 3) Rheem stated that an allowable temperature measurement error would be +/−1 degree Fahrenheit, while Ingersoll Rand stated that the ASHRAE 103–2007 accuracy level should be maintained (i.e., ±2 degrees Fahrenheit). (Rheem, No. 0035 at pg. 5; Ingersoll Rand, No. 0038 at pg. 2)

DOE agrees with AHRI, Lennox, Morrison, and Goodman that an allowable temperature measurement error of ±0.5 °F is not reasonable for thermocouples, which are the temperature measurement instruments typically used in ASHRAE 103. However, DOE finds that T-type thermocouples can meet tighter tolerances than the allowable error of ±2 °F specified in ASHRAE 103. The test procedure established by this final rule specifies an allowable error of ±0.75 °F, which is consistent with the special limit of error for T-type thermocouples specified in ASHRAE 41.1 and referenced in ASHRAE 37. Consequently, manufacturers will be able to continue using thermocouples while errors in temperature measurements will be minimized.

H. Minimum Temperature Rise

In the SNOPR, DOE requested comment on whether a minimum temperature rise of 18 °F should be required. 78 FR 19617 (April 2, 2013)

AHRI, Lennox, Morrison, and Goodman all believe that a minimum temperature rise is not required, but agree that a minimum temperature rise of 18 degrees Fahrenheit is reasonable. (AHRI, No. 0034 at pg. 4; Lennox, No. 0031 at p. 4; Morrison, No. 0036 at pg. 4; Goodman, No. 0037 at pg. 3) Rheem stated that a minimum temperature rise of 18 degrees Fahrenheit could eliminate some furnaces with single speed blower motors from the marketplace. (Rheem, No. 0035 at pg. 5)

DOE agrees with AHRI, Lennox, Morrison, and Goodman that a minimum temperature rise of 18 °F is reasonable. In addition, DOE expects that a significant majority of products are able to meet this minimum requirement. The test procedure established by this final rule includes a minimum temperature rise requirement of 18 °F. Any manufacturer of products that cannot meet this requirement can apply for a test procedure waiver. Waivers could include alternative test methods that ensure a higher level of temperature measurement accuracy in lieu of the minimum temperature rise requirement.

I. Steady-State Stabilization Criteria

In the SNOPR, DOE proposed to adopt the following steady-state stabilization criteria. For testing furnace fans used in gas and oil furnaces, DOE proposed that steady-state conditions are attained as indicated by a temperature variation in three successive readings, taken 15 minutes apart, of not more than:

- 1.5 °F in the stack gas temperature for furnaces equipped with draft diverters;
- 2.5 °F in the stack gas temperature for furnaces equipped with either draft hoods, direct exhaust, or direct vent systems; and
- 0.5 °F in the flue gas temperature for condensing furnaces.

For electric furnaces, DOE proposed that steady-state conditions are reached as indicated by a temperature variation of not more than 1 °F in the outlet temperature in four successive temperature readings taken 15 minutes apart. The proposed criteria for all product types are more stringent than the criteria specified in ASHRAE 103–2007, which are incorporated by reference in the DOE test procedure for furnaces. 78 FR 19617 (April 2, 2013)

AHRI, Lennox, Morrison, Goodman, and Ingersoll Rand all believe that the steady-state stabilization criteria proposed by DOE are not reasonably achievable and will increase testing burden on manufacturers without significantly improving the accuracy of the results. Furthermore, they suggest that the current residential furnace stabilization criteria in 10 CFR part 430, subpart B, appendix N are stringent enough for accuracy and repeatability purposes. (AHRI, No. 0034 at pg. 4; Lennox, No. 0031 at p. 4; Morrison, No. 0036 at pg. 4; Goodman, No. 0037 at pg. 3; Ingersoll Rand, No. 0038 at pg. 2) Additionally, AHRI, Lennox, Rheem, and Morrison stated that a process that involved three temperature readings taken 15 minutes apart, instead of four, is more than adequate for electric furnaces and cold flow tests. (AHRI, No. 0034 at pg. 4; Lennox, No. 0031 at p. 4; Rheem, No. 0035 at pg. 6; Morrison, No. 0036 at pg. 5)

Recent DOE test results confirm AHRI's, Lennox's, Morrison's, Goodman's, and Ingersoll Rand's comments that the steady-state stabilization criteria proposed in the SNOPR are not reasonably achievable. Therefore, the test procedure established by this final rule adopts the steady-state stabilization criteria in ASHRAE 103–2007 (which are identical to those codified in 10 CFR Part 430, Subpart B, Appendix N as part of the DOE furnaces test procedure) for the parts of the test that involve firing a furnace burner or energizing electric heat resistance elements. For the parts of the test that do not require firing a burner or energizing electric heat resistance elements (*i.e.,* cold flow tests), DOE likewise found that the steady-state stabilization criteria proposed in the SNOPR, which are based on outlet temperature variation, are not reasonably achievable. Outlet temperature is sensitive to changes in ambient temperature, which is highly variable in ASHRAE 103–2007 compliant test facilities. To address this issue, the test procedure established by this final rule specifies steady-state conditions for cold-flow tests based on the difference in temperature between the outlet airflow temperature and the ambient temperature. During testing, DOE collected over 30 minutes per test of time series inlet, outlet, and ambient temperature data for over 10 cold-flow tests. DOE observed a maximum difference in temperature between the outlet airflow and ambient of 2.7 °F. DOE believes this is a reasonable threshold for determining steady-state conditions for cold-flow tests. The test procedure established by this final rule specifies that steady-state conditions for cold-flow tests are indicated by a temperature rise variation in three successive readings, taken 15 minutes apart, of not more than 3 °F to address this issue.

J. Inlet and Outlet Airflow Temperature Gradients

In the SNOPR, DOE proposed to specify the use of a mixer, as depicted in Figure 10 of ASHRAE 37, which references ANSI/ASHRAE Standard 41.1–1986 (RA 2001), to minimize outlet flow temperature gradients if the temperature difference between any two thermocouples of the outlet air temperature grid is greater than 1.5 °F. 78 FR 19617 (April 2, 2013)

AHRI, Lennox, Rheem, Morrison, Goodman, and Ingersoll Rand are all opposed to using a mixer due to their effect on external static pressure. They also stated that mixers are never found in the field. (AHRI, No. 0034 at pg. 5; Lennox, No. 0031 at p. 4; Rheem, No. 0035 at pg. 6; Morrison, No. 0036 at pg. 5; Goodman, No. 0037 at pg. 3; Ingersoll Rand, No. 0038 at pg. 2) Furthermore, AHRI and Morrison believe that the air temperature can be adequately measured by the thermocouple arrangements that are specified in ANSI/ASHRAE Standard 103–1993. (AHRI, No. 0034 at pg. 5; Morrison, No. 0036 at pg. 5)

DOE recognizes interested party concerns that using an air mixer is inconsistent with the current DOE residential furnaces test set up. Consequently, the ESP of the test setup with an air mixer installed may be higher than the ESP at which furnace manufacturers typically test to comply with the DOE test procedure for residential furnaces. DOE is not aware of any negative impacts on the results of the DOE test procedure for residential furnaces of gradients in the outlet air temperature. The test procedure established by this final rule does not require the use of an air mixer for these reasons. In addition, the outlet temperature used to calculate airflow, and ultimately FER, is the average of the outlet temperature measurements of the thermocouples in the outlet thermocouple grid required by this test procedure.

K. Certification Testing

In the NOPR, DOE proposed that the existing sampling plans used for furnaces be adopted and applied to measures of energy consumption for furnace fans. 77 FR at 28691 (May 15, 2012). AHRI and a number of manufacturers commented that the furnace sampling plan is too stringent for furnace fans and that DOE should use sampling plan criteria consistent with the DOE test procedure for residential central air conditioners (CAC). (Allied Air, Public Meeting Transcript, No. 23 at p. 225; Goodman, No. 17 at p. 6; Rheem, No. 25 at p. 11; Ingersoll Rand, No. 14 at p. 2; Lennox, No. 12 at p. 5; Morrison, No. 21 at p. 8.) UTC explained that the CAC sampling plan requirements are more appropriate because the components of the furnace fan (*i.e.* electric motors, blower wheels and blower housings) are more analogous to an air conditioner or refrigerator than to the combustion process of a fuel-fired furnace. (UTC, No. 10 at p. 4.) DOE agreed with interested parties that the furnace fan electrical input power measurements and external static pressure measurements that would be required by the test procedure proposed in the SNOPR are different and inherently more variable than the measurements required for AFUE. Consequently, DOE proposed in the SNOPR to adopt a sampling plan that requires any represented value of FER to be greater than or equal to the higher of: the mean of the sample or the upper 90 percent (one-tailed) confidence limit divided by 1.05, as specified in the sampling plan for CAC products. 78 FR 19718 (April 2, 2013)

AHRI, Lennox, Rheem, Morrison, Goodman, Ingersoll Rand, and NPCC/NEEA agree with DOE's proposal to adopt a sampling plan that requires any represented value of FER to be greater than or equal to the higher of the mean of the sample or the upper 90 percent (one-tailed) confidence limit divided by 1.05. (AHRI, No. 0034 at pg. 5; Lennox, No. 0031 at p. 5; Rheem, No. 0035 at pg. 7; Morrison, No. 0036 at pg. 5; Goodman, No. 0037 at pg. 3; Ingersoll Rand, No. 0038 at pg. 3; NPCC/NEEA, No. 0039 at pg. 5)

DOE's testing experience confirms that the furnace fan electrical input power measurements and external static pressure measurements that are required by the test procedure established by this rule are more variable than the measurements required for AFUE. Consequently, as was proposed in the SNOPR, the test procedure established by this final rule adopts a sampling plan that requires any represented value of FER to be greater than or equal to the higher of the mean of the sample or the upper 90 percent (one-tailed) confidence limit divided by 1.05, as specified in the sampling plan for CAC products. 78 FR 19718 (April 2, 2013)

NPCC/NEEA and CA IOU urge DOE to require manufacturers to certify individual mode FERs. (CA IOU, No. 0032 at p. 3) NPCC/NEEA claims there is no additional testing burden associated with this proposal, even though they recognize some manufacturer reluctance to certify multiple values. NPCC/NEEA believes the importance and value of the transparency afforded by certifying the individual mode values far outweighs any concerns the manufacturers might have with regard to certifying the components of a single FER rating metric. (NPCC/NEEA, No. 0039 at pg. 5) WI–DOA stated that furnace manufacturers should be required to provide fan tables for airflow and corresponding watts with static pressure up to 1.20 in. wc. (WI–DOA, No. 0007 at pg. 1) DOE is not adopting certification requirements for furnace fans in this rulemaking. DOE proposed in the furnace fan standards rulemaking that manufacturers be required to certify the single FER rating metric, along with some intermediary values that provide DOE details about the values used when the manufacturer conducted its own testing. DOE will consider these comments on certification requirements for furnace fans along with any others submitted in response to the proposal in the standards rulemaking. Should commenters have additional details about why individual mode values are important and would be useful to consumers, they may provide additional comments to the standards docket (Docket Number: EERE–2010–BT–STD–0011).

AHRI, Morrison, and Ingersoll Rand added that the sampling plan for the DOE enforcement testing of residential furnaces employs a statistic that is based on a 95 percent two-tailed probability level with degrees of freedom ($n_1 - 1$), where n_1 is the total number of tests. AHRI, Morrison, Goodman, and Ingersoll Rand believe that DOE must ensure that the confidence limits with respect to the certification and enforcement testing of the FER metric are the same. (AHRI, No. 0034 at pg. 5; Morrison, No. 0036 at pg. 5; Goodman, No. 0037 at pg. 3; Ingersoll Rand, No. 0038 at pg. 3) The sampling plan for certification testing utilizes a one-sided confidence limit, which ensures that the rating used by manufacturers is supported by the test data they conducted on a given basic model and allows the manufacturers the option to conservatively rate if they desire. DOE uses a one-sided confidence limit in determination of ratings because it is interested in ensuring consumers get a level of performance for a given basic model that is at least as good as what is being represented by manufacturers. In other words, DOE is primarily concerned with preventing overrating. On the other hand, the Department employs a two-sided sampling plan for enforcement testing with a 95-percent probability limit for all high-volume covered products and equipment because it is interested in the variability of all units within the sample when considering compliance against the standard. DOE is looking at the distribution of values within the sample as compared to the Federal standard. While DOE is open to further investigating whether the sampling plans for enforcement testing should be changed, specifically whether DOE should move to a one-sided probability limit for assessing compliance with standards, DOE is declining to do so in this rulemaking. DOE is accepting data which attempts to characterize the variability, both the testing and manufacturing, of furnace fan basic models.

L. Alternative Efficiency Determination Method (AEDM)

AHRI, Rheem, Morrison, Goodman, and Lennox believe the option of employing an alternative efficiency determination method to determine FER must be made available instead of mandating that a minimum of two samples be tested in order to achieve DOE certification. (AHRI, No. 0034 at pg. 2; Rheem, No. 0035 at pg. 2; Morrison, No. 0036 at pg. 2; Goodman, No. 0037 at pg. 4; Lennox, No. 0012 at pg. 5) In response to the NOPR, Mortex Products, Inc. commented that it is concerned about the testing burden and cost for small manufacturers, and requested that DOE prepare a regulatory flexibility analysis for the rulemaking that would relax the testing burden or combine testing requirements with an AEDM so that all models need not be tested. (Mortex, No. 0018 at pg. 3) Morrison, Unico, and AHRI echoed Mortex's comments, requesting DOE provide the option of employing an AEDM. (Morrison, No. 0021 at pg. 8; Unico, No. 0015 at pg. 6; AHRI, No. 0016 at pg. 9)

At this time, DOE is not adopting provisions that allow for the ratings of furnace fans to be established based on simulations or computer models. DOE currently does not allow the use of AEDMs for residential products, with the exception of central air conditioners and heat pumps. DOE believes that the number of furnace fan basic models that a manufacturer will need to test and certify will be significantly smaller than the number of combinations of split-system air conditioners and heat pumps that are currently allowed to be rated with an alternative rating method. While DOE is not opposed to considering AEDMs for furnace fans in the future, it is declining to do so in this rulemaking until manufacturers provide DOE with evidence that alternative rating methods are needed. DOE recognizes Mortex's concerns regarding differential impacts on small manufacturers. DOE conducted a regulatory flexibility analysis as part of the NOPR of the furnace fans energy conservation standards rulemaking to assess impacts on small manufacturers, as Mortex requested. 78 FR 64132–64134 (October 25, 2013). Further, DOE adopted burden reducing measures to the test procedure during the rulemaking in response to manufacturers' comments (e.g., DOE aligned the test procedure established by this final rule with the DOE test procedure for furnaces). Even in the absence of the ability to rate furnace fans with AEDMs, only basic models of furnace fans are required to be tested and rated in accordance with the test procedure established by this final rule. Manufacturers may group individual furnace fan models into a basic model if they have essentially identical physical, functional, and electrical characteristics and are represented by the same FER. For example, only one model of a series of electric furnace fan models that only differ by electric resistance heat capacity is required to be tested in accordance with the test procedure established by this rule, if the capacity variation does not include design changes that alter furnace fan performance as measured by the test procedure established by this rule.

M. FER Modifications and Alternatives

In the NOPR, DOE proposed to require measurements in the absolute maximum airflow-control setting, which DOE found is most often designated for cooling. DOE also proposed to specify that the reference system ESP be set in the maximum airflow-control setting to avoid rating performance above the proposed reference system ESP values. 77 FR 28683 (May 15, 2012). Interested parties commented on the NOPR that the maximum airflow-control setting is not always designated for cooling. In the SNOPR, DOE did not change the airflow-control settings in which it proposed to require measurements nor its proposal to set the reference system ESP in the maximum airflow-control setting. 78 FR 19608 (April 2, 2013)

Interested parties stated that the maximum airflow-control setting is not always designated for cooling. Goodman disagrees with DOE's comment that the maximum airflow-control setting is often designated for cooling operation. They stated that a single furnace capacity (e.g. 60,000 Btu/h) is often offered with more than one air moving option (''drive''), and the heating speed tap will vary depending upon the drive provided. A 60,000 Btu/h furnace for northern applications may have a 3-ton drive with ''high'' speed tap for heating, while a 60,000 Btu/h furnace for southern applications may have a 4-ton drive with ''medium'' speed tap for heating. (Goodman, No. 0037 at pg. 2) Rheem added that the assumption that the cooling speed will be the highest speed is a worst case assumption. (Rheem, No. 0025 at pg. 5) During the NOPR public meeting and in written comments, Ingersoll Rand noted that if the maximum airflow speed is multiplied by cooling hours and the heating speed is higher than the cooling speed, then the FER equation is incorrect. (Ingersoll Rand, No. 0023 at pg. 124) Ingersoll Rand proposed that when a furnace's highest air flow setting is used for heating, that the test procedure and calculations allow Q_{Max} to equal Q_{Heat} and allow the cooling speed energy to be determined at maximum cooling speed tap as specified in the installation and operating instructions. (Ingersoll Rand, No. 0038 at pg. 2) Ingersoll Rand stated that many furnaces will run appropriately with the blower set to the maximum speed setting. They proposed that for those units the airflow, Q_{Max} be determined directly from testing at the maximum airflow setting. Ingersoll Rand went on to state that the DOE proposed method of testing at the heating speed to determine Q_{Heat} and using a multiplier to calculate Q_{Max} should be an optional method for furnaces that cannot be operated or run appropriately at the maximum airflow setting. (Ingersoll Rand, No. 0038 at pg. 2) Rheem added that the assumption that the heating speed can be determined by an assumed system curve must be adjusted by the safety requirement that the furnace operate within prescribed temperature rise range that is listed on each rating plate. (Rheem, No. 0025 at pg. 5)

UTC agreed with DOE that the maximum airflow-control setting on a furnace is typically referred to as the cooling speed. (UTC, No. 0010 at pg. 1)

DOE understands that, in some cases, the maximum airflow-control setting is designated for heating, not cooling. Even though DOE finds that the maximum airflow-control setting is most often designated for cooling, the test procedure established by this final rule specifies that measurements be taken in the absolute maximum airflow-control setting, not the default cooling airflow-control setting to accommodate both scenarios as Ingersoll Rand recommends. Specifying that measurements be taken in the maximum airflow-control setting ensures that the full range of fan operation is accounted for in the FER metric regardless of whether the maximum airflow-control setting is designated for heating or cooling. The test procedure established in this final rule has specific provisions for units for which the maximum airflow-control setting is a heating setting. For such units, the test procedure established by this notice specifies that:

- The burner or electric resistance heat elements of the HVAC product in which the furnace fan is integrated shall be firing/energized while setting the initial conditions (i.e., achieving steady-state at the specified reference system ESP in the maximum airflow-control setting).
- airflow for the maximum airflow-control setting shall be calculated using temperature rise measured in the maximum airflow-control setting (as Ingersoll Rand suggests) because the HVAC product will be producing heat. Consequently, calculating airflow based on temperature rise in an intermediate airflow-control setting that is designated for heating and using the airflow adjustment equation [5] to determine maximum airflow (as is specified for products for which the maximum airflow-control setting is only a cooling setting) is unnecessary. This approach avoids the uncertainty inherent in using the airflow adjustment equation.
- E_{Max} shall be measured while the HVAC product is producing heat in the maximum airflow-control setting and steady-state conditions have been met. For single-stage units, E_{Max} and E_{Heat} are equivalent because the maximum airflow-control setting and the heating airflow-control setting in which measurements are specified to be made are the same. Consequently, the same value is used for both variables in the FER equation. For multi-stage units, E_{Max} and E_{Heat} are not equivalent because the maximum airflow-control setting and the heating airflow-control setting (the default low heat airflow control setting) in which measurements are specified to be made are not the same. E_{Heat} is required to be measured in the reduced heat airflow-control setting.

Contrary to Ingersoll Rand's recommendation, the test procedure established by this final rule does not require firing in the maximum airflow-control setting if that setting is not designated for heating (even if it is possible to do so). Instead, the test procedure established by this final rule requires firing in the default heating airflow-control setting. Requiring firing in the maximum airflow-control setting in addition would result in increased testing burden. Also contrary to Ingersoll Rand's recommendation, the test procedure established by this final rule does not allow fan energy for cooling to be determined at an intermediate airflow-control setting (i.e., the highest airflow-control setting designated for cooling as specified in the installation and operating instructions that is not the absolute maximum airflow-control setting). DOE finds that manufacturers are not as limited in the setting they designate for cooling as they are by safety concerns and design constraints for designating heating settings. Consequently, manufacturers could designate the lowest airflow-control setting for cooling to produce favorable FER values, resulting in a potential loophole in the test method.

In the NOPR, DOE proposed to incorporate the HCR to adjust the heating operating hours in both the numerator (i.e. estimated annual energy consumption) and denominator (i.e. normalization factor of total operating hours times airflow in the maximum airflow-control setting) of the FER equation. 77 FR at 28701 (May 15, 2012). In the SNOPR, DOE revised its

[5] The airflow adjustment equation can be found in the regulatory text of this notice and the furnace fan test procedure SNOPR published on April 2, 2013. 78 FR.

proposed FER equation by proposing to incorporate HCR in the numerator, and eliminate it from the denominator. DOE proposed this revision after finding that this modification results in FER values that more accurately reflect the relative estimated annual energy consumption of multi-stage and modulating units compared to single-stage units. 78 FR 19609 (April 2, 2013)

AHRI, Lennox, Rheem, and Morrison oppose DOE's proposal to modify the FER equation by eliminating the HCR from the denominator and replacing it with 830. They argue that this change will penalize multi-stage and modulating furnaces (AHRI, No. 0034 at pg. 2; Lennox, No. 0031 at p. 5; Rheem, No. 0035 at pg. 2; Morrison, No. 0036 at pg. 2) Goodman also echoed AHRI's comment in regards to the FER equation, but added that the cooling hours should not be included in FER. (Goodman, No. 0037 at pg. 5)

DOE finds that when HCR is included in the numerator and denominator of the FER equation (as AHRI, Lennox, Rheem, Morrison and Goodman recommend), FER comparisons between multi-stage and single-stage units results in an estimated reduction in FER of approximately 30 percent when adding multi-staging to a product with a constant-torque BPM motor. DOE data shows that the estimated annual energy consumption, as calculated for the FER metric, is 15 percent less for multi-stage products compared to similar single-stage products. DOE finds that eliminating HCR from the denominator of the FER equation results in an estimated reduction in FER of 15 percent, which is more consistent with estimated annual energy consumption comparisons. Consequently, the test procedure established by this final rule excludes HCR from the denominator of the FER equation as proposed in the SNOPR. As stated in the SNOPR, cooling hours are included pursuant to EPCA because electricity used to circulate air through duct work occurs in cooling and constant circulation modes, not just in heating mode. 42 U.S.C. 6295(f)(4)(D)

Interested parties suggested modifications and alternatives to the units of FER and how its factors are weighted. ASAP, ACEEE, NCLC, and NRDC recommended that DOE incorporate a time weighted airflow value (i.e., weighted for time spent in cooling, heating, and circulation modes) instead of choosing the maximum airflow. (ACEEE *et al.,* No. 0013 at pg. 5) Unico suggested that a preferred metric to FER would be a weighted average watts/cfm for all modes of operation to prevent a design push to a maximum airflow, where the efficiency is measured. (Unico, No. 0015 at pg. 3) NRCan stated that normalizing the FER rating to produce watts/cfm is difficult for stakeholders to understand when compared to having a kWh metric. (NRCan, No. 0011 at pg. 6) Conversely, ACEEE stated that a watts/cfm metric is better than a kWh/year metric due to the number of assumptions and extrapolations required to determine annual energy consumption. (ACEEE, No. 0023 at pg. 198) During the NOPR public meeting, NEEA stated operating hours should be used to weight average fan efficiency watts/cfm and not the energy use metric because annual energy use will vary more than the efficiency of the fan. (NEEA, No. 0023 at pg. 190)

DOE considered FER metric variations similar to those suggested by ASAP, ACEEE, NRDC, NRCan, NEEA and Unico. The FER metric established by this final rule is not normalized by a time-weighted airflow value instead of the maximum airflow, as ACEEE *et al.* suggests, because the additional measurements required to determine airflow in additional airflow-control settings would increase test burden. The metric recommended by NEEA would also require added burden to measure airflow in additional airflow-control settings. DOE disagrees with Unico that FER will incentivize manufacturers to only optimize performance in the maximum airflow-control setting because FER is determined based on furnace fan electrical input measurements in multiple airflow-control settings across the entire range of expected operation. DOE disagrees with NRCan that interested parties will have difficulty understanding a metric in units of watts per 1000 cfm. Interested parties are familiar with discussing fan efficiency in terms of watts per 1000 cfm, as this is how fan performance is estimated in the alternative rating method for coil-only CAC products.

Interested parties commented on DOE's estimated national average operating hours and how these estimates are used in determining FER. Ingersoll Rand questions the value of using operating hours because those estimates come from such a small section of the country, and suggested evaluating performance of the appliance based on the end condition, removing any dependence on location. (Ingersoll Rand, No. 0023 at pg. 198) Rheem stated that it does not agree that DOE has the authority to set an energy conservation standard that weights multiple metrics (45% heating mode, 34% cooling mode, 21% circulation mode) to create a single FER for furnace fans. (Rheem, No. 0025 at pg. 3) ASAP, ACEEE, NCLC, and NRDC strongly support DOE's proposal to incorporate multiple measures of power consumption into the certifiable rating metric, including heating, cooling, and constant circulation modes. (ACEEE *et al.,* No. 0013 at pg. 2) NRCan, NPCC, and NEEA suggested that DOE consider developing fan efficiency ratings for different climatic conditions which would entail development of different assumptions regarding the operating hours in each mode, mimicking DOE's rating procedures for heat pumps. (NRCan, No. 0011 at pg. 1 and NPCC/ NEEA, No. 0022 at pg. 7) Goodman stated that the FER metric does not accurately portray to the consumer what the relative energy consumption would be as applied in different regions and in different applications. According to Goodman, weighting energy consumption on a ''national average'' basis can potentially cause consumers in either northern or southern regions to choose a product that has a lower FER rating, but actually consumes more energy for their locale. (Goodman, No. 0017 at pg. 5) Goodman stated that a product with a higher SEER, HSPF or AFUE metric will consume less energy annually regardless of climate region than a different product with a lower SEER, HSPF or AFUE. However, this is not the case with the FER metric. (Goodman, No. 0017 at pg. 2)

DOE acknowledges the concerns of Ingersoll Rand, NRCan, and Goodman that using national average operating hours may not result in ratings that are reflective of furnace fan energy consumption in all climate regions. However, the residential furnace fan energy conservation standard will result in a national standard, not a regional standard. Consequently, the metric established by this final rule is proportional to the estimated national average annual energy consumption of furnace fans. As detailed in the NOPR, DOE's estimated national average furnace fan cooling and heating hours are based on data sources that include inputs from all U.S. climate regions. 77 FR 28680 (May 15, 2012) DOE recognizes that its estimated national average constant circulation hours are based on limited data from a single climatic region. As described in the NOPR, DOE made adjustments to its national average constant circulation hours estimate to account for climate region biases. 77 FR 28683 (May 15, 2012) Interested parties did not provide any additional data with which DOE could revise its estimate for national average constant circulation hours. DOE disagrees with Rheem that DOE does not have the authority to issue standards based on a weighted metric. EPCA does not contain language limiting DOE's authority to determine the appropriate metric. Accordingly, determining the nature of a technical measurement is within the scope of authority delegated to the agency.

AGA recommends that DOE include a secondary FER that would convert the primary FER using the extended site measure of energy consumption until DOE/EERE can consider and complete a transition to the use of full-fuel-cycle measure of energy consumption. The addition of a secondary energy descriptor to capture full-fuel-cycle efficiency would be in line with the general response to the National Research Council (NRC) recommendations on appliance efficiency ratings that would also be applicable to ''furnace fans.'' (AGA, No. 0040 at pg. 1)

DOE will continue to set energy conservation standards for covered products based on energy consumption at the point-of-use, as required by EPCA, as amended. (42 U.S.C. 6291(4)–(6), 6311(3)(4), (18)) Consequently, DOE does not require a secondary FER that captures full-fuel-cycle energy consumption. 76 FR 51282 (Aug. 18, 2011), as amended at 77 FR 49701 (August 17, 2012). However, DOE used FFC measures of energy use and greenhouse gas (GHG) and other emissions in the national impact analysis and environmental analysis for the furnace fan energy conservation standard rulemaking. 78 FR 64127 (October 25, 2013)

Interested parties commented that the rating metric should be tied to heating performance and capacity. Taitem Engineering, PC is concerned about a rating metric that is based on power demand per unit of airflow. They recommend a metric based on power demand per delivered unit of heat be used. (Taitem, No. 0033 at p. 1) Unico and Morrison added that since furnace-type products are purchased for their heating capacity, an artificial mechanism like watts/cfm should not be used. (Unico, No. 0023 at pg. 94; Morrison, No. 0023 at pg. 113) Morrison noted that the metric proposed in the NOPR moves too far away from end-user application, and would prefer the metric was tied to heating performance and capacity of the unit so that the energy descriptor is useful to consumers. (Morrison, No. 0023 at pg. 133) Unico suggested that a watts/cfm metric would make a product's efficiency look worse than it actually is compared to using a BTU output comparison. (Unico, No. 0023 at pg. 112)

DOE recognizes that a metric based on power demand per unit of heat, as suggested by Taitem, Unico and Morrison, could be useful. However, furnace fans consume electricity to circulate air through duct work in modes that are not for heating (i.e., cooling and constant circulation). FER accounts for energy consumption in heating and non-heating modes and is therefore, a more appropriate metric for this test procedure. FER, as described in section II, is the rating metric for the test procedure established by this final rule.

Pertaining to the rating metric, AHRI and Morrison commented that the note under Appendix AA to Subpart B of Part 430 on page 19625 of the SNOPR should be revised to clarify that it pertains to the FER rating metric. (AHRI, No. 0034 at pg. 2; Morrison, No. 0036 at pg. 2)

DOE recognizes that furnace fan manufacturers may already include raw fan energy use at various operating conditions in product literature. DOE also realizes that furnace fan manufacturers use fan energy metrics other than FER to report and make representations of fan energy consumption and efficiency. Pursuant to EPCA, manufacturers of covered products must use the applicable test procedure as the basis for certifying to DOE that their products comply with the applicable energy conservation standards adopted pursuant to EPCA and for making representations about the efficiency of those products. (42 U.S.C. 6293(c); 42 U.S.C. 6295(s)) DOE's regulations allow for representations and reporting of raw fan energy consumption in various airflow-control settings and at varying ESP in addition to FER. While DOE is not including fan energy consumption for individual functions of operation (i.e., cooling, heating, and constant circulation) in the certification requirements for this rule, manufacturers can use these representations as long as they are made in accordance with the test procedure established by this rule. In regards to other metrics, manufacturers may continue using the annual auxiliary electrical energy consumption (Eae) metric as specified by the DOE furnace test procedure as long as it is reported in conjunction with FER once compliance with FER is required. Manufacturers cannot use any other metrics to make representations about furnace fan energy consumption or efficiency beginning 180 days after publication of this final rule in the **Federal Register**. DOE understands that current ENERGY STAR specifications are based on a different metric, *e,* which is furnace fan energy consumption as a percentage of total furnace energy consumption. Since manufacturers are prohibited from making representations of furnace fan efficiency using a metric other than FER after 180 days, DOE will work with EPA to transition the ENERGY STAR program.

During the NOPR public meeting, both AHRI and Allied Air stated that they feel that DOE should consider adopting the EISA e_b metric because it allows for relative electrical performance comparison of furnace fans without imposing unnecessary burden of air flow measurement at additional external static pressures.[6] (AHRI, No. 0023 at pg. 16; Allied Air, No. 0023 at pg. 129) On the other hand, ACEEE stated that they would be very uncomfortable with consideration of using e_b because e_b was originally developed as a threshold mechanism for incentive programs that wanted to recognize efficient air handlers. (ACEEE, No. 0023 at pg. 125) In more recent written comments in response to the SNOPR, AHRI (with the support of manufacturers) proposed an alternative test method that included the use of FER as proposed by DOE in the SNOPR as the rating metric. (AHRI, No. 16 at p. 3; Goodman, No. 17 at p. 4; Ingersoll Rand, No. 14 at p. 1; Morrison, No. 21 at p. 3)

DOE believes that BE, *e,* and e_b are less appropriate than FER, because they are based on measurements at one operating point for units with single-stage heating or measurements at two operating points for units with multi-stage or modulating heating. These metrics do not account for operation in cooling or constant circulation modes. Also, these metrics are inappropriate because they are measured at ESPs that are not representative of field conditions.

N. Air Leakage

NPCC and NEEA are concerned about the impacts of air handler cabinet leakage on energy efficiency and health and safety.[7] NPCC/NEEA field testing has shown that cabinet leakage can occur on the order of one to five percent. According to NPCC/NEEA, the appropriate amount of air to measure is the amount of air excluding cabinet air

[6] The ''eb'' metric is a ratio of the electrical energy consumed by the furnace fan to the total fuel and electrical energy consumed by the furnace.

[7] According to NPCC/NEEA, air leakage is also a matter of health and safety when an air handler is located in a garage because contaminants often found in garages are pulled in by the air handler and delivered to the home. (NPCC/NEEA, No. 0039 at pg. 4)

leakage in the process of rating the efficiency with which air is delivered to a residence. NPCC/NEEA strongly recommends that DOE require testing of air handlers using ANSI/ASHRAE 193–2010, and either adjusting the air delivered by an air handler accordingly before calculating FER (and therefore the rated efficiency of the air handler), or providing a separate rating for cabinet leakage, so that consumers and contractors can choose the best-performing products for the market. (NPCC/NEEA, No. 0039 at pg. 4) CA IOU also recommends the adoption of ASHRAE 193–2010 for measuring air leakage, which should also be incorporated into the FER. (CA IOU, No. 0032 at p. 2)

DOE disagrees with NPCC, NEEA, and CA IOU that the test procedure established by this final rule should incorporate ANSI/ASHRAE 193–2010 to account for cabinet air leakage. The test procedure established by this final rule calculates airflow such that the results do not include any air that may have leaked from the cabinet upstream of the heat exchanger. This air will not have absorbed any significant amount of heat before leaking from the cabinet. Hence the heat addition will cause a greater temperature rise in the remaining air that does absorb heat from the heat exchanger, and for which temperature is measured by the discharge temperature sensors. Hence, assuming that most of the leaked air absorbs a negligible amount of heat before leaking out of the cabinet, the measurement already takes the air leakage into account. Air that does not pass over the heat exchanger (which would include air leaked through the cabinet upstream of the heat exchanger, or air that passes near potential leakage gaps in the cabinet casing surrounding, but distant from, the heat exchanger) is not included in the equation.

O. Brushless Permanent Magnet Motor Issues

In the NOPR, DOE requested comment on whether independent test labs would have difficulty selecting and operating a furnace fan in the airflow-control settings DOE proposed in the NOPR. 77 FR 28697 May 15, 2012 UTC, Rheem, and Morrison confirmed that independent test labs will need additional guidance on motor control and recommends that the independent test laboratory be allowed to confer with the individual manufacturers on particular models. (UTC, No. 0010 at pg. 6; Rheem, No. 0025 at pg. 9; Morrison, No. 0021 at pg. 7) DOE expects that independent test labs would have difficulty selecting and operating furnace fans in combinations of airflow-control and heating/cooling/circulation settings for which they are not intended to operate (i.e., firing the burner while the circulation fan operates in an airflow-control setting designated only for cooling). The test procedure established by this final rule does not specify combinations of settings for which a product is not designed. Consequently, independent test labs will be able to achieve operating settings required by this rule without guidance from manufacturers other than the product literature that is shipped with the product.

P. Manufacturer Burden

In response to the NOPR, AHRI stated that it found the manufacturer testing burden to be high since it includes AFUE, standby and off mode requirements, FER rating at different static pressures outside of ASHRAE 103, airflow measurements, as well as Canada's new and different furnace fan metric. (AHRI, No. 0023 at pg. 238) Morrison believes the DOE estimated testing cost of 2% of the manufacturer selling price in the NOPR does not account for the cumulative regulatory burden associated with the AFUE, standby and off mode, and fan efficiency. (Morrison, No. 0021 at pg. 9) Additionally, Morrison believes that the test burden of the NOPR proposal will be increased because this is a second static test point in addition to what is already required under the DOE AFUE testing. (Morrison, No. 0023 at pg. 152) Rheem commented that they do not currently have airflow data to rate current furnace models using the proposed metric, and it is not reasonable to assume manufacturers already have this data. (Rheem, No. 0025 at pg. 3) Lennox stated that due to variability in motor performance, manufacturing and testing, more than two units may need to be tested for some models. The additional testing time, engineering time to review and convert data into the FER calculation, along with time required to statistically develop the FER rating and maintain the required DOE documentation, are additional burdens. (Lennox, No. 0012 at pg. 4) Since the SNOPR, AHRI (with the support of a number of manufacturers) proposed a method of calculating airflow based on temperature rise, which would significantly reduce test burden because it can be measured using procedures and a test setup consistent with those used for the DOE test procedure for furnaces (AHRI, No. 16 at p. 3; Goodman, No. 17 at p. 4; Ingersoll Rand, No. 14 at p. 1; Morrison, No. 21 at p. 3).

DOE realizes that the cumulative effect of multiple regulations on an industry may significantly increase the burden faced by manufacturers that need to comply with regulations and testing requirements from different organizations and levels of government. DOE considers the cumulative cost of multiple regulations on manufacturers in the cumulative regulatory burden section in the standards NOPR published on October 25, 2013. 78 FR 64103 DOE agrees that the key concept embodied in the alternative method suggested by AHRI and manufacturers (using the AFUE test set up and temperature rise to determine airflow) provides reasonable FER values at a significantly reduced burden to manufacturers. The test procedure established by this final rule adopts a modified version of the test method presented by AHRI as the furnace fan test procedure to minimize test burden.

IV. Procedural Issues and Regulatory Review

A. Review Under Executive Order 12866

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

B. Review Under the Regulatory Flexibility Act

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

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

The Small Business Administration (SBA) considers an entity to be a small business if, together with its affiliates, it employs fewer than a threshold number of workers as specified in 13 CFR part 121. The threshold values set forth in these regulations use size standards and codes established by the North American Industry Classification System (NAICS) that are available at: *http://www.sba.gov/sites/default/files/Size_Standards_Table.pdf.* The threshold number for NAICS classification for 333415, which applies to Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing (this includes furnace fan manufacturers) is 750 employees.[8] DOE reviewed AHRI's Directory of Certified Product Performance for Residential Furnaces and Boilers (2009),[9] the ENERGY STAR Product Databases for Gas and Oil Furnaces (May 15, 2009),[10] the California Energy Commission's Appliance Database for Residential Furnaces and Boilers,[11] and the Consortium for Energy Efficiency's Qualifying Furnace and Boiler List (April 2, 2009).[12] From this review, DOE identified 14 small businesses within the furnace fan industry. DOE does not believe the test procedure described in this rule would represent a substantial burden to any manufacturer, including small manufacturers, as explained below.

This rule establishes test procedures that would be used for representations of energy use and to test compliance with new energy conservation standards, which are being developed in a concurrent rulemaking, for the products that are the subject of this rulemaking. This notice establishes new test procedures for active mode testing for all such products. The rule will require a modified version of the testing methods prescribed in a public submission from AHRI (the trade organization that represents manufacturers of furnace fans). The AHRI proposal recommends test methods that are purposely aligned with the current DOE test procedure for furnaces in order to minimize test burden. (AHRI, No. 26); Appendix N of Subpart B of 10 CFR part 430. As discussed above, this would not represent a substantial burden to any furnace fan manufacturer, small or large. According to AHRI, its proposed method would result in an 80 to 90 percent reduction in test burden compared to the test procedure proposed by DOE in the NOPR. AHRI attributed this reduction primarily to manufacturers not having to acquire or use any test equipment beyond the equipment that is already used to conduct the test method specified in the DOE furnace test procedure (*i.e.* the AFUE test setup). (AHRI, No. 16 at p. 3.) Mortex, a small manufacturer, stated that measuring airflow and electrical power input at a few more airflow-control settings as a part of the existing AFUE test procedure should not require any capital outlay, unlike the method proposed by DOE in the NOPR. (Mortex, No. 18 at p. 2.) DOE's modifications to AHRI's approach will not require equipment beyond what is currently used to perform the AFUE test. Therefore, DOE expects no additional cost as the result of the new test procedure.

DOE also expects that the time and cost to conduct testing according to the proposed test procedure will not be significantly burdensome. During discussions with manufacturers, DOE received feedback that the time to test a single unit according to the AHRI method would be 30 to 60 percent less relative to using the procedure DOE proposed in the NOPR. Goodman performed tests according to both DOE's NOPR test procedure proposal and AHRI's suggested method and found that testing time is reduced by almost 60 percent using AHRI's method. (Goodman, No. 17 at p. 3.) Rheem also conducted tests according to both procedures and stated that the time to test a single-stage furnace was reduced from 4 hours to 45 minutes by using the AHRI method. (Rheem, No. 25 at p. 4.) Assuming that the labor rate for a given manufacturer would be the same regardless of test method, DOE expects that the cost to conduct a test would also be reduced by 30 to 60 percent. DOE estimated that conducting a test according to its NOPR proposed test procedure would cost a small manufacturer $2.30 per unit shipped. This estimate is largely based on DOE's experience with third-party test lab labor rates for fan testing. 77 FR at 28691 (May 15, 2012). A 30 percent reduction would yield a conservative cost estimate of $1.61 per unit shipped to conduct a test according to AHRI's method. DOE does not expect that its modifications to the AHRI method would result in additional costs to conduct a test. DOE finds that the selling price for HVAC products that incorporate furnace fans ranges from approximately $400 to $4,000. Therefore, the added cost of testing according to DOE's test procedure would be less than one percent of the manufacturer selling price (and lower than 0.1 percent in some cases).

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

C. Review Under the Paperwork Reduction Act of 1995

There is currently no information collection requirement related to the test procedure for furnace fans. In the event that DOE proposes an energy conservation standard with which manufacturers must demonstrate compliance, or otherwise proposes to require the collection of information derived from the testing of furnace fans according to this test procedure, DOE will seek OMB approval of such information collection requirement.

Manufacturers of covered products must certify to DOE that their products comply with any applicable energy conservation standard. 10 CFR 429.12. In certifying compliance, manufacturers must test their products according to the applicable DOE test procedure, including any amendments adopted for that test procedure. *See* 10 CFR 429.13.

DOE established regulations for the certification and recordkeeping requirements for certain covered consumer products and commercial equipment. 76 FR 12422 (March 7, 2011). The collection-of-information requirement for the certification and

[8] U.S. Small Business Administration, Table of Small Business Size Standards (August 22, 2008) (Available at: *http://www.sba.gov/sites/default/files/Size_Standards_Table.pdf*).

[9] The Air-Conditioning, Heating, and Refrigeration Institute, Directory of Certified Product Performance (June 2009) (Available at: *http://www.ahridirectory.org/ahridirectory/pages/home.aspx*).

[10] The U.S. Environmental Protection Agency and the U.S. Department of Energy, ENERGY STAR Furnaces—Product Databases for Gas and Oil Furnaces (May 15, 2009) (Available at: *http://www.energystar.gov/index.cfm?c=furnaces.pr_furnaces).*

[11] The California Energy Commission, Appliance Database for Residential Furnaces and Boilers (2009) (Available at: *http://www.appliances.energy.ca.gov/QuickSearch.aspx).*

[12] Consortium of Energy Efficiency, Qualifying Furnace and Boiler List (April 2, 2009) (Available at: *http://www.ceedirectory.org/ceedirectory/pages/cee/ ceeDirectoryInfo.aspx).*

recordkeeping was subject to review and approval by OMB under the Paperwork Reduction Act (PRA). This requirement was approved by OMB under OMB Control Number 1910–1400. Public reporting burden for the certification was estimated to average 20 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

As stated above, in the event DOE proposes an energy conservation standard for furnace fans with which manufacturers must demonstrate compliance, DOE will seek OMB approval of the associated information collection requirement. DOE will seek approval either through a proposed amendment to the information collection requirement approved under OMB control number 1910–1400 or as a separate proposed information collection requirement.

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

D. Review Under the National Environmental Policy Act of 1969

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

E. Review Under Executive Order 13132

Executive Order 13132, ''Federalism,'' 64 FR 43255 (August 4, 1999) imposes certain requirements on agencies formulating and implementing policies or regulations that preempt State law or that have Federalism implications. The Executive Order requires agencies to examine the constitutional and statutory authority supporting any action that would limit the policymaking discretion of the States and to carefully assess the necessity for such actions. The Executive Order also requires agencies to have an accountable process to ensure meaningful and timely input by State and local officials in the development of regulatory policies that have Federalism implications. On March 14, 2000, DOE published a statement of policy describing the intergovernmental consultation process it will follow in the development of such regulations. 65 FR 13735. DOE examined this final rule and determined that it will not have a substantial direct effect on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government. EPCA governs and prescribes Federal preemption of State regulations as to energy conservation for the products that are the subject of today's final rule. States can petition DOE for exemption from such preemption to the extent, and based on criteria, set forth in EPCA. (42 U.S.C. 6297(d)) No further action is required by Executive Order 13132.

F. Review Under Executive Order 12988

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

G. Review Under the Unfunded Mandates Reform Act of 1995

Title II of the Unfunded Mandates Reform Act of 1995 (UMRA) requires each Federal agency to assess the effects of Federal regulatory actions on State, local, and Tribal governments and the private sector. Public Law 104–4, sec. 201 (codified at 2 U.S.C. 1531). For a regulatory action resulting in a rule that may cause the expenditure by State, local, and Tribal governments, in the aggregate, or by the private sector of $100 million or more in any one year (adjusted annually for inflation), section 202 of UMRA requires a Federal agency to publish a written statement that estimates the resulting costs, benefits, and other effects on the national economy. (2 U.S.C. 1532(a), (b)) The UMRA also requires a Federal agency to develop an effective process to permit timely input by elected officers of State, local, and Tribal governments on a proposed ''significant intergovernmental mandate,'' and requires an agency plan for giving notice and opportunity for timely input to potentially affected small governments before establishing any requirements that might significantly or uniquely affect small governments. On March 18, 1997, DOE published a statement of policy on its process for intergovernmental consultation under UMRA. 62 FR 12820; also available at *http://energy.gov/gc/office-general-counsel*. DOE examined today's final rule according to UMRA and its statement of policy and determined that the rule contains neither an intergovernmental mandate, nor a mandate that may result in the expenditure of $100 million or more in any year, so these requirements do not apply.

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

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

I. Review Under Executive Order 12630

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

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

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

K. Review Under Executive Order 13211

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

Today's regulatory action is not a significant regulatory action under Executive Order 12866. Moreover, it would not have a significant adverse effect on the supply, distribution, or use of energy, nor has it been designated as a significant energy action by the Administrator of OIRA. Therefore, it is not a significant energy action, and, accordingly, DOE has not prepared a Statement of Energy Effects.

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

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

The test procedure established by this action incorporates testing methods contained in the DOE test procedure for furnaces codified in Appendix N or Subpart B of part 430 of the CFR (which incorporates by reference ANSI/ASHRAE Standard 103, ''*Method of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers,''*) and ANSI/ASHRAE Standard 37–2009, *''Methods of Testing for Rating Electrically Driven Unitary Air-Conditioning and Heat Pump Equipment.''*) While today's proposed test procedure is not exclusively based on these standards, some components of the DOE test procedure would adopt definitions, test setup, measurement techniques, and additional calculations from them without any change. DOE has evaluated these two versions of this standard and is unable to conclude whether it fully complies with the requirements of section 32(b) of the FEAA (i.e. whether it was developed in a manner that fully provides for public participation, comment, and review.) DOE has consulted with both the Attorney General and the Chairman of the FTC about the impact on competition of using the methods contained in these standards and has received no comments objecting to their use.

M. Congressional Notification

As required by 5 U.S.C. 801, DOE will report to Congress on the promulgation of today's rule before its effective date. The report will state that it has been determined that the rule is not a ''major rule'' as defined by 5 U.S.C. 804(2).

N. Approval of the Office of the Secretary

The Secretary of Energy has approved publication of this final rule.

List of Subjects

10 CFR Part 429

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

10 CFR Part 430

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

Issued in Washington, DC, on December 24, 2013.

Kathleen B. Hogan,

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

For the reasons stated in the preamble, DOE amends parts 429 and 430 of chapter II, subchapter D, of Title 10 of the Code of Federal Regulations as set forth below:

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

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

Authority: 42 U.S.C. 6291–6317.

■ 2. Add § 429.58 to read as follows:

§ 429.58 Furnace fans.

(a) *Sampling plan for selection of units for testing.* (1) The requirements of § 429.11 are applicable to furnace fans; and

(2) For each basic model of furnace fan, a sample of sufficient size shall be randomly selected and tested to ensure that any represented value of fan energy rating (FER), rounded to the nearest integer, shall be greater than or equal to the higher of:

(i) The mean of the sample, where:

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

And, $\bar{x}$ is the sample mean; n is the number of samples; and x_i is the measured value for the i^{th} sample;

Or,

(ii) The upper 90 percent confidence limit (UCL) of the true mean divided by 1.05, where:

$$UCL = \bar{x} + t_{0.90}\left(\frac{s}{\sqrt{n}}\right)$$

And $\bar{x}$ is the sample mean; s is the sample standard deviation; n is the number of samples; and $t_{0.90}$ is the t statistic for a 90% one-tailed confidence interval with n-1 degrees of freedom (from Appendix A).

(b) [Reserved]

PART 430—ENERGY CONSERVATION PROGRAM FOR CONSUMER PRODUCTS

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

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

■ 4. Section 430.2 is amended by
■ a. Adding paragraph (3) to the definition for ''basic model''; and
■ b. Adding a definition for ''furnace fan'' in alphabetical order.

The additions read as follows:

§ 430.2 Definitions.

* * * * *

Basic model * * *

(3) with respect to furnace fans: Are marketed and/or designed to be installed in the same type of installation.

* * * * *

Furnace fan means an electrically-powered device used in a consumer product for the purpose of circulating air through ductwork.

* * * * *

■ 5. Section 430.3 is amended by:
■ a. Redesignating paragraphs (f)(4) through (10) as paragraphs (f)(5) through (11);
■ b. Adding new paragraph (f)(4);
■ c. Removing, in newly redesignated (f)(5), ''Reaffirmed 2001'' and adding in its place ''Reaffirmed 2006''; and removing ''appendix E and appendix M to subpart B'' and adding in its place ''appendices E, M, and AA to subpart B'';
■ d. Revising newly redesignated paragraph (f)(10);

The addition and revision read as follows:

§ 430.3 Materials incorporated by reference.

* * * * *

(f) * * *

(4) ANSI/ASHRAE Standard 37–2009, (''ASHRAE 37–2009''), Methods of Testing for Rating Electrically Driven Unitary Air-Conditioning and Heat Pump Equipment, ANSI approved June 25, 2009, IBR approved for appendix AA to subpart B.

* * * * *

(10) ANSI/ASHRAE Standard 103–2007, (''ASHRAE 103–2007''), Methods of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers, except for sections 7.2.2.5, 8.6.1.1, 9.1.2.2, 9.5.1.1, 9.5.1.2.1, 9.5.1.2.2, 9.5.2.1, 9.7.1, 11.2.12, 11.3.12, 11.4.12, 11.5.12 and appendices B and C, ANSI approved March 25, 2008, IBR approved for appendix AA to subpart B.

* * * * *

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

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

* * * * *

(cc) *Furnace Fans.* The energy consumption of a single unit of a furnace fan basic model expressed in watts per 1000 cubic feet per minute (cfm) to the nearest integer shall be calculated in accordance with Appendix AA of this subpart.

■ 7. Appendix AA to subpart B of part 430 is added to read as follows:

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

Note: Any representation made after July 2, 2014 for energy consumption of furnace fans must be based upon results generated under this test procedure. Upon the compliance date(s) of any energy conservation standard(s) for furnace fans, use of the applicable provisions of this test procedure to demonstrate compliance with the energy conservation standard will also be required.

1. *Scope.* This appendix covers the test requirements used to measure the energy consumption of fans used in weatherized and non-weatherized gas furnaces, oil furnaces, electric furnaces, and modular blowers.

2. *Definitions.* Definitions include the definitions as specified in section 3 of ASHRAE 103–2007 (incorporated by reference, see § 430.3) and the following additional definitions, some of which supersede definitions found in ASHRAE 103–2007:

2.1. *Active mode* means the condition in which the product in which the furnace fan is integrated is connected to a power source and circulating air through ductwork.

2.2. *Airflow-control settings* are programmed or wired control system configurations that control a fan to achieve discrete, differing ranges of airflow—often designated for performing a specific function (*e.g.,* cooling, heating, or constant circulation)—without manual adjustment other than interaction with a user-operable control such as a thermostat that meets the manufacturer specifications for installed-use. For the purposes of this appendix, manufacturer specifications for installed-use shall be found in the product literature shipped with the unit.

2.3. *ASHRAE 103–2007* means ANSI/ASHRAE Standard 103–2007, published in 2007 by ASHRAE, approved by the American National Standards Institute (ANSI) on March 25, 2008, and entitled ''Method of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers''. Only those sections of ASHRAE 103–2007 (incorporated by reference; see § 430.3) specifically referenced in this test procedure are part of this test procedure. In cases where there is a conflict, the language of the test procedure in this appendix takes precedence over ASHRAE 103–2007.

2.4. *ANSI/ASHRAE Standard 41.1–1986 (RA 2006)* means the test standard published in 1986, approved by ANSI on February 18, 1987, reaffirmed in 2006, and entitled ''Standard Method for Temperature Measurement'' (incorporated by reference; see § 430.3).

2.5. *ASHRAE Standard 37–2009* means the test standard published in 2009 by ASHRAE entitled ''Methods of Testing for Rating Unitary Air-Conditioning and Heat Pump Equipment'' (incorporated by reference; see § 430.3).

2.6. *Default airflow-control settings* are the airflow-control settings specified for installed-use by the manufacturer. For the purposes of this appendix, manufacturer specifications for installed-use are those specifications provided for typical consumer installations in the product literature shipped with the product in which the furnace fan is installed. In instances where a manufacturer specifies multiple airflow-control settings for a given function to account for varying installation scenarios, the highest airflow-control setting specified for the given function shall be used for the procedures specified in this appendix.

2.7. *External static pressure* (ESP) means the difference between static pressures measured in the outlet duct and return air opening (or return air duct when used for testing) of the product in which the furnace fan is integrated.

2.8. *Furnace fan* means an electrically-powered device used in a consumer product for the purpose of circulating air through ductwork.

2.9. *Modular blower* means a product which only uses single-phase electric current, and which:

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

(b) Is not contained within the same cabinet as a furnace or central air conditioner; and

(c) Is designed to be paired with HVAC products that have a heat input rate of less than 225,000 Btu per hour and cooling capacity less than 65,000 Btu per hour.

2.10. *Off mode* means the condition in which the product in which the furnace fan is integrated either is not connected to the power source or is connected to the power source but not energized.

2.11. *Seasonal off switch* means a switch on the product in which the furnace fan is integrated that, when activated, results in a measurable change in energy consumption between the standby and off modes.

2.12. *Standby mode* means the condition in which the product in which the furnace fan is integrated is connected to the power source, energized, but the furnace fan is not circulating air.

2.13. *Thermal stack damper* means a type of stack damper that opens only during the direct conversion of thermal energy of the stack gases.

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

4. *Requirements.* Requirements are as specified in section 5 of ASHRAE 103–2007 (incorporated by reference, see § 430.3). In addition, Fan Energy Rating (FER) of furnace fans shall be determined using test data and estimated national average operating hours pursuant to section 10.10 of this appendix.

5. *Instruments.* Instruments must be as specified in section 6, not including section 6.2, of ASHRAE 103–2007 (incorporated by reference, see § 430.3); and as specified in section 5.1 and 5.2 of this appendix.

5.1. *Temperature.* Temperature measuring instruments shall meet the provisions specified in section 5.1 of ASHRAE 37–2009 (incorporated by reference, see § 430.3) and shall be accurate to within 0.75 degree Fahrenheit (within 0.4 degrees Celsius).

5.1.1. *Outlet Air Temperature Thermocouple Grid.* Outlet air temperature shall be measured as described in section 8.2.1.5.5 of ASHRAE 103–2007 (incorporated by reference, see § 430.3) and illustrated in Figure 2 of ASHRAE 103–2007. Thermocouples shall be placed downstream of pressure taps used for external static pressure measurement.

5.2. *Humidity.* Air humidity shall be measured with a relative humidity sensor that is accurate to within 5% relative humidity. Air humidity shall be measured as close as possible to the inlet of the product in which the furnace fan is installed.

6. *Apparatus.* The apparatus used in conjunction with the furnace during the testing shall be as specified in section 7 of ASHRAE 103–2007 (incorporated by reference, see § 430.3) except for section 7.1, the second paragraph of section 7.2.2.2, section 7.2.2.5, and section 7.7, and as specified in sections 6.1, 6.2, 6.3,6.4, 6.5 and 6.6 of this appendix.

6.1. *General.* The product in which the furnace fan is integrated shall be installed in the test room in accordance with the product manufacturer's written instructions that are shipped with the product unless required otherwise by a specific provision of this appendix. The apparatus described in this section is used in conjunction with the product in which the furnace fan is integrated. Each piece of the apparatus shall conform to material and construction specifications and the reference standard cited. Test rooms containing equipment shall have suitable facilities for providing the utilities necessary for performance of the test and be able to maintain conditions within the limits specified.

6.2. *Downflow furnaces.* Install the internal section of vent pipe the same size as the flue collar for connecting the flue collar to the top of the unit, if not supplied by the manufacturer. Do not insulate the internal vent pipe during the jacket loss test (if conducted) described in section 8.6 of ASHRAE 103–2007 (incorporated by reference, see § 430.3) or the steady-state test described in section 9.1 of ASHRAE 103–2007. Do not insulate the internal vent pipe before the cool-down and heat-up tests described in sections 9.5 and 9.6, respectively, of ASHRAE 103–2007. If the vent pipe is surrounded by a metal jacket, do not insulate the metal jacket. Install a 5-ft test stack of the same cross sectional area or perimeter as the vent pipe above the top of the furnace. Tape or seal around the junction connecting the vent pipe and the 5-ft test stack. Insulate the 5-ft test stack with insulation having a minimum R-value of 7 and an outer layer of aluminum foil. (See Figure 3–E of ASHRAE 103–2007.)

6.3. *Modular Blowers.* A modular blower shall be equipped with the electric heat resistance kit that is likely to have the largest volume of retail sales with that particular basic model of modular blower.

6.4. *Ducts and Plenums.* Ducts and plenums shall be built to the geometrical specifications in section 7 of ASHRAE 103–2007. An apparatus for measuring external static pressure shall be integrated in the plenum and test duct as specified in sections 6.4, excluding specifications regarding the minimum length of the ducting and minimum distance between the external static pressure taps and product inlet and outlet, and 6.5 of ASHRAE 37–2009 (incorporated by reference, see § 430.3). External static pressure measuring instruments shall be placed between the furnace openings and any restrictions or elbows in the test plenums or ducts. For all test configurations, external static pressure taps shall be placed 18 inches from the outlet.

6.4.1. *For tests conducted using a return air duct.* Additional external static pressure taps shall be placed 12 inches from the product inlet. Pressure shall be directly measured as a differential pressure as depicted in Figure 8 of ASHRAE 37–2009 rather than determined by separately measuring inlet and outlet static pressure and subtracting the results.

6.4.2. *For tests conducted without a return air duct.* External static pressure shall be directly measured as the differential pressure between the outlet duct static pressure and the ambient static pressure as depicted in Figure 7a of ASHRAE 37–2009.

6.5. *Air Filters.* Air filters shall be removed.

6.6. *Electrical Measurement.* Only electrical input power to the furnace fan (and electric resistance heat kit for electric furnaces and modular blowers) shall be measured for the purposes of this appendix. Electrical input power to the furnace fan and electric resistance hate kit shall be sub-metered separately. Electrical input power to all other electricity-consuming components of the product in which the furnace fan is integrated shall not be included in the electrical input power measurements used in the FER calculation. If the procedures of this appendix are being conducted at the same time as another test that requires metering of components other than the furnace fan and electric resistance heat kit, the electrical input power to the furnace fan and electric resistance heat kit shall be sub-metered separately from one another and separately from other electrical input power measurements.

7. *Test Conditions.* The testing conditions shall be as specified in section 8, not including section 8.6.1.1, of ASHRAE 103–2007 (incorporated by reference, see § 430.3); and as specified in section 7.1 of this appendix.

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

8. *Test Procedure.* Testing and measurements shall be as specified in section 9 of ASHRAE 103–2007 (incorporated by reference, see § 430.3) except for sections 9.1.2.1, 9.3, 9.5.1.1, 9.5.1.2.1, 9.5.1.2.2, 9.5.2.1, and section 9.7.1; and as specified in sections 8.1 through 8.6 of this appendix.

8.1. *Direct Measurement of Off-Cycle Losses Testing Method.* [Reserved.]

8.2. *Measurement of Electrical Standby and Off Mode Power.* [Reserved]

8.3. *Steady-State Conditions for Gas and Oil Furnaces.* Steady-state conditions are indicated by an external static pressure within the range shown in Table 1 and a temperature variation in three successive readings, taken 15 minutes apart, of not more than any of the following:

(a) 3 °F in the stack gas temperature for furnaces equipped with draft diverters;

(b) 5 °F in the stack gas temperature for furnaces equipped with either draft hoods, direct exhaust, or direct vent systems; and

(c) 1 °F in the flue gas temperature for condensing furnaces.

8.4. *Steady-state Conditions for Electric Furnaces and Modular Blowers.* Steady-state conditions are indicated by an external static pressure within the range shown in Table 1 and a temperature variation of not more than 5 °F in the outlet air temperature in four successive temperature readings taken 15 minutes apart.

8.5. *Steady-State Conditions for Cold Flow Tests.* For tests during which the burner or electric heating elements are turned off (i.e., cold flow tests), steady-state conditions are indicated by an external static pressure within the range shown in Table 1 and a variation in the difference between outlet temperature and ambient temperature of not more than 3 °F in three successive temperature readings taken 15 minutes apart.

8.6. *Fan Energy Rating (FER) Test.*

8.6.1. *Initial FER test conditions and maximum airflow-control setting measurements.* Measure the relative humidity (W) and dry bulb temperature (T_{db}) of the test room.

8.6.1.1. *Furnace fans for which the maximum airflow-control setting is not a default heating airflow-control setting.* The main burner or electric heating elements shall be turned off. Adjust the external static pressure to within the range shown in Table 1 by symmetrically restricting the outlet of the test duct. Maintain these settings until steady-state conditions are attained as specified in section 8.3, 8.4, and 8.5 of this appendix. Measure furnace fan electrical input power (E_{Max}), external static pressure (ESP_{Max}), and outlet air temperature ($T_{Max,Out}$).

8.6.1.2. *Furnace fans for which the maximum airflow-control setting is a default heating airflow-control setting.* Adjust the main burner or electric heating element controls to the default heat setting designated for the maximum airflow-control setting. Burner adjustments shall be made as specified by section 8.4.1 of ASHRAE 103–2007 (incorporated by reference, see § 430.3). Adjust the furnace fan controls to the maximum airflow-control setting. Adjust the external static to within the range shown in Table 1 by symmetrically restricting the outlet of the test duct. Maintain these settings until steady-state conditions are attained as specified in section 8.3, 8.4, and 8.5 of this appendix and the temperature rise (ΔT_{Max}) is at least 18 °F. Measure furnace fan electrical input power (E_{Max}), fuel or electric resistance heat kit input energy ($Q_{IN,\ Max}$), external static pressure (ESP_{Max}), steady-state efficiency for this setting ($Effy_{SS,\ Max}$) as specified in sections 11.2 and 11.3 of ASHRAE 103–2007, outlet air temperature ($T_{Max,Out}$), and temperature rise (ΔT_{Max})

TABLE 1—REQUIRED MINIMUM EXTERNAL STATIC PRESSURE IN THE MAXIMUM AIRFLOW-CONTROL SETTING BY INSTALLATION TYPE

Installation type	ESP (in. wc.)*
Units with an internal, factory-installed evaporator coil	0.50–0.55
Units designed to be paired with an evaporator coil, but without one installed	0.65–0.70
Mobile home	0.30–0.35

Once the specified ESP has been achieved, the same outlet duct restrictions shall be used for the remainder of the furnace fan test.

8.6.2. *Constant circulation airflow-control setting measurements.* The main burner or electric heating elements shall be turned off. The furnace fan controls shall be adjusted to the default constant circulation airflow-control setting. If the manufacturer does not specify a constant circulation airflow-control setting, the lowest airflow-control setting shall be used. Maintain these settings until steady-state conditions are attained as specified in section 8.3, 8.4, and 8.5 of this appendix. Measure furnace fan electrical input power (E_{Circ}) and external static pressure (ESP_{Circ}).

8.6.3. *Heating airflow-control setting measurements.* For single-stage gas and oil furnaces, the burner shall be fired at the maximum heat input rate. For single-stage electric furnaces, the electric heating elements shall be energized at the maximum heat input rate. For multi-stage and modulating furnaces the reduced heat input rate settings shall be used. Burner adjustments shall be made as specified by section 8.4.1 of ASHRAE 103–2007 (incorporated by reference, see § 430.3). After the burner is activated and adjusted or the electric heating elements are energized, the furnace fan controls shall be adjusted to operate the fan in the default heat airflow-control setting. In instances where a manufacturer specifies multiple airflow-control settings for a given function to account for varying installation scenarios, the highest airflow-control setting specified for the given function shall be used. High heat and reduced heat shall be considered different functions for multi-stage heating units. Maintain these settings until steady-state conditions are attained as specified in section 8.3, 8.4, and 8.5 of this appendix and the temperature rise (ΔT_{Heat}) is at least 18 °F. Measure furnace fan electrical input power (E_{Heat}), external static pressure (ESP_{Heat}), steady-state efficiency for this setting ($Effy_{SS}$) as specified in sections 11.2 and 11.3 of ASHRAE 103–2007, outlet air temperature ($T_{Heat,\ Out}$) and temperature rise (ΔT_{Heat}).

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

CH = annual furnace fan cooling hours

CCH = annual furnace fan constant-circulation hours

E_{Circ} = furnace fan electrical consumption at the default constant-circulation airflow-control setting (or minimum airflow-control setting operating point if a default constant-circulation airflow-control setting is not specified), in watts

E_{Heat} = furnace fan electrical consumption in the default heat airflow-control setting for single-stage heating products or the default low-heat setting for multi-stage heating products, in watts

E_{Max} = furnace fan electrical consumption in the maximum airflow-control setting, in watts

ESP_i = external static pressure, in inches water column, at time of the electrical power measurement in airflow-control setting *i,* where *i* can be ‘‘Circ’’ to represent constant-circulation (or minimum airflow) mode, ‘‘Heat’’ to represent heating mode, or ‘‘Max’’ to represent cooling (or maximum airflow) mode.

FER = fan energy rating, in watts/1000 cfm

HH = annual furnace fan heating operating hours

HCR = heating capacity ratio (nameplate reduced heat input capacity divided by nameplate maximum input heat capacity)

k_{ref} = physical descriptor characterizing the reference system

T_{db} = dry bulb temperature of the test room, in °F

$T_{i,\ In}$ = inlet air temperature at time of the electrical power measurement, in °F, in airflow-control setting *i,* where *i* can be ‘‘Circ’’ to represent constant-circulation (or minimum airflow) mode, ‘‘Heat’’ to represent heating mode, or ‘‘Max’’ to represent maximum airflow (typically designated for cooling) mode

$T_{i,\ Out}$ = average outlet air temperature as measured by the outlet thermocouple grid at time of the electrical power measurement, in °F, in airflow-control setting *i,* where *i* can be ‘‘Circ’’ to represent constant-circulation (or minimum airflow) mode, ‘‘Heat’’ to represent heating mode, or ‘‘Max’’ to represent maximum airflow (typically designated for cooling) mode

ΔT_i = $T_{i,\ Out}$ minus $T_{i,\ In}$, which is the air throughput temperature rise in setting *i,* in °F

Q_i = airflow in airflow-control setting *i,* in cubic feet per minute (CFM)

$Q_{IN,i}$ = for electric furnaces and modular blowers, the measured electrical input power to the electric resistance heat kit at specified operating conditions *i* in kW. For gas and oil furnaces, measured fuel energy input rate, in Btu/h, at specified operating conditions *i* based on the fuel's high heating value determined as required in section 8.2.1.3 or 8.2.2.3 of ASHRAE 103–2007, where *i* can be ‘‘Max’’ for the maximum heat setting or ‘‘R’’ for the reduced heat setting.

W = humidity ratio in pounds water vapor per pounds dry air

v_{air} = specific volume of dry air at specified operating conditions per the equations in the psychrometric chapter in 2001 ASHRAE Handbook—Fundamentals in lb/ft³

10. *Calculation of derived results from test measurements for a single unit.* Calculations shall be as specified in section 11 of ASHRAE 103–2007 (incorporated by reference, see § 430.3), except for appendices B and C; and as specified in sections 10.1 through 10.10 and Figure 1 of this appendix.

10.1. *Fan Energy Rating (FER)*

$$FER = \frac{(CH \times E_{Max}) + (HH \times E_{Heat}) + (CCH \times E_{Circ})}{(CH + 830 + CCH) \times Q_{Max}} \times 1000$$

Where:

$Q_{max} = Q_{heat}$ for products for which the maximum airflow-control setting is a default heat setting, or

$$Q_{Max} = Q_{Heat}\sqrt{\frac{ESP_{Max}}{ESP_{Heat}} \times \frac{(T_{Heat,Out} + 460)}{(T)_{Max,Out} + 460)}}$$

for products for which the maximum airflow control setting is only designated for cooling; and

$$Q_i = \frac{(Effy_{SS,i} - L_J) \times Q_{IN,i} + (3413 \times E_i)}{60 \times (0.24 + 0.44 \times W) \times \left(\frac{1}{v_{air}}\right) \times \Delta T_i}$$

The estimated national average operating hours presented in Table IV.2 shall be used to calculate FER.

TABLE IV.2—ESTIMATED NATIONAL AVERAGE OPERATING HOUR VALUES FOR CALCULATING FER

Operating mode	Variable	Single-stage (hours)	Multi-stage or modulating (hours)
Heating	HH	830	830/HCR.
Cooling	CH	640	640.
Constant Circulation	CCH	400	400.

Where:

$$HCR = \frac{Q_{IN,R(nameplate)}}{Q_{IN,Max(nameplate)}}$$

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