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10 CFR Parts 429 and 430
Energy Conservation Program: Test Procedures for Ceiling Fans; Final Rule

DEPARTMENT OF ENERGY

10 CFR Parts 429 and 430

[Docket No. EERE–2013–BT–TP–0050]

RIN 1904–AD10

Energy Conservation Program: Test Procedures for Ceiling Fans

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

ACTION: Final rule.

SUMMARY: The U.S. Department of Energy (DOE) is issuing a final rule to amend the test procedures for ceiling fans. DOE is establishing an integrated efficiency metric for ceiling fans, based on airflow and power consumption at high and low speed for low-speed small-diameter ceiling fans; at high speed for high-speed small-diameter ceiling fans; and at up to five speeds for large-diameter ceiling fans. The integrated efficiency metric also accounts for power consumed in standby mode. DOE is also adopting new test procedures for large-diameter ceiling fans, multi-mount ceiling fans, ceiling fans with multiple fan heads, and ceiling fans where the airflow is not directed vertically, and clarifying when these methods must be conducted. Additionally, DOE is adopting the following changes to the current test procedure: Eliminating the test cylinder from the test setup; specifying the method of measuring the distance between the ceiling fan blades and the air velocity sensors during testing; specifying the fan configuration during testing for ceiling fans that can be mounted in more than one configuration; specifying the test method for ceiling fans with heaters; specifying that a ceiling fan is not subject to the test procedure if the plane of rotation of the ceiling fan's blades cannot be within 45 degrees of horizontal; specifying that centrifugal ceiling fans are not subject to the test procedure; specifying that all small-diameter ceiling fans must be mounted directly to the real ceiling for testing; revising the allowable measurement tolerance for air velocity sensors; revising the allowable mounting tolerance for air velocity sensors; revising the testing temperature requirement; requiring measurement axes to be perpendicular to walls; specifying the position of air conditioning vents and doors during testing; specifying operation of room conditioning equipment; specifying the power source and how power measurements are to be made; and specifying stable measurement criteria and a method for determining stability.

DATES: The effective date of this rule is August 24, 2016. The final rule changes will be mandatory for representations made with respect to the energy use or efficiency of ceiling fans starting January 23, 2017. The incorporation by reference of certain publications listed in this rule was approved by the Director of the Federal Register on August 24, 2016.

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://www.regulations.gov/#!docketDetail;D=EERE-2013-BT-TP-0050.* This Web page will contain a link to the docket for this document 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. Lucy deButts at (202) 287–1604 or by email: *ceiling_fans@ee.doe.gov.*

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

(1) ANSI/AMCA Standard 230–15, (''AMCA 230–15''), ''Laboratory Methods of Testing Air Circulating Fans for Rating and Certification,'' ANSI approved October 16, 2015.

(2) IEC 62301, (''IEC 62301–U''), ''Household electrical appliances—Measurement of standby power,'' (Edition 2.0, 2011–01).

You can obtain copies of ANSI/AMCA Standard 230–15 from the American National Standards Institute, 25 W. 43rd Street, 4th Floor, New York, NY 10036, 212–642–4900, or *www.ansi.org.* You can obtain copies of IEC 62301:2011 from the International Electrotechnical Commission, 3, rue de Varembé, P.O. Box 131, CH—1211 Geneva 20—Switzerland, or *https://webstore.iec.ch.*

For a further discussion of these standards, see section IV.M.

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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. 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 consumer products include ceiling fans, the subject of this document. (42 U.S.C. 6291(49), 6293(b)(16)(A)(i) and (B), and 6295(ff))

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

Under 42 U.S.C. 6293, EPCA sets forth the criteria and procedures that DOE must follow when prescribing or amending test procedures for covered products, including ceiling fans. EPCA provides that any test procedures must be reasonably designed to produce test results that 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 must not be unduly burdensome to conduct. (42 U.S.C. 6293(b)(3))

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

EPCA established energy conservation standards (design standards) for ceiling fans, as well as requirements for the ceiling fan test procedure. (42 U.S.C. 6295(ff) and 6293(b)(16)(A)(1)) Specifically, EPCA requires that test procedures for ceiling fans be based on the ''ENERGY STAR Testing Facility Guidance Manual: Building a Testing Facility and Performing the Solid State Test Method for ENERGY STAR Qualified Ceiling Fans, Version 1.1.'' Id. The current DOE ceiling fan test procedure, based on that source, was published in a 2006 final rule (71 FR 71341 (Dec. 8, 2006)), which codified the test procedure in DOE's regulations in the Code of Federal Regulations (CFR) at 10 CFR 430.23(w) and 10 CFR part 430, subpart B, appendix U, ''Uniform Test Method for Measuring the Energy Consumption of Ceiling Fans.''

EPCA requires DOE, at least once every 7 years, to conduct an evaluation of the test procedures for all covered products and either amend the test procedures (if the Secretary determines that amended test procedures would more accurately or fully comply with the requirements of 42 U.S.C. 6293(b)(3)) or publish a determination in the **Federal Register** not to amend them. (42 U.S.C. 6293(b)(1)(A)) The final rule resulting from this rulemaking will satisfy this requirement.

In addition, for covered products with test procedures that do not fully account for standby-mode and off-mode energy consumption, EPCA directs DOE to amend its test procedures to do so with such energy consumption integrated into the overall energy efficiency, energy consumption, or other energy descriptor, if technically feasible. (42 U.S.C. 6295(gg)(2)(A)) If an integrated test procedure is technically infeasible, DOE must prescribe a separate standby-mode and off-mode test procedure for the covered product, if technically feasible. Id. This test procedure rulemaking addresses standby-mode and off-mode power consumption.

DOE is concurrently conducting an energy conservation standards rulemaking for ceiling fans.[1] On September 29, 2014, DOE published in the **Federal Register** a Notice of Public Meeting and Availability of the Preliminary Technical Support Document for the energy conservation standards rulemaking for ceiling fans. 79 FR 58290. DOE held the preliminary analysis public meeting on November 19, 2014. DOE requested feedback in the preliminary analysis document and received both written comments and comments at the public meeting from interested parties on many issues related to test methods for evaluating the airflow and electrical consumption performance of ceiling fans. Some of the comments that DOE received related to the test procedure for ceiling fans were addressed in the test procedure SNOPR (80 FR 31487 (Jun. 3, 2015)), and the remaining comments are addressed throughout this final rule. The ceiling fan energy conservation standards NOPR was published on January 13, 2016, and the associated public meeting was held on February 3, 2016. (81 FR 1688) DOE received comments on the standards NOPR pertaining to various aspects of the test procedure, particularly regarding definitions of ceiling fan types, and these comments are also addressed throughout this final rule.

II. Synopsis of the Final Rule

This final rule amends DOE's current test procedures for ceiling fans contained in 10 CFR part 430, subpart B, appendix U; 10 CFR 429.32; and 10 CFR 430.23(w). This final rule: (1) Specifies new test procedures for large-diameter ceiling fans, multi-mount ceiling fans, ceiling fans with multiple fan heads, and ceiling fans where the airflow is not directed vertically, and (2) adopts the following changes to the current test procedure: (a) Low-speed small-diameter ceiling fans must be tested at high and low speeds; (b) high-speed small-diameter ceiling fans must be tested at high speed only; (c) large-diameter ceiling fans must be tested at

[1] The ceiling fan energy conservation standard rulemaking information is available at regulations.gov under docket number EERE–2012–BT–STD–0045.

up to five speeds; (d) a test cylinder is not to be used during testing; (e) fans that can be mounted at more than one height are to be mounted in the configuration that minimizes the distance between the fan blades and the ceiling; (f) any heater installed with a ceiling fan is to be switched off during testing; (g) small-diameter ceiling fans must be mounted directly to the real ceiling; (h) the allowable measurement tolerance for air velocity sensors is ±5%; (i) the allowable mounting distance tolerance for air velocity sensors is ±1/16''; (j) the air delivery room must be at 70 F ±5 F during testing; (k) air delivery room doors and air conditioning vents must be closed and forced-air conditioning equipment turned off during testing; (l) small-diameter ceiling fans capable of being operated on both single- and multi-phase power must be tested with single-phase power, and large-diameter ceiling fans capable of being operated on both single- and multi-phase power must be tested with multi-phase power; (m) any fan rated for operation either at 120 V or at 240 V must be tested at that voltage, otherwise a fan must be tested at its lowest rated voltage or the mean of its lowest rated voltage range; (n) measurement axes must be perpendicular to test room walls; and (o) measurement stabilization requirements must be met for a valid test (*i.e.,* average air velocity for all axes for each sensor must be within 5% and average electrical power measurement must be within 1% for successive measurements).[2] DOE also determines that belt-driven ceiling fans, centrifugal ceiling fans, oscillating ceiling fans, and ceiling fans for which the plane of rotation of the fan blades cannot be within 45 degrees of horizontal are not subject to this final rule.

Additionally, to support the ongoing energy conservation standards rulemaking for ceiling fans, this final rule establishes test procedures for an integrated efficiency metric measured in cubic feet per minute per watt (CFM/W) that is applicable to all ceiling fans for which DOE has proposed energy conservation standards.[3] In this final rule, DOE also addresses standby mode and off-mode power consumption for ceiling fans. (42 U.S.C. 6295(gg)(2)(A) and (3))

III. Discussion

A. Scope of Applicability

EPCA defines a ''ceiling fan'' as ''a non-portable device that is suspended from a ceiling for circulating air via the rotation of fan blades.'' (42 U.S.C. 6291(49)) The test procedures described in this final rule apply to any product meeting this definition, including applications where large airflow volume may be needed and highly decorative fans (as discussed in section III.A.4.), except for belt-driven ceiling fans, centrifugal ceiling fans, oscillating ceiling fans, or ceiling fans whose blades' plane of rotation cannot be within 45 degrees of horizontal (see Section III.A.2). All fans that meet the statutory definition of a ceiling fan are ceiling fans and do not fall within the scope of the rulemaking under consideration for commercial and industrial fans and blowers.[4]

1. Clarification of the Statutory Definition of a Ceiling Fan

DOE previously interpreted the definition of a ceiling fan such that it excluded certain types of ceiling fans commonly referred to as hugger fans. 71 FR 71343 (Dec. 8, 2006). However, in the test procedure final rule for ceiling fan light kits (CFLKs), DOE reinterpreted the definition of ceiling fan to include hugger fans and clarified that the definition also includes fans capable of producing large volumes of airflow. 80 FR 80209 (Dec. 24, 2015)

2. Ceiling Fans Not Subject to the Test Procedure

In the October 2014 test procedure NOPR, DOE proposed that centrifugal ceiling fans (commonly referred to as ''bladeless'' ceiling fans) would not be required to test such fans according to the ceiling fan test procedure, which would not accurately measure the energy efficiency of such fans. ALA supported this proposal, and DOE received no comments expressing disagreement. (ALA, No. 8 at p. 1) DOE is defining a centrifugal ceiling fan as a ceiling fan for which the primary airflow direction is in the same plane as the rotation of the fan blades. In this final rule, DOE is not requiring manufacturers of centrifugal ceiling fans to test such fans according to the test procedure.

In the ceiling fans test procedure supplemental notice of proposed rulemaking (SNOPR) published on June 3, 2015, DOE proposed that manufacturers are not required to test ceiling fans pursuant to the test procedure if the plane of rotation of the ceiling fan's blades cannot be within 45 degrees of horizontal, as the test procedure is not designed to provide accurate performance data for such fans. 80 FR 31487. In response to this proposal, Big Ass Solutions (BAS) suggested DOE base this exemption on the direction of discharge for the majority of the airflow rather than on the plane of rotation of the ceiling fan's blades. (BAS, No. 13 at pp. 1–2)[5] BAS also provided two examples of ceiling fans for which the blades have a horizontal plane of rotation, but for which the proposed test procedure would not adequately evaluate the ceiling fan's performance due to the direction of the majority of the airflow not being vertically downward. (Id.)

DOE considers the two example ceiling fans BAS provided to be centrifugal ceiling fans, which DOE has separately determined will not be subject to this final rule. Therefore, DOE maintains that ceiling fans whose blades' plane of rotation cannot be within 45 degrees of horizontal will not be subject to this final rule.

In the concurrent ceiling fans energy conservation standards NOPR, DOE has proposed to define belt-driven ceiling fans as ceiling fans with a series of one or more fan heads, each driven by a belt connected to one or more motors. However, in the energy conservation standards NOPR, DOE does not propose standards for belt-driven ceiling fans, based on the limited number of basic models and lack of available data. Therefore, although DOE is investigating appropriate test procedures for belt-driven ceiling fans, such fans will not be subject to the test procedure adopted here.

DOE has observed that there are ceiling fans capable of oscillating, either through an oscillation of the axis of rotation of individual fan heads or a rotation in position amongst multiple fan heads. Such fans can be tested according to the appropriate proposed test procedures for ceiling fans with tilt and/or multi-headed fans if the axis of rotation of the fan blades can remain in a fixed position relative to the ceiling (*e.g.,* by switching off the oscillating feature). However, DOE recognizes that not all ceiling fans capable of oscillating can meet this requirement. In this final

[2] This provision allows for in-axis variation amongst sensors while making sure the measurement as a whole is stable.

[3] The docket for the concurrent ceiling fans energy conservation standards rulemaking is located here: *http://www.regulations.gov/#!docketDetail;D=EERE-2012-BT-STD-0045.*

[4] *https://www.regulations.gov/#!docketDetail;D=EERE-2013-BT-STD-0006.*

[5] A notation in this form provides a reference for information that is in the docket of DOE's rulemaking to develop test procedures for ceiling fans (Docket No. EERE–2013–BT–TP–0050), which is maintained at *www.regulations.gov.* This notation indicates that the statement preceding the reference is document number 13 in the docket and appears at pages 1–2 of that document.

rule, DOE is defining an ''oscillating ceiling fan'' as ''a ceiling fan containing one or more fan heads for which the axis of rotation of the fan blades cannot remain in a fixed position relative to the ceiling. Such fans have no inherent means by which to disable the oscillating function separate from the fan blade rotation.'' Although DOE is investigating appropriate test procedures for oscillating ceiling fans, fans with an oscillating function that cannot remain in a fixed position relative to the ceiling will not be subject to the test procedures adopted here. For the purpose of this test procedure, multi-head ceiling fans for which the fan will not oscillate if fan blades are only installed on one fan head do not meet the definition of ''oscillating fan'' and are subject to the test procedure established by this final rule. For this rulemaking, because the airflow measurement for multi-head fans is to be taken with the fan blades installed on only one fan head, such ceiling fans are not considered oscillating ceiling fans, and are therefore subject to the test procedures adopted here.

3. Definitions of Low-Speed Small-Diameter, High-Speed Small-Diameter, and Large-Diameter Ceiling Fans

In the October 2014 test procedure NOPR, DOE proposed definitions for low-volume and high-volume ceiling fans based on airflow volume, blade span, blade edge thickness, and the maximum tip speed of the fan blades. Furthermore, in the test procedure SNOPR, DOE proposed different test procedures for low-volume ceiling fans, high-volume ceiling fans with blade spans less than or equal to seven feet, and high-volume ceiling fans with blade spans greater than seven feet. Specifically, DOE proposed to test all ceiling fans with blade spans less than or equal to seven feet (*i.e.,* both low-volume ceiling fans and high-volume ceiling fans with blade spans less than or equal to seven feet) using a test procedure based on version 1.1 of the ENERGY STAR test method, while all high-volume ceiling fans with blade spans greater than seven feet would be tested using a modified version of the AMCA 230–12 test procedure. DOE further proposed that high-volume ceiling fans with blade spans less than or equal to seven feet would be tested at only high speed, whereas other ceiling fans with blade spans less than or equal to seven feet (*i.e.,* low-volume ceiling fans) would be tested at both high and low speeds. DOE proposed this change to harmonize the DOE test procedure with accepted industry testing practices, and DOE received no stakeholder feedback in disagreement with this approach.

In this final rule, DOE is employing different terminology to delineate fans that were previously known as low-volume, high-volume small-diameter, and high-volume. To maintain consistency with the definitions proposed in the concurrent ceiling fans energy conservation standards rulemaking, DOE is defining the following categories of ceiling fans for use in this final rule: (1) A ''large-diameter ceiling fan'' is a ceiling fan that is greater than seven feet in diameter; (2) A ''small-diameter ceiling fan'' is a ceiling fan that is less than or equal to seven feet in diameter; (3) A ''low-speed small-diameter ceiling fan'' is a small diameter ceiling fan that meets both requirements in Table 1; and (4) A ''high-speed small-diameter ceiling fan'' is a small diameter ceiling fan that fails to meet at least one of the requirements in Table 1. Table 1 indicates maximum speed tip for low-speed small-diameter ceiling fans, depending on blade thickness. The values in Table 1 are based on the Underwriters Laboratory (UL) ceiling fan safety standard (UL Standard 507–1999, ''UL Standard for Safety for Electric Fans'') which designates maximum fan tip speeds (for a given thicknesses at the edge of the blades) that are safe for use in applications where the distance between the fan blades and the floor is 10 feet or less. Given the definitions and the requirements set forth in Table 1, DOE notes that any small-diameter ceiling fan with blade edge thickness less than 3.2 mm is necessarily a high-speed small-diameter (HSSD) ceiling fan. DOE also notes that, in response to the ceiling fan energy conservation standards NOPR, ALA provided minor, clarifying edits to the definitions of several fan types, including high-speed small diameter ceiling fans, standard ceiling fans and hugger ceiling fans. (ALA, No. 137 [6] at pp. 4–5) These edits have been incorporated into the definitions in this final rule.

TABLE 1—UL 507 BLADE THICKNESS AND MAXIMUM TIP SPEED LIMITS

Airflow direction *	Thickness (t) of edges of blades		Maximum speed at tip of blades	
	(mm)	(Inch)	(m/s)	(feet per minute)
Downward-only	4.8 > t ≥ 3.2	3/16 > t ≥ 1/8	16.3	3200
Downward-only	t ≥ 4.8	t ≥ 3/16	20.3	4000
Reversible	4.8 > t ≥ 3.2	3/16 > t ≥ 1/8	12.2	2400
Reversible	t ≥ 4.8	t ≥ 3/16	16.3	3200

* The ''downward-only'' and ''reversible'' airflow directions are mutually exclusive; therefore, a ceiling fan that can only produce airflow in the downward direction need only meet the ''downward-only'' blade edge thickness and tip speed requirements and a ceiling fan that can produce airflow in the downward and upward directions need only meet the ''reversible'' requirements.

4. Definitions of Hugger, Standard, Multi-Mount, Highly-Decorative, Belt-Driven, and Very-Small-Diameter Ceiling Fans

In the October 2014 test procedure NOPR, DOE proposed to define a hugger ceiling fan as ''a ceiling fan where the lowest point on the fan blades is no more than ten inches from the ceiling.'' Furthermore, DOE proposed to define standard and multi-mount ceiling fans as ''a ceiling fan where the lowest point on the fan blades is more than ten inches from the ceiling'' and ''a ceiling fan that can be mounted in both the standard and hugger ceiling fan configurations,'' respectively. Stakeholders did not object to the 10-inch threshold specified in the October 2014 test procedure NOPR, but DOE did receive comments from Emerson and Westinghouse Lighting asking for the inclusion of a blade warpage tolerance. (Emerson, Public Meeting Transcript, No. 83 at pp. 86–87; Westinghouse Lighting, Public Meeting Transcript, No. 83 at p. 89) DOE understands the concern put forth by Emerson and Westinghouse Lighting, but DOE

[6] This document was submitted to the docket of DOE's rulemaking to develop energy conservation standards for ceiling fans (Docket No. EERE–2012–BT–STD–0045).

concludes that a specific distance needs to be selected to provide a clear division between the product classes for hugger and standard ceiling fans. For example, DOE found that standard ceiling fans on the market have a median distance of 12 inches from the ceiling to the fan blades; therefore, increasing the 10-inch distance by way of a blade warpage tolerance could result in the miscategorization of ceiling fans.

DOE also proposed regulatory definitions for hugger and standard ceiling fans and other low-speed small-diameter (LSSD) ceiling fans as part of the ceiling fans energy conservation standards rulemaking. Under the proposed definitions, a hugger ceiling fan is ''a ceiling fan that is not a very small-diameter ceiling fan, highly-decorative ceiling fan or belt-driven ceiling fan; and where the lowest point on fan blades is ≤ 10 inches from the ceiling; and has a blade thickness of ≥3.2 mm at the edge and a maximum tip speed ≤ the applicable limit in the table in this definition,'' and a standard ceiling fan is ''a ceiling fan that is not a very small-diameter ceiling fan, highly-decorative ceiling fan or belt-driven ceiling fan; and where the lowest point on fan blades is >10 inches from the ceiling; and has a blade thickness of ≥3.2 mm at the edge and a maximum tip speed ≤ the applicable limit in the table in this definition.'' (81 FR 1688 (January 13, 2016)) In both of these definitions, the table referenced is Table 1 above. DOE finalizes these definitions, with minor clarifying edits suggested by ALA (ALA, No. 137 [7] at pp. 4–5), in this rulemaking. DOE also defines a multi-mount ceiling fan as ''a ceiling fan that can be mounted in the configurations associated with the definitions of both standard and hugger ceiling fans,'' consistent with the proposed definition in the October 2014 test procedure NOPR.

DOE also proposed regulatory definitions for highly-decorative, belt-driven, and very-small diameter ceiling fans as part of the energy conservation standards rulemaking. Because the hugger and standard ceiling fan definitions finalized here invoke these terms, DOE is addressing any comments related to the definitions of these terms here. DOE proposed to define a highly-decorative ceiling fan as ''a ceiling fan with a maximum rotational speed of 90 RPM and less than 1,840 CFM airflow at high speed;'' a belt-driven ceiling fan as ''a ceiling fan with a series of one or more fan heads, each driven by a belt connected to one or more motors;'' and a very-small-diameter ceiling fan as ''a ceiling fan that is not a highly-decorative ceiling fan or belt-driven ceiling fan; and has one or more fan heads, each of which has a blade span of 18 inches or less.''

ALA did not oppose the inclusion of RPM and CFM in the highly-decorative ceiling fan definition. (ALA, No. 137 [8] at p. 6) However, BAS commented that the proposed definition for highly-decorative fans should be based on tip speed, rather than a combination of RPM and CFM. According to BAS, using RPM as a basis for the definition without incorporating blade span limits smaller-diameter fans more than larger-diameter fans. BAS added that the use of tip speed rather than RPM is consistent with the definitions for standard and hugger fans, and RPM and blade span measurements are generally easier to make than airflow measurements for highly-decorative fans. BAS therefore suggests DOE adopt a definition requiring that only highly-decorative ceiling fans have tip speeds less than or equal to 700 feet per minute. (BAS, No. 138 [9] at pp. 2–4)

DOE understands BAS's concern regarding the potential for disproportionate impact on fans of different diameters if RPM is the sole criterion for determining whether a ceiling fan is highly-decorative, but it is for this reason that a maximum airflow requirement is also part of the definition of a highly-decorative ceiling fan. In regard to BAS's comment that basing the definition of highly-decorative ceiling fans off of tip speed rather than RPM is consistent with the definition for standard and hugger fans, DOE notes that the tip speed limits in the standard and hugger ceiling fan definitions that delineate those fans from high-speed small-diameter ceiling fans are drawn from UL Standard 507 and based on safety considerations for fans installed in the residential sector. EPCA describes highly-decorative ceiling fans as ceiling fans for which air movement performance is a secondary design feature; therefore, the criteria are different for highly-decorative ceiling fans and including an airflow limit in the definition for highly-decorative ceiling fans is consistent with the statutory intent. (42 U.S.C. 6295(ff)(6)(B)(ii)) Furthermore, BAS did not elaborate on the statement that measuring the airflow of highly-decorative fans is more difficult than measuring RPM and blade span, and no other stakeholders expressed concern with measuring the airflow of highly-decorative fans. Therefore, DOE is finalizing the definition of a highly-decorative ceiling fan as ''a ceiling fan with a maximum rotational speed of 90 RPM and less than 1,840 CFM airflow at high speed, as determined by sections 3 and 4 of appendix U.''

DOE notes that efficiency performance standards have not been proposed for highly-decorative ceiling fans in the concurrent energy conservation standards rulemaking (81 FR 1688 (January 13, 2016)). If DOE does not establish performance standards for highly-decorative fans, manufacturers would continue to submit certification reports to DOE for such fans with respect to the statutory design standards. Both DOE and manufacturers would determine whether a fan met the definition of a highly decorative fan using the final test procedure, though manufacturers would not be required to submit the supporting information, including any test data, that supports their highly decorative classification as part of their certification submission to DOE. In addition, manufacturers would be required to test highly-decorative fans according to the test procedure established in this final rule to make representations of the energy efficiency of such fans (*e.g.,* for the EnergyGuide label).

The CA IOUs recommended that DOE include in the proposed definition of belt-driven ceiling fans that belt-driven ceiling fans have one or more motors located outside of the fan head. (CA IOUs, No. 144 [10] at p. 1) To reduce potential regulatory ambiguity, DOE is finalizing the definition of a belt-driven ceiling fan as ''a ceiling fan with a series of one or more fan heads, each driven by a belt connected to one or more motors that are located outside of the fan head.''

DOE received no comments in the proposed definition of very-small-diameter ceiling fans; therefore, DOE is finalizing the definition of a very-small-diameter ceiling fan as ''a ceiling fan that is not a highly-decorative ceiling fan or belt-driven ceiling fan; and has one or more fan heads, each of which has a blade span of 18 inches or less.''

[7] This document was submitted to the docket of DOE's rulemaking to develop energy conservation standards for ceiling fans (Docket No. EERE–2012–BT–STD–0045).

[8] This document was submitted to the docket of DOE's rulemaking to develop energy conservation standards for ceiling fans (Docket No. EERE–2012–BT–STD–0045).

[9] This document was submitted to the docket of DOE's rulemaking to develop energy conservation standards for ceiling fans (Docket No. EERE–2012–BT–STD–0045).

[10] This document was submitted to the docket of DOE's rulemaking to develop energy conservation standards for ceiling fans (Docket No. EERE–2012–BT–STD–0045).

B. Compliance Date

In the October 2014 test procedure NOPR, DOE proposed a compliance date 180 days after the publication of any final amended test procedures in the **Federal Register**. ALA urged DOE to not require use of a revised ceiling fans test procedure until the compliance date of the energy conservation standards established by the ongoing standards rulemaking, because DOE's revised test procedure will require manufacturers to retest every basic model of ceiling fan currently on the market. Additionally, DOE regulations already contain a test procedure for ceiling fans that can continue to be used up to the compliance date of the new ceiling fan efficiency standards. (ALA, No. 14 at p. 2)

This final rule, which would amend appendix U to Subpart B of 10 CFR 430, would not affect a manufacturer's ability to comply with current energy conservation standards, because DOE does not currently have performance-based standards for ceiling fans as measured by the airflow efficiency. As a result, manufacturers will not need time to re-design and re-tool their ceiling fans to meet any energy conservation standards based on the updated test procedures. The key requirement manufacturers will need to meet prior to the compliance date of the concurrent ceiling fan energy conservation standards is the requirement that any representations of ceiling fan efficiency be based on the test procedures set forth in this final rule on and after the compliance date of this final rule. Because re-tooling and re-design of ceiling fans will not be required, a compliance date 180 days after the publication of this final rule in the **Federal Register** will give manufacturers enough time to have their ceiling fans tested to meet the representation requirement.

Manufacturers are required to use the revised appendix U for representations of ceiling fan efficiency 180 days after the publication of any final amended test procedures in the **Federal Register**. If DOE establishes minimum energy conservation standards for ceiling fans based on airflow efficiency in the concurrent energy conservation standards rulemaking, manufacturers will be required to use the revised appendix U for determining compliance with any amended standards.

With respect to hugger fans, compliance with requirements related to the ceiling fan reinterpretation (see Section III.A.1) was discussed in the CFLK test procedure final rule. 80 FR 80209 (Dec. 24, 2015) As discussed in that rulemaking, DOE will not assert civil penalty authority for violations of the applicable standards arising as a result of the reinterpretation of the ceiling fan definition before June 26, 2017.

C. Existing Test Procedure

DOE's test procedure for ceiling fans is codified in appendix U to subpart B of part 430 of Title 10 of the CFR; 10 CFR 429.32; and 10 CFR 430.23(w). The current DOE test procedure references the ''ENERGY STAR® Testing Facility Guidance Manual: Building a Testing Facility and Performing the Solid State Test Method for ENERGY STAR Qualified Ceiling Fans,'' version 1.1.[11] ENERGY STAR has since revised its test procedure, creating version 1.2 of ENERGY STAR's guidance manual.[12]

Although certain proposals in this rulemaking are consistent with version 1.2 of the ENERGY STAR test procedure, including test room dimensions and associated tolerances, DOE has proposed no modification to the 15-minute ceiling fan warm-up time specified in the current DOE test procedure, which is in accordance with the specifications of version 1.1 (as opposed to the 30-minute warm-up time before low speed specified in version 1.2). On this issue, the People's Republic of China (P.R. China) commented that International Electrotechnical Commission (IEC) standard 60879:1986, Performance and Construction of Electric Circulating Fans and Regulators, requires a warm-up time of two hours to achieve steady-state conditions at the test voltage. (P.R. China, No. 17 at p. 3)

DOE determined, however, that a 15-minute warm-up time for testing is sufficient to bring the fan's performance into near-steady-state conditions while still keeping test burden (in this case, time) to a minimum. Therefore, DOE has retained the 15-minute warm-up time in this final rule.

D. Integrated Efficiency Metric

DOE is applying a single metric based on airflow efficiency to all ceiling fans required to be tested according to the procedure established in this final rule (see Section III.A.2 for a discussion of ceiling fans not required to be tested). Airflow efficiency appears to be a nearly-universal metric used to describe the efficiency of ceiling fans and consists of airflow (*i.e.,* the service provided by a ceiling fan), as measured in cubic feet per minute (CFM), divided by power consumption, as measured in watts (W). Additionally, in accordance with the proposal in the October 2014 test procedure NOPR, DOE is amending 10 CFR 429.32 to provide sampling requirements for determining the represented values for ceiling fans.

Stakeholders generally agreed with DOE's test procedure NOPR proposal to use airflow efficiency as the efficiency metric for ceiling fans; however, MacroAir suggested DOE use fan efficiency—the amount of wind power produced by the fan divided by the power consumption of the fan—instead. (MacroAir, No. 6 at pp. 1–4) Part of MacroAir's argument for using fan efficiency as opposed to airflow efficiency is that fan efficiency does not overly inflate when revolutions per minute (RPM) are reduced, whereas airflow efficiency tends to be higher at lower fan speeds. DOE analyzed reports from testing over 30 ceiling fans in early 2014 and found that while airflow efficiency does tend to be lower at higher RPM, the reverse is true for fan efficiency: Fan efficiency tends to be lower at lower RPM and higher at higher RPM. Therefore, in the same way that manufacturers could opt to add more lower-RPM speeds on their ceiling fans to increase their overall airflow efficiency, manufacturers could opt to remove lower-RPM speeds on their ceiling fans to increase their overall fan efficiency. DOE notes that lower-RPM speeds consume less energy than higher-RPM speeds, and the removal of lower-RPM speeds eliminates the ability of consumers to use lower speeds when appropriate. Additionally, the fan efficiency calculation provided by MacroAir incorporates blade span as an input, which could result in unintentional market shifts (in this case, toward smaller blade spans). Because airflow efficiency is the metric accepted by the majority of the ceiling fan industry, DOE is using airflow efficiency as the basis of the integrated efficiency metric for ceiling fans in this final rule.

With regard to the integrated efficiency metric, BAS and ALA commented that the metric should incorporate the effect of energy-saving controls (*e.g.,* occupancy sensors) intended to reduce the amount of time a ceiling fan is operated in active mode.

[11] U.S. Environmental Protection Agency. *ENERGY STAR® Testing Facility Guidance Manual: Building a Testing Facility and Performing the Solid State Test Method for ENERGY STAR Qualified Ceiling Fans: Version 1.1.* 2002. (Last accessed October 9, 2015.) *https://www.energystar.gov/ia/partners/manuf_res/downloads/ceiltestfinal.pdf.*

[12] U.S. Environmental Protection Agency. *ENERGY STAR® Laboratory Guidance Manual: Building a Testing Facility and Performing the Solid State Test Method for ENERGY STAR Qualification of Ceiling Fans: Version 1.2.* 2011. (Last accessed October 9, 2015.) *http://www.energystar.gov/ia/partners/manuf_res/downloads/Ceiling_Fan_Laboratory_Guidance_Manual.pdf.*

(BAS, Public Meeting Transcript, No. 5 at p. 145; ALA, Public Meeting Transcript, No. 5 at pp. 150–151) Results from a Lawrence Berkeley National Laboratory (LBNL) survey of the residential sector [13] showed that ceiling fans are operated in unoccupied spaces more than 40% of the time, on average, suggesting significant potential energy savings for controls. However, DOE is unaware of any similar data for the commercial or industrial sectors, or any data quantifying the actual decrease in energy consumption from the use of ceiling fan controls and sensors. Finally, ceiling fan sensors and controls are an emerging technology, and such devices are currently rare, so it is difficult to anticipate which controls may actually reduce energy use, or how much energy use may be saved by a particular control or sensor type. Given this, DOE has not considered measuring the energy savings of controls or sensors in this final rule.

1. Low-Speed Small-Diameter Ceiling Fans

To apply a single energy efficiency metric to LSSD ceiling fans, DOE is using a weighted average of the airflow and power consumption at high and low fan speeds, defined as the highest available and lowest available speeds, respectively. While most LSSD ceiling fans have one or more speeds between high and low, DOE is using only high and low speed in the metric to limit test burden and avoid confusion regarding the definition of medium speed for ceiling fans with more than three speeds.

In the October 2014 test procedure NOPR, DOE proposed to use hours-of-use results from a Lawrence Berkeley National Laboratory (LBNL) survey of U.S. ceiling fan owners to weight the low and high speed test results in the efficiency metric calculation for LSSD ceiling fans.[14] The LBNL survey indicated these ceiling fans are operated on high setting 41% of the time and on low setting 22% of the time. In response, the American Lighting Association (ALA) requested that DOE use data from an AcuPOLL survey indicating different hours of use—specifically, that ceiling fans are operated only 26% of the time on high setting and 36% of the time on low setting.[15] (ALA, No. 8 at p. 6) Hunter Fan Company (Hunter) also asked DOE to review the hours-of-use assumptions in light of the AcuPOLL survey results, especially because energy consumption at medium speed is typically less than the mid-point in energy consumption between high and low speeds. (Hunter, Public Meeting Transcript, No. 83 at pp. 15, 104) ALA again submitted a comment in response to the TP SNOPR asking that DOE use the AcuPOLL data for the LSSD ceiling fans efficiency metric weighting. (ALA, No. 14 at p. 6)

In light of ALA's and Hunter's comments and the AcuPOLL survey results, DOE compared the LBNL and AcuPOLL survey results and concluded that both surveys are relevant sources of information that should be taken into account to determine the fraction of time spent at each fan speed. DOE therefore estimated that the fraction of time LSSD ceiling fans were operated at each speed was equal to the simple average of the fractions reported by the LBNL and AcuPOLL surveys: 33% on high speed, 38% on medium speed, and 29% on low speed. When normalized to 100%, the fractions for high and low speed are 53% and 47%, respectively. DOE is weighting the high and low speed test results for LSSD ceiling fans based on these normalized fractions. Therefore, for calculating the overall efficiency for LSSD ceiling fans, DOE apportions the following daily operating hours (based on an overall daily usage of 6.4 hours per day, as proposed in the October 2014 test procedure NOPR): 3.4 hours at high speed, 3.0 hours at low speed, and 17.6 hours in off or standby mode.

The CA IOUs supported DOE's use of airflow efficiency as the metric for ceiling fan efficiency, but are concerned that DOE's proposal to test LSSD ceiling fans at low speed and high speed may not be specific enough. In particular, the CA IOUs suggest DOE require testing of ceiling fans at speeds that provide a specific airflow, which allows for a more direct comparison of the utility provided by ceiling fans. (CA IOUs, No. 15 at pp. 1–3) This suggestion aligned with comments made by BAS and Fanimation regarding HSSD and large–diameter ceiling fans during the October 2014 test procedure NOPR public meeting. (BAS, Public Meeting Transcript, No. 5 at pp. 106–108; Fanimation, Public Meeting Transcript, No. 5 at p. 110) DOE concluded that, while airflow is the main utility provided by ceiling fans, consumers of LSSD ceiling fans are unlikely to select a particular ceiling fan setting based on the specific amount of airflow that speed provides; instead, because LSSD ceiling fans typically have a small number of discrete speeds, consumers are expected to select the setting based on an imprecise determination of whether a given setting is providing too much or too little airflow. DOE also notes that as a consequence of LSSD ceiling fans having discrete speeds, precise airflow comparisons between different LSSD ceiling fans is impossible. Test burden would be added by having to test all available speed settings to determine which settings most closely align with the chosen airflow values. Therefore, in this final rule DOE is requiring all LSSD ceiling fans to be tested at their lowest and highest speed settings, regardless of the airflow volume provided at those settings.

2. High-Speed Small-Diameter Ceiling Fans

For reasons set forth in the test procedure SNOPR, DOE proposed in the SNOPR to test all ceiling fans with blade spans less than or equal to seven feet according to a test procedure based on air velocity sensor measurements (*i.e.,* as in the ENERGY STAR test procedure), with the caveat that HSSD fans would still be tested only at high speed. BAS and ALA supported testing HSSD fans at high speed only. (BAS, No. 13 at p. 2; ALA, No. 14 at p. 6) DOE is keeping the proposal to test HSSD fans only at high speed because they typically do not have discrete speeds, and therefore speeds other than high may not be well defined. Additionally, DOE does not have enough information to estimate a distribution of time spent at speeds other than high speed for the efficiency metric for HSSD ceiling fans.

In the October 2014 test procedure NOPR, DOE proposed operating hours for HSSD ceiling fans of 12 hours per day. No stakeholders indicated disagreement with the SNOPR testing proposal nor the NOPR's proposed operating hours for HSSD fans; therefore, for calculating the overall efficiency for these ceiling fans, DOE apportions the following daily operating hours: 12 hours at high speed and 12 hours in off or standby mode.

3. Large-Diameter Ceiling Fans

In the test procedure SNOPR, DOE proposed to test all large-diameter ceiling fans at five equally-spaced speeds: 100% (max speed), 80%, 60%, 40%, and 20%. The SNOPR also proposed that each speed other than 100% is given a tolerance of ±1% of the average measured RPM at 100% speed.

[13] Kantner, C. L. S., S. J. Young, S. M. Donovan, and K. Garbesi. *Ceiling Fan and Ceiling Fan Light Kit Use in the U.S.—Results of a Survey on Amazon Mechanical Turk.* 2013. Lawrence Berkeley National Laboratory: Berkeley, CA. Report No. LBNL–6332E. (Last accessed October 13, 2015.) *http://www.escholarship.org/uc/item/3r67c1f9.*

[14] Kantner, *et al.* (2013), *op. cit.*

[15] AcuPOLL® Precision Research, Inc. *Survey of Consumer Ceiling Fan Usage and Operations.* 2014.

BAS and AMCA commented that if testing at multiple speeds is required, the tolerance should be revised to be the greater of 2 RPM and ±1% of the average measured RPM at 100% speed. (BAS, No. 13 at p. 8; AMCA, No. 140 [16] at p. 2) The tolerance DOE proposed in the SNOPR would mean that the RPM tolerance for fans that only achieve 50 RPM at high speed would be 0.5 RPM.

DOE has concluded that the proposed tolerance may be too stringent, and perhaps not measurable, given the measurement tolerance of the test lab equipment. On the other hand, BAS's suggested tolerance means in practice that the 2 RPM tolerance would be in effect for any large-diameter ceiling fans that provide 200 RPM or less on high speed (which is a significant fraction of the large-diameter ceiling fan market). According to BAS's proposal, a ceiling fan that only provides 50 RPM at high speed would have a tolerance of ±4% of the average measured RPM at high speed, which DOE believes may be insufficient to ensure repeatability in test measurements. Therefore, in this final rule, DOE specifies an RPM tolerance of the greater of 1 RPM and ±1% of the average measured RPM at 100% speed.

In the test procedure SNOPR, to weight the performance results of the ceiling fans at each of the five speeds, DOE took a simple average of hours-of-use estimates provided by BAS and MacroAir. In doing so, DOE assumed that BAS agreed with DOE's estimate in the October 2014 NOPR of 12 hours of active mode operation per day. (BAS, No. 13 at pp. 5–6) BAS took issue with DOE's assumption and, therefore, disagreed with DOE's overall active mode estimate of 15 hours per day, calculated using a simple average of the 12 hours assumed from BAS and the 18 hours of active mode operation submitted by MacroAir. Id. DOE received no new operating hours estimates that could be used to calculate an alternative active mode operation time for large-diameter ceiling fans; however, based on BAS's comment and the lack of available large-diameter hours-of-use data, DOE has determined that using the active mode time of 12 hours per day originally proposed in the October 2014 test procedure NOPR is the most appropriate and representative estimate. As a result, DOE retains the 12 hours of daily active-mode operation for large-diameter ceiling fans proposed in the October 2014 test procedure NOPR.

In response to the SNOPR, BAS suggested that DOE require testing only at high speed for large-diameter ceiling fans. (BAS, No. 13 at p. 8) BAS also provided examples of multiple large-diameter fans that are unable to operate at those five equally-spaced speeds; therefore, BAS suggests that if testing at multiple speeds is required, DOE report the results of each tested speed separately. (BAS, No. 13 at pp. 4–5) The California investor-owned utilities (CA IOUs) suggested reporting the airflow and power draw of each of the speeds tested, in addition to the weighted airflow efficiency. (CA IOUs, No. 15 at pp. 1–3) BAS added that no reputable source of hours-of-use data exist for large-volume ceiling fans, which would be required to calculate the weighted airflow efficiency of the ceiling fan if such fans are tested at five speeds. (BAS, No. 13 at pp. 5–6)

While hours-of-use for large-diameter ceiling fans have not been well-studied, a more representative ceiling fan efficiency can be calculated by testing large-diameter ceiling fans at multiple speeds and weighting all those speeds equally (when compared to calculating the efficiency at only high speed). Therefore, as explained in more detail in Section III.F.1, DOE will require testing of large-diameter ceiling fans at up to five speeds. For calculating a ceiling fan's overall efficiency, the calculated efficiency at each tested speed will be apportioned active mode operating hours equally (*e.g.,* if five speeds are tested, each speed is given 20% of the overall daily operating hours).

E. Modifications to Existing Test Procedure

1. Required Testing Speeds for Low-Speed Small-Diameter and High-Speed Small-Diameter Ceiling Fans

As discussed in Section III.D.1, DOE is requiring all LSSD ceiling fans to be tested at high and low speeds. DOE has concluded that this approach will yield a more representative airflow efficiency than testing only at high speed, while limiting test burden and avoiding confusion regarding the definition of medium speed for ceiling fans with more than three speeds. In the test procedure SNOPR, DOE proposed to test LSSD ceiling fans at high speed first, and then to test them at low speed. BAS suggested DOE reverse this proposal, requiring low speed to be tested prior to high speed to reduce the likelihood of entrained air affecting the test results. (BAS, No. 13 at p. 7) In light of BAS's suggestion, and because DOE has concluded that there is no compelling reason to test at high speed first, in this final rule, DOE specifies that LSSD ceiling fans be tested at low speed first, and then high speed.

As discussed in Section III.D.2, DOE is requiring all HSSD fans to be tested at high speed only.

2. Elimination of Test Cylinder From Test Setup and Specification of Effective Area

In the October 2014 test procedure NOPR, DOE proposed to eliminate the current test procedure requirement to use a test cylinder while conducting airflow measurements. Under the proposed rule, the positioning of the ceiling fan and the air velocity sensors would remain the same as in the current test procedure, but without a test cylinder between them. Additionally, the same effective area and number of sensors as in the current test procedure would be used to calculate the airflow of a low-volume ceiling fan; specifically, to measure the airflow using enough air velocity sensors to record air delivery within a circle 8 inches larger in diameter than the blade span of the ceiling fan being tested.

DOE received unanimous agreement from stakeholders regarding the proposal to eliminate the test cylinder from the test setup. (Hunter, Public Meeting Transcript, No. 83 at pp. 124–125; Fanimation, Public Meeting Transcript, No. 83 at p. 125; BAS, No. 88 at p. 52; American Lighting Association, No. 8 at p. 8) According to DOE testing,[17] as well as comments from BAS and Hunter regarding their in-house testing, testing with a cylinder does not result in any significant difference in measured efficiency when compared to testing without the cylinder in place; furthermore, testing without a cylinder in place is more representative of typical usage conditions. (BAS, Public Meeting Transcript, No. 83 at p. 124; Hunter, Public Meeting Transcript, No. 83 at pp. 124–125) Therefore, in this final rule DOE has eliminated the test cylinder from the test setup.

In regard to the effective area and the number of air velocity sensors to use during testing, ALA conducted testing according to the test procedure proposed in the SNOPR and commented that including airflow measurements outside the limits of the proposed sensor setup would provide a more

[16] This document was submitted to the docket of DOE's rulemaking to develop energy conservation standards for ceiling fans (Docket No. EERE–2012–BT–STD–0045).

[17] U.S. Department of Energy–Office of Energy Efficiency and Renewable Energy. *Ceiling Fan Test Procedure Development Testing Final Report, Part 1: Energy Conservation Program for Consumer Products: Ceiling Fans.* 2014. (Last accessed November 5, 2015.) *http://www.regulations.gov/#!documentDetail;D=EERE-2013-BT-TP-0050-0002.*

accurate representation of the airflow for many small-diameter ceiling fans. (ALA, No. 18 at p. 2) Therefore, ALA suggested DOE modify the proposed test procedure for all small-diameter ceiling fans to incorporate data from 12 air velocity sensors per sensor arm, spaced at 4-inch intervals, and incorporate the airflow data only from sensors recording an average airflow of more than 40 feet per minute (fpm). If DOE declined to adopt this approach, ALA suggested that DOE use enough air velocity sensors per sensor arm to record air delivery within a circle 24 inches larger in diameter than the blade span of the ceiling fan being tested. (ALA, No. 18 at pp. 2–3)

DOE appreciates ALA's concern that more airflow sensors should be used to characterize small-diameter ceiling fans now that a test cylinder is not required. In regard to requiring 12 sensors for all fans, DOE concluded that this approach would not provide a representative comparison between larger and smaller ceiling fans. This is because the airflow efficiency for all small-diameter ceiling fans would be evaluated across the same effective area, despite ceiling fan guides consistently recommending that consumers scale the size of a ceiling fan to the size of a room (*e.g.,* installing larger ceiling fans in larger spaces), making such a comparison unlikely to be representative of typical use.

In regards to the 40 fpm minimum, DOE conducted testing to determine the effect ALA's proposal would have on a fan's measured airflow efficiency. Across nearly 40 fans DOE tested, no sensors recorded an average velocity less than 40 fpm while the fan was operating at high speed; however, average measurements below 40 fpm were observed for some ceiling fans while operating at low speed. Therefore, either the airflow efficiency of some ceiling fans would be calculated using a different effective area at high speed compared to low speed—which DOE believes would not be representative of typical use, as an installed ceiling fan is intended to service the same area regardless of the fan speed setting at which it is operating at a given time—or all sensors specified for a given ceiling fan should be used, because all sensors were required when taking the measurement at high speed. Furthermore, the test results showed that for many fans operating at low speed, a discontinuous set of sensors would meet the 40 fpm average airflow requirement (*e.g.,* sensors 1 and 3 would meet the 40 fpm requirement, but not sensor 2). However consumers expect airflow service from a ceiling fan over a continuous area; a discontinuous set of measurements would not be representative of the service provided by a ceiling fan. Additionally, imposing a 40 fpm sensor threshold could present test repeatability issues, especially in cases where one or more sensors measure an average airflow near 40 fpm. For example, a subset of sensors meets the threshold in one test, but in a subsequent test on the same fan a different subset of sensors meets the threshold. DOE also notes that the definition for highly-decorative ceiling fans finalized in this rule is based in part on airflow (as measured using the SNOPR proposal), so incorporating this 40 fpm threshold could affect whether certain fans are categorized as highly-decorative.

In regard to ALA's alternate proposal of using enough airflow sensors to record air delivery within a circle 24 inches larger in diameter than the blade span of the ceiling fan being tested, DOE notes that in practice this would result in adding two extra airflow sensors per sensor arm to the number of sensors specified in the SNOPR, regardless of blade span. This also increases by two the total number of sensors required to be installed in the experimental set up to be able to accommodate testing of the largest small-diameter ceiling fans. Requiring two additional sensors be used during testing may therefore add additional cost burden on the order of $1,000 per sensor to the test procedure without clear evidence that this would result in a more representative measurement.

Therefore, in this final rule DOE has not implemented the proposals set forth by ALA regarding the number of air velocity sensors to be used in the airflow measurement, but requires the usage of the same number of sensors for measuring airflow of small-diameter ceiling fans that was set forth in the TP SNOPR. The number of the sensors being finalized in this test procedure final rule is in line with the number of sensors required by the current DOE and Energy Star test procedures for ceiling fans. Additionally, test labs are already accustomed to testing ceiling fans per the current DOE and Energy Star test procedures, and so retaining the same number of sensors in this final rule would not add any additional test burden.

3. Specification of Method of Measuring the Distance Between Ceiling Fan Blades and Air Velocity Sensors During Testing

In the October 2014 test procedure NOPR, DOE proposed to specify that the appropriate vertical position of LSSD ceiling fans in relation to the air velocity sensors should be determined by the position of the lowest point on the ceiling fan blades, rather than ''the middle of the fan blade tips.'' DOE proposed this because it may be unclear how the ''middle of blade tip'' measurement specified in the previous test procedure should be made for ceiling fans having non-flat or unusually shaped blades. BAS expressed agreement with this proposal, and no stakeholders expressed disagreement. (BAS, Public Meeting Transcript, No. 83 at p. 132)

Additionally, DOE notes that because HSSD ceiling fans are required to be tested according to the same test procedure prescribed for LSSD ceiling fans, with the exception that only high speed will be tested for HSSD fans (see the discussion in Section III.D.2), this clarification also applies to testing HSSD ceiling fans. DOE, therefore, requires that the appropriate vertical position for LSSD and HSSD ceiling fans (hereinafter collectively referred to as small-diameter ceiling fans) in relation to the air velocity sensors be determined by the position of the lowest point on the ceiling fan blades.

4. Specification of Fan Configuration During Testing

In the October 2014 test procedure NOPR, DOE proposed that if a fan has more than one mounting option that would meet the configuration associated with the definition of a standard ceiling fan (see section III.A.4), that ceiling fan should be tested in the configuration with the smallest distance between the ceiling and the lowest point of the fan blades. Similarly, if a fan has more than one mounting option that would meet the configuration associated with the definition of a hugger ceiling fan (see section III.A.4), that ceiling fan should be tested in the configuration with the smallest distance between the ceiling and the lowest point of the fan blades. DOE received general agreement with this proposal from Westinghouse Lighting, because all ceiling fans would receive equitable treatment (*i.e.*, tested in the same relative configuration). (Westinghouse Lighting, Public Meeting Transcript, No. 83 at pp. 132–134) Therefore, in this final rule DOE adopts the proposal from the October 2014 test procedure NOPR: Small-diameter ceiling fans that can be mounted in more than one configuration that meets the standard or hugger ceiling fan definition are required to be tested in the configuration that minimizes the distance between the ceiling and lowest part of the fan blades.

5. Specification of Test Method for Ceiling Fans With Heaters

In the October 2014 test procedure NOPR, DOE proposed that during testing any heater packaged with a ceiling fan should be installed, because an object hanging directly below the fan blades might affect airflow, but switched off. The single stakeholder comment DOE received from Hunter on this proposal was supportive. (Hunter, Public Meeting Transcript, No. 83 at pp. 135) Therefore, DOE requires any heaters packaged with ceiling fans to be installed but switched off during testing.

6. Specification on Mounting Fans to Real Ceiling for Testing

In the test procedure SNOPR, DOE proposed to require that all small-diameter ceiling fans be mounted to the real ceiling (rather than a false ceiling) for testing. One of the reasons that DOE cited for this proposal was data supplied by BAS in response to the October 2014 test procedure NOPR indicating a decrease in measured efficiency performance when a ceiling fan is mounted to a false ceiling rather than a real ceiling. (BAS, Public Meeting Transcript, No. 5 at pp. 125–126) Other stakeholders expressed agreement with mounting ceiling fans to the real ceiling during testing in the test procedure NOPR public meeting. (Fanimation, Public Meeting Transcript, No. 5 at pp. 129; Minka Group, Public Meeting Transcript, No. 5 at pp. 129) However, ALA requested DOE conduct further testing at an independent test lab to confirm the results supplied by BAS before finalizing a requirement to test with the ceiling fans mounted to the real ceiling. (ALA, No. 14 at pp. 4–5)

DOE performed additional testing of ceiling fans provided by a number of manufacturers in December 2015. For this testing, DOE mounted the ceiling fan to the real ceiling, and adjusted the height of the air velocity sensors, as proposed in the SNOPR. DOE testing confirmed a decrease in measured efficiency when a ceiling fan is mounted to a false ceiling rather than a real ceiling. Based on the testing, DOE concludes that no significant additional test burden will be added by testing ceiling fans mounted to the real ceiling and adjusting the height of the air velocity sensors, relative to mounting the ceiling fans to a false ceiling, keeping the air velocity sensors stationary, and adjusting the height of the false ceiling. There is a one-time cost needed to set up the sensor arms such that the height of the air velocity sensors can be adjusted for all ceiling fans. However, once this has been set-up, there is no additional test burden. Additionally, testing ceiling fans mounted to the real ceiling is more representative of actual use than testing the ceiling fans mounted to a false ceiling. For these reasons, DOE requires mounting the ceiling fan to the real ceiling for testing small-diameter ceiling fans. DOE notes that because HSSD ceiling fans are required to be tested according to the same test procedure prescribed for LSSD ceiling fans, with the exception that only high speed will be tested for HSSD fans (see the discussion in Section III.D.2), this requirement applies to all small-diameter ceiling fans.

7. Revised Allowable Measurement Tolerance for Air Velocity Sensors

In the October 2014 test procedure NOPR, DOE proposed to change the air velocity sensor measurement tolerances from the current test procedure (based on ENERGY STAR guidance manual v1.1) value of 1% to 5%, the stringency required by ENERGY STAR guidance manual v1.2. Hunter and ALA supported this proposal, and no stakeholders opposed the proposal. (Hunter, Public Meeting Transcript, No. 83 at p. 136; ALA, No. 8 at p. 8) Therefore, DOE requires an air velocity sensor measurement tolerance not to exceed 5% for testing small-diameter ceiling fans. It is worth noting that the ENERGY STAR guidance manuals explicitly list ''suggested equipment'', including air velocity sensors, to be used for ENERGY STAR testing. The test procedure established by this final rule includes equipment specifications, including tolerances, but does not list specific equipment. Note that some ''suggested equipment'' in the ENERGY STAR guidance manuals may not meet the equipment specifications included in this test procedure, so testing laboratories should check their equipment and ensure that it is capable of meeting the specifications being adopted in this final rule.

8. Revised Allowable Mounting Tolerance for Air Velocity Sensors

The proposed regulatory text for testing small-diameter ceiling fans in the test procedure SNOPR required mounting the air velocity sensors every four inches along each sensor arm, as specified in the current ENERGY STAR test procedure. BAS suggested DOE alter this requirement to specify a tolerance of 1/16″. (BAS, No. 13 at p. 6) DOE agrees that having a specified tolerance for the air velocity sensor mounting interval is useful and would not significantly alter the measured test results; therefore, in this final rule DOE specifies the air velocity sensors be mounted every 4″ ± 1/16″ along the sensor arm.

9. Specifications To Reduce Testing Variation

ALA commented that there are problems with variation in the results of DOE's proposed ceiling fan test procedure that will raise the cost of manufacturer compliance. ALA's members observed these issues by testing the same ceiling fan at different test labs and by testing identical ceiling fans at the same test lab. According to ALA, separate tests of the same ceiling fan at different test labs produced test results that vary by as much as 31 percent; and separate tests of identical ceiling fans at the same test lab produced results that vary by as much as 15 percent. ALA stated that the variability in test results is beyond commercially reasonable tolerances for ceiling fan manufacturers. They concluded that these problems will effectively require manufacturers to adopt much larger-than-customary ''safety factors'' in their ceiling fan design and development processes to ensure that the significant variation in test results will not result in finding of noncompliance by DOE. (ALA, No. 139 at pp. 5–6)

Lutron commented that while they do not manufacture ceiling fans, they agree with the concerns of the fan industry with regard to the impact of changing test procedures and the concerns over data consistency. (Lutron, No. 141 at p. 3)

In response to these concerns, DOE conducted a thorough review of all available test data to identify opportunities to decrease testing variation. During this review, DOE found that sudden temperature variations in the test room are the primary driver of test result variations. The hot-wire anemometer sensors typically used to measure air velocity sense a change in temperature induced by the flow of air. Hot-wire anemometer sensors must have the ability to store heat, a property known as thermal mass, to make such measurements. The rate at which a hot-wire anemometer loses stored heat to air flowing at a given velocity is fixed based on the hot-wire anemometer's physical and material properties. If the rate at which the hot-wire anemometer loses stored heat is different than the rate at which the temperature in the test room is changing, the measurements of that hot-wire anemometer will vary. While the hot-wire anemometers typically have temperature compensating functions, the thermal mass of a hot-wire anemometer is not capable of compensating for sudden changes. In the context of this test procedure, the air velocity measured by a sensor may vary markedly if the temperature in the test room has changed significantly and quickly between measurements. Consequently, test results may vary significantly.

DOE considered many options to address the temperature control and air velocity measurement issues, including alternative air velocity sensors and changes to test room specifications related to temperature control. DOE determined that hot-wire anemometers are still the preferred sensor for air velocity measurements. DOE did not find an alternative air velocity measurement sensor type or apparatus that would produce significantly better air velocity measurements at similar cost, effectiveness, or industry familiarity. In addition, changes to the test room specifications related to temperature control could result in additional test burden due to capital investment in new equipment or test room renovations. Ultimately, DOE found in its review of available test data that average air velocity measurements did not vary significantly between axes for all tests. This leads DOE to believe that reducing variation is achievable without using alternative air velocity sensors or specifying significant changes to the test room and equipment. Instead, in this final rule, DOE is adopting the following provisions to minimize test procedure output variation:

- Specifying criteria for air velocity and power measurements that indicate stable measurements.
- Require measurement axes be perpendicular to test room walls.
- Require forced-air space conditioning equipment be turned off during air velocity measurements, but allow for conditioning equipment that does not supply air to the test room, such as radiant conditioning equipment, to be left on.
- Require voltage be measured within 6 inches of connection supplied with fan.

These provisions are modifications to those proposed in the June 2015 test procedure SNOPR. The June 2015 SNOPR proposed air velocity and power measurements and tolerances on each. A lab should be able to measure air velocity and power in the same way it would have per the test procedure proposed in the SNOPR. 80 FR 31500–31502 (June 3, 2015) The stability criteria established by this final rule specify that air velocity and power be measured until variation in those measurements is satisfactorily limited. The SNOPR proposed axes be perpendicular to walls or directed into corners. 80 FR 31500, 31501 (June 3, 2015) This document maintains the requirement for axes perpendicular to walls but disallows axes directed into the corners because of a higher degree of observed output variation when using this configuration. The SNOPR proposed to turn off space-conditioning equipment during air velocity measurements. 80 FR 31501 (June 3, 2015) This document maintains that requirement for forced-air equipment, but allows non-forced-air equipment to remain on. This allowance is a zero-burden method for improving temperature control and in turn, minimizing test result variation. The SNOPR proposed voltage measurements. 80 FR 31501 (June 3, 2015) This document clarifies where this measurement should be taken to minimize test result variation. DOE does not expect these provisions to change measured efficiency, only improve measurement repeatability. Also, DOE does not expect these provisions to result in significant increases in test burden.

In this final rule, DOE is establishing stability criteria to minimize test result variation. These stability criteria are in terms of acceptable air velocity and power measurement variation. Subsequent measurements must be made until stable measurements are achieved. Stable measurements are achieved when: (1) The average air velocity for all axes for each sensor varies by less than 5% compared to the average air velocity measured for that same sensor in a successive set of air velocity measurements, and (2) average power consumption varies by less than 1% in a successive set of power consumption measurements. Variations that do not meet those criteria indicate that a significant change in temperature likely occurred during the test and results will vary too significantly. DOE is adopting a provision that measurements that do not meet the definition of stable measurements are prohibited from being used in the test result. Instead, this final rule specifies that the measurement of air velocity and power be repeated until stable measurements are achieved. DOE understands that this will result in tests that require at least two iterations of measurements in each axis for each speed tested to achieve stable measurements and a valid test. These iterations represent additional test time and therefore burden. Each additional axis is 100 additional seconds plus the time it may take a sensor arm to travel to another axis if a single, sweeping sensor arm is being used. DOE estimates additional measurements to meet stability criteria to be less than 10 minutes total for four additional axes of measurements (*i.e.*, one additional iteration). Even if two additional measurements in all 4 axes are necessary for each speed, 40 minutes (two iterations multiplied by 10 minutes multiplied by two speeds) of additional test time is not a significant increase in overall test time which is roughly 3 hours including set up and warm up periods and one iteration of air velocity and power measurements per speed tested. DOE recognizes that some labs may need to make investments in facility upgrades to improve temperature control to meet these stability criteria. These upgrades could include low-cost weatherization techniques like adding weather stripping to test-room doors or adding insulation, or more costly improvements like switching from forced-air to non-forced-air space-conditioning equipment. DOE testing indicates that these stability requirements can be met in labs that performed testing per the test procedure proposed in the SNOPR and the ENERGY STAR test procedure using forced-air conditioning equipment. Therefore, these stability provisions do not require significant investment in changes to the lab set up compared to test procedures that the industry is already using.

Requiring measurement axes to be perpendicular to test room walls will reduce air swirl patterns that can occur in test room corners and potentially lead to unstable test measurements. This provision should not result in any additional test burden because no additional time or materials are needed.

Requiring forced-air space conditioning equipment be turned off during air velocity measurements, but allowing for conditioning equipment that does not supply air to the test room to be left on, is similar to what DOE proposed in the SNOPR. The difference in the provision being adopted in this final rule and the SNOPR proposal is that forced-air and non-forced air space conditioning equipment are differentiated and non-forced air space conditioning equipment can be left on during air velocity measurements. Allowing non-forced air space conditioning equipment to operate during air velocity measurements will help keep test room temperature conditions stable. Allowing forced-air space conditioning equipment to remain on during air velocity measurements may also help keep test room temperature stable, but the air supplied to the room from this equipment can interfere with air velocity measurements. Any lab already using non forced-air space conditioning equipment should not experience additional burden from this provision. Through testing, DOE also determined that labs that use forced-air conditioning equipment can produce stable test results despite turning off the forced-air equipment. Such facilities will also not require additional time or materials to test as a result of this provision.

Requiring test voltage be measured within 6 inches of the connection supplied with the fan avoids variations in measurements that may result from measuring voltage at varying distances from the supplied connection. Wires have losses that are proportional to length. Consequently, a voltage measurement taken 12 inches from the supplied connection will be different than a measurement taken 6 inches from the supplied connection. Putting limits on the distance of the voltage measurement will minimize differences in test results that may otherwise result between test labs or iterations of the test in a given lab.

10. Revised Testing Temperature Requirement

In the test procedure SNOPR, the proposed regulatory text for testing small-diameter ceiling fans required the air delivery room temperature be kept at 76 F ± 2 F during testing, which is in line with the current DOE test procedure for ceiling fans (which is based on the ENERGY STAR test procedure v. 1.1). BAS suggested DOE update this requirement to 70 F ± 5 F, which aligns with the ENERGY STAR test procedure v. 1.2. BAS indicated that tightening the air temperature requirements results in significant burden on the test lab, and also noted that the anemometers and associated software used by the test labs automatically correct for changes in temperature and humidity. (BAS, No. 13 at p. 7) DOE has concluded that relaxing the temperature requirement from 76 F ± 2 F to 70 F ± 5 F will not significantly impact the measured test results if stable measurement criteria are achieved and will align with the requirements of the current industry-standard test procedure; therefore, in this final rule, DOE specifies the air delivery room temperature to be 70 F ± 5 F during testing. Stable measurement criteria are described in more detail in section III.E.9.

11. Specification of Air Delivery Room Doors and Air Conditioning Vents

The proposed regulatory text for testing of small-diameter ceiling fans in the test procedure SNOPR indicates that the air delivery room's air conditioning vents must be closed three minutes prior to and during testing. BAS suggested DOE update this language to indicate that air delivery room doors should also be closed during testing, but that the air conditioning vents and doors may be open between test sessions to maintain space conditions. (BAS, No. 13 at p. 7) DOE agrees with BAS's suggestion, and notes that further down in that same section of the regulatory text the procedure requires the test lab to ''close all doors and vents.'' In this final rule, DOE requires that all doors and vents must be closed three minutes prior to and during testing, but that they may be opened when testing is not taking place (*e.g.*, between testing different speeds of a ceiling fan, or between testing different ceiling fans) to maintain space conditions. Better maintaining space conditions by allowing doors and vents to be open as often and long as possible except for three minutes prior and during testing will facilitate achieving the stability criteria established by this document, as discussed in section III.E.9.

12. Specification of Power Source and Measurement

The proposed regulatory text for testing all fans in the test procedure SNOPR instructs the test lab to measure power consumption of the fan, but it does not specify how the fan power should be measured in the case of fans operated with multi-phase electricity. BAS suggested DOE specify that active (real) power be measured in all phases simultaneously, as many large-diameter ceiling fans are operated with three-phase electricity. (BAS, No. 13 at p. 8) DOE agrees with BAS's suggestion, which will alleviate any confusion from measuring power consumption of fans utilizing multi-phase electricity. DOE also notes that this requirement aligns with the power measurement requirements set forth in AMCA 230–15. In this final rule, DOE specifies that active (real) power must be measured simultaneously in all phases for all ceiling fans required to be tested using the test procedure.

The test procedure SNOPR also instructs that the tests be conducted with the fan connected to a supply circuit with a specific voltage according to the fan's rating (120 V or 240 V), but it does not specify how to test fans that are rated for use with both single-phase and multi-phase electricity. AMCA and BAS made the following suggestions: (1) Test voltage at the rated voltage of the variable-speed device, or the rated voltage of the motor if no variable-speed control exists; (2) test the fan at the mean input voltage if a voltage range is specified; (3) test and rate fans capable of operating with single- and multi-phase power under both conditions; and (4) test fans with multiple voltage ranges, but the same phase power, at the mean of the lowest input voltage range. (AMCA, No. 140 at p. 3; BAS, No. 138 at pp. 16–20) [18]

DOE appreciates the comments received regarding test input voltage, and agrees that a provision should be made to test certain fans that are not rated for use with 120 V or 240 V. DOE also agrees that if multiple voltage ranges are specified for a given ceiling fan, the ceiling fan should be tested according to the lower voltage range. DOE therefore finalizes the following supply voltage requirements for all tested ceiling fans: The supply voltage must be: (1) 120 V if the ceiling fan's minimum rated voltage is 120 V or the lowest rated voltage range contains 120 V, (2) 240 V if the ceiling fan's minimum rated voltage is 240 V or the lowest rated voltage range contains 240 V, or (3) the ceiling fan's minimum rated voltage (if a voltage range is not given) or the mean of the lowest rated voltage range, in all other cases.

In regard to the comments about testing and rating ceiling fans that can be operated on both single- and multi-phase power under both conditions, DOE has determined that LSSD and HSSD fans are typically operated on single-phase circuits whereas large diameter fans are typically operated on multi-phase circuits. Therefore, DOE specifies in this final rule that LSSD and HSSD fans capable of operating with single- and multi-phase power be tested with single-phase power, and large diameter fans capable of operating with single- and multi-phase power be tested with multi-phase power. DOE will further allow manufacturers to test such fans in the other configuration (*i.e.*, using multi-phase power for LSSD and HSSD fans and single-phase power for large diameter fans) and make representations of efficiency associated with both single and multi-phase electricity if a manufacturer desires to do so, but the test results in this configuration will not be valid to assess

[18] Both documents were submitted to the docket of DOE's rulemaking to develop energy conservation standards for ceiling fans (Docket No. EERE–2012–BT–STD–0045).

compliance with any amended energy conservation standard. DOE also clarifies that any ceiling fan rated to operate on only single-phase power must be tested and rated at single-phase power. Similarly, any ceiling fan rated to operate on only multi-phase power must be tested and rated at multi-phase power.

13. Specification of Blade Span Measurement

The proposed regulatory text for testing all fans in the test procedure SNOPR instructs the test lab to conduct the appropriate test procedure based, in part, on the blade span of the ceiling fan, but it does not clearly articulate if or how the blade span is to be measured. BAS suggested that the blade span of a particular ceiling fan be determined as follows: (1) The blade span should be defined as the diameter of the largest circle swept by any part of the fan blade assembly, including any blade attachments; and (2) The rated blade span of a particular ceiling fan should be the average or the larger of the measured blade spans of the multiple samples required for testing. (BAS, No. 138 [19] at pp. 16–17) DOE concludes that the blade span of a ceiling fan is the diameter of the largest circle swept by any part of the fan blade assembly, including any blade attachments. Furthermore, DOE agrees that the average measured blade span of the tested ceiling fan samples, rounded to the nearest inch, be used for determining a ceiling fan's product class and the number of air velocity sensors required (in the case of an LSSD fan), rather than using the ceiling fan's rated blade span (which in some cases may not be publicly advertised). Therefore, for the purposes of this final rule test procedure, DOE requires that the blade span of a ceiling fan be the average of the measurements of the diameter of the largest circle swept by any part of the fan blade assembly (including any blade attachments) of the tested samples, rounded to the nearest inch.

F. Additional Test Methods

1. Test Method for Large-Diameter Ceiling Fans

In the October 2014 test procedure NOPR, DOE proposed to incorporate AMCA 230–12 by reference. An updated version of AMCA 230 published on October 16, 2015. DOE is incorporating by reference AMCA 230–15 in this final rule. The test procedure specified in AMCA 230–15 is fundamentally equivalent to the test procedure specified in AMCA 230–12 (*i.e.*, both test procedures use thrust, as measured by a load cell, to determine a ceiling fan's airflow), with a few notable differences: (1) AMCA 230–15 is applicable to ceiling fans of all blade spans, whereas AMCA 230–12 was only applicable to ceiling fans with blade spans less than or equal to 6 feet; (2) AMCA 230–15 specifies the number of speeds to test, whereas AMCA 230–12 did not provide such a specification; and (3) AMCA 230–15 has updated test room dimensions relative to AMCA 230–12. In the test procedure SNOPR, DOE proposed to limit the applicable blade span to less than or equal to 24 feet, to align with the anticipated number of speeds to test to be specified in AMCA 230–15, and to align with the anticipated test room dimensions to be specified in AMCA 230–15. (Anticipated changes to AMCA 230 were based on comments from AMCA (AMCA, No. 84 [20] at p. 2.))

In regard to the test procedure SNOPR proposal to limit the blade span applicable for testing to 24 feet, BAS suggested that DOE not have a maximum blade span limit at all, which would align with AMCA 230–15. (BAS, No. 13 at p. 7) DOE notes that it is currently unaware of any commercially-available large-diameter fans with blade spans greater than 24 feet. Because larger ceiling fans are not currently commercially available, DOE cannot confirm that that the test procedure will produce reliable results for fans larger than 24 feet in diameter. In addition, DOE prefers to align the scope of the test procedure with the scope of the concurrent energy conservation standards rulemaking for ceiling fans, which includes fans with blade spans less than or equal to 24 feet. Therefore, in this final rule DOE confirms that the test procedure is applicable to ceiling fans up to 24 feet in diameter.

BAS supported the test room dimensions proposed in the SNOPR and no stakeholders expressed disagreement. (BAS, No. 13 at p. 6) In this final rule DOE requires the following test room dimensions for large-diameter ceiling fans: (1) The minimum distance between the ceiling and the blades of a ceiling fan being tested shall be 40% of the ceiling fan blade span; (2) the minimum distance between the floor and the blades of the fan shall be the larger of 80% of the ceiling fan blade span or 4.6 m; [21] and (3) the minimum distance between the centerline of a ceiling fan and walls and/or large obstructions is 150% of the ceiling fan blade span.

DOE also notes that the efficiency metric for large-diameter ceiling fans is to be calculated based on the fan efficiency at up to five speeds (see the discussion provided in Section III.D.3). Table 2 provides the requirements for selecting which speeds to test and how to weight the efficiency results at each tested speed for calculating the weighted efficiency metric.[22]

TABLE 2—REQUIREMENTS FOR TESTING LARGE-DIAMETER CEILING FANS

Available speeds	Number of speeds to test	Which speeds to test	Efficiency metric weighting for each speed ** (%)
1	All	All	100
2	All	All	50
3	All	All	33
4	All	All	25
5	All	All	20
6+ (discrete)	5	5 fastest speeds	20

[19] This document was submitted to the docket of DOE's rulemaking to develop energy conservation standards for ceiling fans (Docket No. EERE–2012–BT–STD–0045).

[20] This document was submitted to the docket of DOE's rulemaking to develop energy conservation standards for ceiling fans (Docket No. EERE–2012–BT–STD–0045).

[21] In the SNOPR, DOE proposed a minimum distance between the floor and the blades of the ceiling fan as the larger of 80% of the ceiling fan blade span or 15 feet, based on comments submitted by BAS and AMCA indicating this would be the requirement set forth in AMCA 230–15. However, the AMCA 230–15 requirement indicates 80% of the ceiling fan blade span or 4.6 m for this requirement. 4.6 m is approximately 15.1 feet, so the difference between the SNOPR proposal and AMCA 230–15 is trivial.

[22] The percentages in the final row of the ''Which Speeds to Test'' column in Table 2 are based on the RPM at the fastest speed setting (*e.g.*, 80% speed corresponds to 80% of the measured RPM at the fastest speed).

TABLE 2—REQUIREMENTS FOR TESTING LARGE-DIAMETER CEILING FANS—Continued

Available speeds	Number of speeds to test	Which speeds to test	Efficiency metric weighting for each speed ** (%)
Infinite (continuous) *	5	100% (max) speed 80% speed 60% speed 40% speed 20% speed	20

* This corresponds to a ceiling fan, such as a ceiling fan with a variable-frequency drive (VFD), which operates over a continuous (rather than discrete) range of speeds.
** All tested speeds are to be weighted equally. Therefore, the weighting shown here for a ceiling fan with three available speeds is approximate.

Therefore, DOE requires all large-diameter ceiling fans to be tested according to AMCA 230–15, but with the modification that the number of speeds to be tested is as set forth in Table 2.

2. Test Method for Multi-Mount Ceiling Fans

Because multi-mount ceiling fans can be installed in configurations associated with both standard and hugger ceiling fans, DOE proposed in the October 2014 test procedure NOPR to test multi-mount ceiling fans in both configurations: (1) In the configuration associated with standard ceiling fans, while minimizing the distance between the ceiling and the lowest part of the fan blades, and (2) in the configuration associated with hugger ceiling fans, while minimizing the distance between the ceiling and the lowest part of the fan blades. DOE received feedback from BAS indicating agreement with this proposal. (BAS, Public Meeting Transcript, No. 83 at p. 81) However, ALA suggested DOE revise this proposal to allow manufacturers to choose to test multi-mount fans in either both configurations or only the configuration associated with hugger ceiling fans, as that configuration should provide a conservative measured efficiency when compared to the efficiency measurement in the configuration associated with standard ceiling fans. (ALA, No. 8 at p. 8)

AcuPoll survey data submitted by ALA suggest that a significant fraction of multi-mount ceiling fans are installed in the configuration associated with hugger fans and a significant fraction are installed in the configuration associated with standard fans, and DOE cannot know the installation configuration *a priori*.[23] Because consumers may install multi-mount fans in either configuration, DOE believes testing these fans in both configurations provides the most representative measurement of efficiency.

3. Test Method for Ceiling Fans With Multiple Fan Heads

In the October 2014 test procedure NOPR, DOE proposed to test ceiling fans with multiple fan heads according to the following: (1) A single fan head is to be tested, with the fan head in the same position as when a fan with a single head is tested, such that it is directly over sensor 1 (*i.e.*, at the center of the test set-up, where the four sensor axes meet); (2) the effective blade span is the blade span of an individual fan head (if all fan heads are the same size) or the blade span of the largest fan head (if the fan heads are of various sizes); (3) the distance between the air velocity sensors and the fan blades of the centered fan head should be the same as for all other small-diameter ceiling fans; (4) the airflow measurements should be made in the same manner as for all other LSSD ceiling fans, but with only the centered fan head switched on; (5) at least one of each unique category of fan head is to be tested for ceiling fans that include more than one category of fan head (if all the fan heads are the same, then only one fan head needs to be tested); (6) the total airflow is to be determined by multiplying the airflow results of an individual fan head by the number of fan heads of that category (and summing over all of the categories of heads); (7) the power consumption at a given speed is to be measured with all fan heads switched on.

In response, multiple stakeholders expressed agreement with DOE's proposal. (Fanimation, Public Meeting Transcript, No. 83 at p. 138; Matthews Fan Company, Public Meeting Transcript, No. 83 at p. 138; Minka Group, Public Meeting Transcript, No. 83 at p. 138; ALA, No. 8 at p. 8) Therefore, DOE requires all multi-head ceiling fans to be tested in accordance with the aforementioned provisions proposed in the October 2014 test procedure NOPR.

4. Test Method for Ceiling Fans Where the Airflow Is Not Directed Vertically

In the October 2014 test procedure NOPR, for ceiling fans where the airflow is not directed vertically, DOE proposed to adjust the ceiling fan head such that the airflow is as vertical as possible and oriented along one of the four sensor axes. In this proposal, the distances between the lowest point on the fan blades and the air velocity sensors should be the same as for all other LSSD ceiling fans. Then, instead of measuring the air velocity for only those sensors directly beneath the ceiling fan, the air velocity should be measured at all sensors along the axis for which the airflow is oriented, as well as the axis oriented 180 degrees with respect to that axis. Using the same total number of sensors as would be utilized if the airflow was directly downward, the airflow should be calculated based on the continuous set of sensors with the largest air velocity measurements. The effective area used to calculate airflow under this proposal would be the same as for an un-tilted ceiling fan with the same blade span.

In response to this proposal, Fanimation expressed agreement, and no other stakeholders provided comment. (Fanimation, Public Meeting Transcript, No. 83 at p. 140) In this final rule, DOE requires ceiling fans where the airflow is not directed vertically to be tested in accordance with the aforementioned provisions proposed in the October 2014 test procedure NOPR.

5. Test Method for Power Consumption in Standby Mode

In the 2014 test procedure NOPR, DOE proposed to add standby mode power consumption testing for all ceiling fans sold with hardware to maintain any of the standby functions defined in 42 U.S.C. 6295(gg)(1)(A)(iii)(II) either (1) installed

[23] AcuPOLL® Precision Research, Inc. *Survey of Consumer Ceiling Fan Usage and Operations.* 2013.

in the body of the ceiling fan, or the ceiling fan light kit packaged with it, prior to sale, or (2) packaged with the ceiling fan, and which is the sole means of operating the ceiling fan. DOE proposed to perform the standby test following the active mode test in accordance with the procedure in IEC standard 62301:2011. Because IEC 62301:2011 would add at least 40 minutes to the test procedure for ceiling fans subject to standby mode testing, DOE proposed to reduce the IEC 62301:2011-specified interval of time over which testing occurs and period of time prior to conducting the standby testing. Specifically, DOE proposed to wait three minutes after active mode functionality has been switched off to begin the standby mode test and then to collect power consumption data in standby mode for 100 seconds.

All stakeholders expressed agreement with DOE's proposal to include standby testing. However, BAS noted that the proposed method of incorporating standby power losses into the airflow efficiency metric could penalize very efficient ceiling fans while boosting the efficiency of lower-efficiency ceiling fans, and BAS provided example data for support. (BAS, Public Meeting Transcript, No. 5 at pp. 100–102)

DOE appreciates BAS's review of the proposed method for incorporating standby loss into the airflow efficiency metric; however, DOE notes that BAS's assertion that high-efficiency ceiling fans are disproportionately penalized for any standby consumption is based on a comparison of the measured efficiency calculated using the existing ENERGY STAR test procedure and the measured efficiency calculated using the test procedure proposed in the October 2014 test procedure NOPR. Using this comparison, BAS found that an efficient ceiling fan having 1.5 W of power consumption in standby mode has a calculated efficiency approximately 13% lower than the efficiency calculated using the current ENERGY STAR test method. BAS also found that less efficient ceiling fans with standby power consumption actually received an increase in calculated efficiency using the proposed test method. When comparing the measured efficiency using the proposed test method with and without standby, however, DOE concluded that all ceiling fans with standby power consumption receive an efficiency penalty relative to the calculated efficiency assuming no standby power consumption. DOE notes that this approach penalizes more efficient ceiling fans more than less efficient ceiling fans for an equal amount of standby power consumption; however, this reflects the fact that equivalent standby power consumption represents a larger fraction of the overall power consumption for more efficient ceiling fans. In other words, the effect of including standby power consumption for a more efficient fan is not greater in absolute terms, but rather greater only relative to the energy used by that fan in active mode. This is a result of incorporating standby mode into any integrated efficiency metric, as required by 42 U.S.C. 6295(gg)(2). Therefore, DOE retains the method proposed in the October 2014 test procedure NOPR for incorporating standby power consumption into the integrated efficiency metric.

G. Certification and Enforcement

Ceiling fan manufacturers must submit certification reports for each basic model before it is distributed in commerce per 10 CFR 429.12. Components of similar design may be substituted without additional testing, if the substitution does not affect the energy consumption of the ceiling fan. (10 CFR 429.11) Ceiling fan certification reports must follow the product-specific sampling and reporting requirements specified in 10 CFR 429.32. Consistent with the dates specified for use in section III.B, ceiling fan manufacturers are required to calculate ceiling fan efficiency utilizing the calculations provided in revised appendix U. Upon the compliance date of any amended energy conservation standards for ceiling fans, manufacturers would be required to follow the revised reporting requirements provided at 10 CFR 429.32 for each ceiling fan basic model.

IV. Procedural Issues and Regulatory Review

A. Review Under Executive Order 12866

The Office of Management and Budget has determined that test procedure rulemakings do not constitute ''significant regulatory actions'' under section 3(f) of Executive Order 12866, Regulatory Planning and Review, 58 FR 51735 (Oct. 4, 1993). Accordingly, this 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 that when an agency promulgates a final rule under 5 U.S.C. 553, after being required by that section or any other law to publish a general notice of proposed rulemaking, the agency shall prepare a final regulatory flexibility analysis (FRFA). 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 this final rule under the provisions of the Regulatory Flexibility Act and the policies and procedures published on February 19, 2003. The final rule prescribes test procedure amendments that would be used to determine compliance with any amended energy conservation standards that DOE may prescribe for ceiling fans. DOE has prepared a final regulatory flexibility analysis (FRFA) for this rulemaking. The FRFA describes potential impacts on small businesses associated with ceiling fan testing requirements.

DOE has transmitted a copy of this FRFA to the Chief Counsel for Advocacy of the Small Business Administration for review.

1. Description of the Need For, and Objectives of, the Rule

A description of the need for, and objectives of, the rule is set forth elsewhere in the preamble and not repeated here.

2. Description of Significant Issues Raised by Public Comment

DOE received no comments specifically on the initial regulatory flexibility analysis prepared for this rulemaking. Comments on the economic impacts of the rule are discussed elsewhere in the preamble and did not necessitate changes to the analysis required by the Regulatory Flexibility Act.

3. Description of Comments Submitted by the Small Business Administration

The Small Business Administration did not submit comments on DOE's proposed rule.

4. Description of Estimated Number of Small Entities Regulated

For the manufacturers of the covered ceiling fan products, the Small Business Administration (SBA) has set a size threshold, which defines those entities classified as ''small businesses'' for the purposes of the statute. DOE used the SBA's small business size standards to determine whether any small entities would be subject to the requirements of the rule. See 13 CFR part 121. The size standards are listed by North American Industry Classification System (NAICS) code and industry description and are available at: *https://www.sba.gov/sites/default/files/files/Size_Standards_Table.pdf.* Ceiling fan manufacturing is classified under NAICS code 335210, ''Small Electrical Appliance Manufacturing.'' The SBA sets a threshold for NAICS classification for 335210 of 1,500 employees or less.[24]

DOE reviewed ALA's list of ceiling fan manufacturers,[25] the ENERGY STAR Product Databases for Ceiling Fans,[26] the California Energy Commission's Appliance Database for Ceiling Fans,[27] and the Federal Trade Commission's Appliance Energy Database for Ceiling Fans.[28] Based on this review, using data on the companies for which DOE was able to obtain information on the numbers of employees, DOE identified 66 companies that sell ceiling fans covered by this test procedure. 25 of these companies are large businesses with more than 1,500 total employees. DOE determined that of the remaining 41 companies with less than 1,500 employees, only six companies are small businesses that maintain domestic production facilities. Of the six small ceiling fan businesses, four manufacture HSSD ceiling fans and three manufacture large-diameter ceiling fans.[29]

5. Description of the Projected Compliance Requirements of the Final Rule

a. Additional Fans Required To Be Tested

In the ceiling fan light kit test procedure final rule, DOE reinterpreted the EPCA definition of ceiling fan to include hugger fans and stated that ceiling fans that produce large volumes of airflow (*i.e.*, large-diameter ceiling fans) also meet the EPCA definition. 80 FR 80209 (Dec. 24, 2015) The changes in interpretation of the ceiling fan definition discussed above result in the applicability of the design standards set forth in EPCA at 42 U.S.C. 6295(ff)(1) to the following types of fans 30 days after the publication of the ceiling fan light kit final test procedure, which is January 25, 2016. 80 FR 80209 (Dec. 24, 2015).

DOE research indicates that all ceiling fans currently on the market, including large-diameter ceiling fans, appear to meet the EPCA design standards. For large-diameter ceiling fans, DOE searched for product specifications on the Web sites of manufacturers of large-diameter ceiling fans and from Web sites of retailers of HSSD ceiling fans. Only one large-diameter ceiling fan model was found with a light kit, and the fan controls were separate from the lighting controls for that fan. Most large-diameter ceiling fans appeared to be capable of operating at more than one speed (typically with an adjustable speed control).

Based on this research, DOE does not expect any cost of complying with the design requirements for small business manufacturers of large-diameter ceiling fans. DOE discusses the costs of testing in the following section.

b. Projected Testing Costs

DOE establishes test procedures that measure energy efficiency or energy use of a representative average use cycle for a given product, and that are not unduly burdensome to conduct. If the concurrent rulemaking regarding energy conservation standards for ceiling fans results in efficiency performance standards, DOE would require testing for certification of two ceiling fans per basic model, the minimum sample size required by 10 CFR 429.11. To determine the potential cost of the final test procedure on small ceiling fan manufacturers of HSSD and large-diameter ceiling fans under a potential energy conservation standard for ceiling fans, DOE estimated the cost of testing two ceiling fans. The cost of testing was then multiplied over the estimated number of basic models produced by a small manufacturer. The estimated cost of testing HSSD and large-diameter ceiling fans is discussed in further detail below.

High-Speed Small-Diameter Ceiling Fans

DOE estimated the cost to test HSSD ceiling fans, based on estimates from third-party testing facilities of the cost to perform the current ENERGY STAR test procedure for ceiling fans, which is similar to DOE's final test procedure, and the changes in cost associated with the key differences between the two test procedures. DOE expects that the following modifications would impose a change in test burden compared to the current ENERGY STAR test procedure: (1) The requirement to test at only one fan speed instead of three speeds; (2) the elimination of the requirement to use a test cylinder; (3) the requirement to mount the ceiling fan to the real ceiling; (4) the reduced warm up time before testing at low speed, (5) the requirement to conduct standby-mode testing, and (6) specifying criteria for air velocity and power measurements that indicate stable measurements. In total, DOE estimates that these changes reduce the typical time to perform the final test procedure by one hour compared to the ENERGY STAR test procedure, as described below.

(1) Testing at only one speed instead of three yields a total test time that is approximately 70 minutes shorter than the ENERGY STAR test procedure. DOE specifies that only high speed is to be tested. Based on test quotes from third-party labs, DOE estimates that the average cost for each speed is $87.50 per speed. Therefore, testing at only one speed instead of three reduces the total test cost by $175 per ceiling fan.

(2) Not requiring use of a test cylinder eliminates any potential costs associated with purchasing new test cylinders. If the test procedure required the use of test cylinders, then a new cylinder would be necessary to test any ceiling fan with a diameter that does not correspond to one of the cylinders in a test lab's existing inventory. Based on discussions with third-party testing facilities, DOE estimates that new test cylinders would cost approximately $2,000–3,000 per cylinder. By not using a cylinder, these costs will be avoided. Not requiring a test cylinder also shortens the test time of DOE's final test procedure relative to ENERGY STAR's test procedure for all HSSD ceiling fans, because time is not required to put a test cylinder in place for each test (estimated to take 15 minutes).

(3) Requiring mounting ceiling fans to the real ceiling involves a one-time lab cost for a mechanism that allows for the adjustment of the height of the air velocity sensors to keep the distance between the bottom of the fan blades and the air velocity sensor heads at a specified vertical distance (43 inches). Based on the materials employed and test quotes from third-party labs, DOE estimates the one-time cost to construct a mechanism to allow for the

[24] 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*).

[25] The American Lighting Association, list of Manufacturers & Representatives (Available at: *http://www.americanlightingassoc.com/Members/Resources/Manufacturers-Representatives.aspx*).

[26] The U.S. Environmental Protection Agency and the U.S. Department of Energy, ENERGY STAR Ceiling Fans—Product Databases for Ceiling Fans (Available at: *http://www.energystar.gov/products/certified-products/detail/ceiling-fans*).

[27] The California Energy Commission, Appliance Database for Ceiling Fans (Available at: *http://www.appliances.energy.ca.gov/QuickSearch.aspx*).

[28] The Federal Trade Commission, Appliance Energy Databases for Ceiling Fans (Available at: *http://www.ftc.gov/bcp/conline/edcams/eande/appliances/ceilfan.htm*).

[29] These numbers do not add up to six because one company manufacturers both types of ceiling fans.

adjustment of the height of the air velocity sensors is less than $2,000. Once the mechanism is constructed, it can be used to test all HSSD ceiling fans, and therefore does not add substantial test cost thereafter.

(4) Requiring 15 minutes of warm up time before testing at low speed compared to 30 minutes in the ENERGY STAR test procedure further reduces the relative amount of time required for DOE's final test procedure by 15 minutes.

(5) Requiring standby-mode testing for ceiling fans with standby functionality yields an additional cost for such fans. Using the quotes provided by third-party testing facilities, DOE estimates that the standby test for all ceiling fans with standby functionality costs $200 per basic model.

(6) Specifying criteria for air velocity and power measurements that indicate stable measurements may increase test time and require one-time capital costs. If stability criteria are not met after taking air velocity and power measurements in each axis, these measurements must be repeated until stability criteria are met. Measurements in each additional axis is 100 additional seconds plus the time it may take a sensor arm to travel to another axis if a single, sweeping sensor arm is being used. DOE estimates this to be less than 10 minutes total if four additional axes of measurements are needed to meet stability criteria. Even if four additional measurements in all four axes are necessary, only 40 minutes of additional test time would be required. DOE recognizes that some labs may need to make investments in facility upgrades to improve temperature control to meet these stability criteria. These upgrades could include low-cost weatherization techniques like adding weather stripping to test-room doors or adding insulation. More costly improvements, like switching from forced-air to non-forced-air space-conditioning equipment, are unlikely but may be necessary. Even the most costly upgrade of adding insulation and switching to a non-forced-air conditioning system would only be a one-time cost on the order of $5,000. Once these upgrades to the test room are completed, they can be used to test all HSSD ceiling fans, and therefore do not add substantial test cost thereafter.

In addition, DOE expects that the following modifications as described in section III.E would impose no additional test burden compared to the current ENERGY STAR test procedure: (7) Specifying that the vertical position in relation to the air velocity sensors be determined by the position of the lowest point on the ceiling fan blades, (8) specifying that ceiling fans should be tested in the configuration that minimizes the distance between the ceiling and the lowest part of the fan blades, (9) requiring that any heaters packaged with ceiling fans to be installed but switched off during testing, (10) revised allowable measurement tolerance for air velocity sensors, (11) revised allowable mounting tolerance for air velocity sensors, (12) revised testing temperature requirement, (13) requiring that all doors and vents must be closed during testing, (14) specifying that active (real) power must be measured simultaneously in all phases, (15) requiring measurement axes be perpendicular to test room walls, (16) require forced-air space conditioning equipment be turned off during air velocity measurements, but allow for conditioning equipment that does not supply air to the test room, such as radiant conditioning equipment, to be left on, and (17) requiring voltage be measured within 6 inches of connection supplied with fan.

Based on all of the differences between the final test procedure and the ENERGY STAR test procedure, and estimates from third-party testing facilities of the labor costs associated with these differences, DOE estimates that the final test procedure for HSSD ceiling fans will cost $1,325 on average per basic model, once the mechanism for the adjustment of the height of the air velocity sensors is constructed, and the insulation and non-forced-air conditioning system is added, if necessary. DOE did not find accurate data on the percentage of HSSD ceiling fans with standby capability, though DOE located some HSSD ceiling fans without standby capability in Web searches. To provide a conservative cost estimate, DOE made the assumption that all HSSD ceiling fans should be tested for standby power. Using the standby test quote of $200 per basic model, DOE estimates that the total test cost for the final test procedure and standby testing for single-headed HSSD ceiling fans will be $1,525.

For the four small business manufacturers of HSSD ceiling fans that DOE identified, the number of basic models produced per manufacturer varies significantly from one to approximately 30. Therefore, based on the test cost per ceiling fan basic model, the testing cost in the first year would range from approximately $1,525 to $45,750 for small manufacturers of HSSD ceiling fans. DOE expects this cost to be lower in subsequent years because only new or redesigned ceiling fan models would need to be tested.

In response to stakeholder comments, DOE considered alternatives to the test procedure established by this final rule. Specifically, DOE considered requiring additional sensors for HSSD fan testing. DOE found that additional sensors would cost an estimated $1,000 per sensor added, but found no evidence that additional sensors would improve how well the test procedure represents an HSSD fan's typical energy use. Consequently, DOE decided not to adopt provisions for additional sensors.

Large-Diameter Ceiling Fans

DOE estimated the cost to test a large-diameter ceiling fan based on discussions with testing facilities capable of performing the AMCA 230 test procedure as well as cost estimates based on the time and labor costs necessary to perform the test procedure on large-diameter ceiling fans. DOE estimates that the one-time cost for a lab to buy a load-cell, a fabricated load-cell frame, power meter, and one air velocity sensor is approximately $4,500. Based on test quotes, DOE estimates that the test procedure for large-diameter ceiling fans will cost manufacturers on average $7,500 per basic model for testing at up to five speeds. Using the standby test quote of $200 per basic model, DOE estimates that the total test cost for the final test procedure and standby testing for a large-diameter ceiling fans will be $7,700.

For the three small business manufacturers of large-diameter ceiling fans that DOE identified, the number of basic models produced per manufacturer varies from one to 30. Therefore, based on the test cost per ceiling fan basic model, the testing cost in the first year would range from approximately $7,700 to $231,000 for small manufacturers of large-diameter ceiling fans. DOE expects this cost to be lower in subsequent years because only new or redesigned ceiling fan models would need to be tested.

6. Description of Steps Taken To Minimize Impacts to Small Businesses

DOE considered a number of industry and governmental test procedures that measure the efficiency of ceiling fans to develop the test procedure in today's rulemaking. There appear to be two common approaches to testing ceiling fans: An approach based on using air velocity sensors to calculate airflow, such as the current DOE test procedure for ceiling fans, ENERGY STAR's test procedure, and CAN/CSA–C814–10, and an approach based on using a load cell to measure thrust, such as AMCA 230.

In principle, either approach could be used to measure the airflow efficiency of all ceiling fans, but maintaining consistency with industry practice would minimize test burden for all ceiling fan manufacturers. Though a load-cell based approach appears to be a potentially simpler method of estimating airflow efficiency, in industry, ceiling fans less than or equal to 7 feet in diameter, have historically been tested according to the air-velocity sensor based approach. Large-diameter ceiling fans, on the other hand, have historically been tested according to the load-cell based approach. It also appears to be cost-prohibitive to scale up the air-velocity sensor based approach to the large-diameter ceiling fans currently on the market given the number of sensors that would be required to cover ceiling fans 24 feet in diameter and the cost of constructing an appropriate rotating sensor arm. Therefore, DOE adopted the less burdensome approach in this final rule.

DOE also adopted a number of other measures in this final rule that will minimize impacts to small businesses: (1) Retaining the 15-minute warm-up time (see section III.C); (2) Eliminating the test cylinder from the test setup for HSSD ceiling fans (see section III.E.1); (3) Mounting HSSD ceiling fans to the real ceiling, rather than a false ceiling, for testing (see section III.E.6); (4) Relaxing the allowable measurement tolerance for the air velocity sensors used in testing HSSD ceiling fans (see section III.E.7); and (5) Relaxing the test room temperature tolerance (see section III.E.9).

C. Review Under the Paperwork Reduction Act of 1995

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

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

D. Review Under the National Environmental Policy Act of 1969

In this final rule, DOE amends its test procedure for ceiling fans to more accurately measure the energy consumption of these products. 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 has 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 this 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

When reviewing existing regulations or promulgating 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. Pub. L. 104–4, sec. 201 (codified at 2 U.S.C. 1531). For a regulatory action likely to result in a rule that may cause the expenditure by State, local, and Tribal governments, in the aggregate, or by the private sector of

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

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

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

I. Review Under Executive Order 12630

DOE has determined, under Executive Order 12630, ''Governmental Actions and Interference with Constitutionally Protected Property Rights'' 53 FR 8859 (March 18, 1988), that this regulation 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 this 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.

This regulatory action to amend the test procedure for measuring the energy efficiency of ceiling fans 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 final rule incorporates testing methods contained in the following commercial standards: ANSI/AMCA Standard 230–15, ''Air Movement and Control Association Laboratory Methods of testing Air Circulating Fans for Rating and Certification'' and IEC 62301:2011, ''Household Electrical Appliances—Measurement of Standby Power.'' The Department has evaluated these standards and is unable to conclude whether they fully comply with the requirements of section 32(b) of the FEAA (*i.e.,* whether they were developed in a manner that fully provides for public participation, comment, and review.) DOE 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. Description of Materials Incorporated by Reference

In this final rule, DOE is incorporating by reference specific sections of the following industry standards: (1) ANSI/AMCA Standard 230–15 (''AMCA 230–15''), ''Air Movement and Control Association Laboratory Methods of Testing Air Circulating Fans for Rating and Certification,'' and (2) IEC 62301–U (Edition 2.0, 2011–01), ''Household Electrical Appliances—Measurement of Standby Power.''

AMCA 230–15 is an industry-standard test procedure for measuring the airflow efficiency of commercial and industrial ceiling fans. The test procedure in this final rule references Section 3 through Section 9 of AMCA 230–15 (except sections 5.1 and 9.5 and Test Figures 2 and 3), which specify the test apparatus, general instructions, procedure, and calculations for measuring airflow efficiency. AMCA 230–15 is available from the American National Standards Institute, 25 W. 43rd Street, 4th Floor, New York, NY 10036, 212–642–4900, or *www.ansi.org.*

IEC 62301–U is an industry-standard test procedure for measuring the standby power draw of electrical appliances (including ceiling fans). The test procedure in this final rule references Section 4.3.1 through Section 5.3.2 of IEC 62301–U (except sections 5.1 and 5.2), which specify the test apparatus, general instructions, procedure and calculations for measuring standby power consumption. Copies of IEC 62301–U are available from the International Electrotechnical

Commission, 3, rue de Varembé, P.O. Box 131, CH–1211 Geneva 20–Switzerland, or *https://webstore.iec.ch.*

N. Congressional Notification

As required by 5 U.S.C. 801, DOE will report to Congress on the promulgation of this 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).

V. 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 July 6, 2016.

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, Code of Federal Regulations, as set forth below:

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

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

Authority: 42 U.S.C. 6291–6317.

■ 2. Section 429.32 is amended by revising paragraph (a) to read as follows:

§ 429.32 Ceiling fans.

(a) *Determination of represented value.* Manufacturers must determine the represented value, which includes the certified rating, for each basic model of ceiling fan by testing, in conjunction with the following sampling provisions:

(1) The requirements of § 429.11 are applicable to ceiling fans; and

(2) For each basic model of ceiling fan selected for testing, a sample of sufficient size must be randomly selected and tested to ensure that—

(i) Any represented value of the efficiency or airflow is less than or equal to the lower of:

(A) 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 i^{th} sample; or

(B) The lower 90 percent confidence limit (LCL) of the true mean divided by 0.9, where:

$$LCL = \overline{x} - t_{0.90}(\frac{s}{\sqrt{n}})$$

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 to subpart B); and

(ii) Any represented value of the wattage is greater than or equal to the higher of:

(A) 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 i^{th} sample; or

(B) The upper 95 percent confidence limit (UCL) of the true mean divided by 1.1, where:

$$UCL = \overline{x} + t_{0.95}(\frac{s}{\sqrt{n}})$$

And $\bar{x}$ is the sample mean; s is the sample standard deviation; n is the number of samples; and $t_{0.95}$ is the t statistic for a 95% one-tailed confidence interval with n − 1 degrees of freedom (from appendix A to this subpart).

* * * * *

PART 430—ENERGY CONSERVATION PROGRAM FOR CONSUMER PRODUCTS

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

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

■ 4. Section 430.2 is amended by revising the definition for ''ceiling fan'' to read as follows:

§ 430.2 Definitions.

* * * * *

Ceiling fan means a nonportable device that is suspended from a ceiling for circulating air via the rotation of fan blades. For all other ceiling fan-related definitions, see appendix U to this subpart.

* * * * *

■ 5. Section 430.3 is amended by adding paragraphs (b)(3) and (p)(6) to read as follows:

§ 430.3 Materials incorporated by reference.

* * * * *

(b) * * *

(3) ANSI/AMCA Standard 230–15 (''AMCA 230–15''), ''Laboratory Methods of Testing Air Circulating Fans for Rating and Certification,'' ANSI approved October 16, 2015, IBR approved for appendix U to this subpart, as follows:

(i) Section 3—Units of Measurement;

(ii) Section 4—Symbols and Subscripts; (including Table 1—Symbols and Subscripts);

(iii) Section 5—Definitions (except 5.1);

(iv) Section 6—Instruments and Section Methods of Measurement;

(v) Section 7—Equipment and Setups (except the last 2 bulleted items in 7.1—Allowable test setups);

(vi) Section 8—Observations and Conduct of Test;

(vii) Section 9—Calculations (except 9.5); and

(viii) Test Figure 1—Vertical Airflow Setup with Load Cell (Ceiling Fans).

* * * * *

(p) * * *

(6) IEC 62301 (''IEC 62301–U''), Household electrical appliances—Measurement of standby power, (Edition 2.0, 2011–01), IBR approved for appendix U to this subpart, as follows:

(i) Section 4.3—General conditions for measurements: Power supply: Section 4.3.1—Supply voltage and frequency (first paragraph only),

(ii) Section 4.3—General conditions for measurements: Power supply: Section 4.3.2—Supply voltage waveform;

(iii) Section 4.4—General conditions for measurements: Power measuring instruments;

(iv) Section 5.3—Measurements: Procedure: Section 5.3.1—General (except the last bulleted item), and

(v) Section 5.3—Measurements: Procedure: Section 5.3.2—Sampling method (first two paragraphs and Note 1).

* * * * *

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

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

* * * * *

(w) *Ceiling fans.* Measure the efficiency of a ceiling fan, expressed in cubic feet per minute per watt (CFM/W), in accordance with appendix U to this subpart.

* * * * *

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

Appendix U To Subpart B OF Part 430—Uniform Test Method for Measuring the Energy Consumption of Ceiling Fans

Prior to January 23, 2017, manufacturers must make any representations with respect to the energy use or efficiency of ceiling fans as specified in Section 2 of this appendix (other than hugger ceiling fans, multi-mount ceiling fans in the hugger configuration, and large-diameter ceiling fans) in accordance with the results of testing pursuant either to this appendix, or to the applicable test requirements set forth in 10 CFR parts 429 and 430, as they appeared in the 10 CFR parts 200 to 499 edition revised as of January 1, 2016. On or after January 23, 2017, manufacturers of ceiling fans, as specified in Section 2 of this appendix, must make any representations with respect to energy use or efficiency in accordance with the results of testing pursuant to this appendix.

1. Definitions:

1.1. *20% speed* means the ceiling fan speed at which the blade RPM are measured to be 20% of the blade RPM measured at high speed.

1.2. *40% speed* means the ceiling fan speed at which the blade RPM are measured to be 40% of the blade RPM measured at high speed.

1.3. *60% speed* means the ceiling fan speed at which the blade RPM are measured to be 60% of the blade RPM measured at high speed.

1.4. *80% speed* means the ceiling fan speed at which the blade RPM are measured to be 80% of the blade RPM measured at high speed.

1.5. *Airflow* means the rate of air movement at a specific fan-speed setting expressed in cubic feet per minute (CFM).

1.6. *Belt-driven ceiling fan* means a ceiling fan with a series of one or more fan heads, each driven by a belt connected to one or more motors that are located outside of the fan head.

1.7. *Blade span* means the diameter of the largest circle swept by any part of the fan blade assembly, including any blade attachments.

1.8. *Ceiling fan efficiency* means the ratio of the total airflow to the total power consumption, in units of cubic feet per minute per watt (CFM/W).

1.9. *Centrifugal ceiling fan* means a ceiling fan for which the primary airflow direction is in the same plane as the rotation of the fan blades.

1.10. *High speed* means the highest available ceiling fan speed, *i.e.,* the fan speed corresponding to the maximum blade revolutions per minute (RPM).

1.11. *High-speed small-diameter* ceiling fan means a small-diameter ceiling fan that is not a very-small-diameter ceiling fan, highly-decorative ceiling fan or belt-driven ceiling fan and that has a blade thickness of less than 3.2 mm at the edge or a maximum tip speed greater than the applicable limit specified in the table in this definition.

HIGH-SPEED SMALL-DIAMETER CEILING FAN BLADE AND TIP SPEED CRITERIA

Airflow direction	Thickness (t) of edges of blades		Tip speed threshold	
	Mm	inch	m/s	feet per minute
Downward-only	4.8 > t ≥ 3.2	3/16 > t ≥ 1/8	16.3	3,200
Downward-only	t ≥ 4.8	t ≥ 3/16	20.3	4,000
Reversible	4.8 > t ≥ 3.2	3/16 > t ≥ 1/8	12.2	2,400
Reversible	t ≥ 4.8	t ≥ 3/16	16.3	3,200

1.12. *Highly-decorative ceiling fan* means a ceiling with a maximum rotational speed of 90 RPM and less than 1,840 CFM airflow at high speed, as determined by sections 3 and 4 of this appendix.

1.13. *Hugger ceiling fan* means a low-speed small-diameter ceiling fan that is not a very-small-diameter ceiling fan, highly-decorative ceiling fan or belt-driven ceiling fan; for which the lowest point on the fan blades is less than or equal to 10 inches from the ceiling.

1.14. *Large-diameter ceiling fan* means a ceiling fan that is greater than seven feet in diameter.

1.15. *Low speed* means the lowest available ceiling fan speed, *i.e.,* the fan speed corresponding to the minimum, non-zero, blade RPM.

1.16. *Low-speed small-diameter ceiling fan* means a small-diameter ceiling fan that has a blade thickness greater than or equal to 3.2 mm at the edge and a maximum tip speed less than or equal to the applicable limit specified in the table in this definition.

LOW-SPEED SMALL-DIAMETER CEILING FAN BLADE AND TIP SPEED CRITERIA

Airflow direction	Thickness (t) of edges of blades		Tip speed threshold	
	Mm	inch	m/s	feet per minute
Reversible	4.8 > t ≥ 3.2	3/16 > t ≥ 1/8	12.2	2,400
Reversible	t ≥ 4.8	t ≥ 3/16	16.3	3,200

1.17. *Multi-head ceiling fan* means a ceiling fan with more than one fan head, *i.e.,* more than one set of rotating fan blades.

1.18. *Multi-mount ceiling fan* means a low-speed small-diameter ceiling fan that can be mounted in the configurations associated with both the standard and hugger ceiling fans.

1.19. *Oscillating ceiling fan* means a ceiling fan containing one or more fan heads for which the axis of rotation of the fan blades cannot remain in a fixed position relative to the ceiling. Such fans have no inherent means by which to disable the oscillating function separate from the fan blade rotation.

1.20. *Small-diameter ceiling fan* means a ceiling fan that is less than or equal to seven feet in diameter.

1.21. *Standard ceiling fan* means a low-speed small-diameter ceiling fan that is not a very-small-diameter ceiling fan, highly-decorative ceiling fan or belt-driven ceiling fan; for which the lowest point on fan blades is greater than 10 inches from the ceiling.

1.22. *Total airflow* means the sum of the product of airflow and hours of operation at all tested speeds. For multi-head fans, this includes the airflow from all fan heads.

1.23. *Very-small-diameter ceiling fan* means a small-diameter ceiling fan that is not a highly-decorative ceiling fan or belt-driven ceiling fan; and has one or more fan heads, each of which has a blade span of 18 inches or less.

2. Scope:

The provisions in this appendix apply to ceiling fans except:

(1) Ceiling fans where the plane of rotation of a ceiling fan's blades is not less than or

equal to 45 degrees from horizontal, or cannot be adjusted based on the manufacturer's specifications to be less than or equal to 45 degrees from horizontal;

(2) Centrifugal ceiling fans;

(3) Belt-driven ceiling fans; and

(4) Oscillating ceiling fans.

3. General Instructions, Test Apparatus, and Test Measurement:

The test apparatus and test measurement used to determine energy performance depend on the ceiling fan's blade span. For each tested ceiling fan, measure the lateral distance from the center of the axis of rotation of the fan blades to the furthest fan blade edge from the center of the axis of rotation, and multiply this distance by two. The blade span for a basic model of ceiling fan is then calculated as the arithmetic mean of this distance across each ceiling fan in the sample, rounded to the nearest inch.

3.1. General instructions.

3.1.1. Record measurements at the resolution of the test instrumentation. Round off calculations to the number of significant digits present at the resolution of the test instrumentation, except for blade span, which is rounded to the nearest inch. Round the final ceiling fan efficiency value to the nearest whole number as follows:

3.1.1.1. A fractional number at or above the midpoint between the two consecutive whole numbers shall be rounded up to the higher of the two whole numbers; or

3.1.1.2. A fractional number below the midpoint between the two consecutive whole numbers shall be rounded down to the lower of the two whole numbers.

3.1.2. For multi-head ceiling fans, the effective blade span is the blade span (as specified in section 3) of an individual fan head, if all fan heads are the same size. If the fan heads are of varying sizes, the effective blade span is the blade span (as specified in section 3) of the largest fan head.

3.2. Test apparatus for low-speed small-diameter and high-speed small-diameter ceiling fans: All instruments are to have accuracies within ±1% of reading, except for the air velocity sensors, which must have accuracies within ±5% of reading or 2 feet per minute (fpm), whichever is greater. Equipment is to be calibrated at least once a year to compensate for variation over time.

3.2.1. *Air Delivery Room Requirements*

(1) The air delivery room dimensions are to be 20 ± 0.75 feet x 20 ± 0.75 feet with an 11 ± 0.75 foot-high ceiling. The control room shall be constructed external to the air delivery room.

(2) The ceiling shall be constructed of sheet rock or stainless plate. The walls must be of adequate thickness to maintain the specified temperature and humidity during the test. The paint used on the walls, as well as the paint used on the ceiling material, must be of a type that minimizes absorption of humidity and that keeps the temperature of the room constant during the test (*e.g.,* oil-based paint).

(3) The room must not have any ventilation other than an air conditioning and return system used to control the temperature and humidity of the room. The construction of the room must ensure consistent air circulation patterns within the room. Vents must have electronically-operated damper doors controllable from a switch outside of the testing room.

3.2.2. *Equipment Set-Up*

(1) Make sure the transformer power is off. Hang the ceiling fan to be tested directly from the ceiling, according to the manufacturer's installation instructions. Hang all non-multi-mount ceiling fans in the fan configuration that minimizes the distance between the ceiling and the lowest point of the fan blades. Hang and test multi-mount fans in two configurations: The configuration associated with the definitions of a standard fan that minimizes the distance between the ceiling and the lowest point of the fan blades and the configuration associated with the definition of a hugger fan that minimizes the distance between the ceiling and the lowest point of the fan blades.

(2) Connect wires as directed by manufacturer's wiring instructions. *Note:* Assemble fan prior to the test; lab personnel must follow the instructions provided with the fan by the fan manufacturer. Balance the fan blade assembly in accordance with the manufacturer's instructions to avoid excessive vibration of the motor assembly (at any speed) during operation.

(3) With the ceiling fan installed, adjust the height of the air velocity sensors to ensure the vertical distance between the lowest point on the ceiling fan blades and the air velocity sensors is 43 inches.

(4) Either a rotating sensor arm or four fixed sensor arms can be used to take airflow measurements along four axes, labeled A–D. Axes A, B, C, and D are at 0, 90, 180, and 270 degree positions. Axes A–D must be perpendicular to the four walls of the room. See Figure 1 of this appendix.

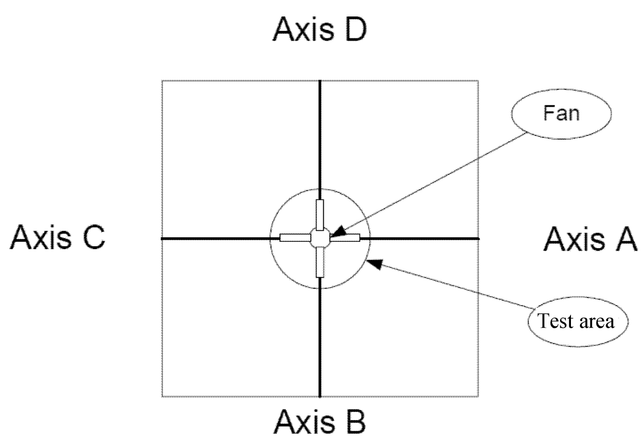

Figure 1 to Appendix U to Subpart B of Part 430: Testing Room and Sensor Arm Axes

(5) Minimize the amount of exposed wiring. Store all sensor lead wires under the floor, if possible.

(6) Place the sensors at intervals of 4 ± 0.0625 inches along a sensor arm, starting with the first sensor at the point where the four axes intersect. Do not touch the actual sensor prior to testing. Use enough sensors to record air delivery within a circle 8 inches larger in diameter than the blade span of the ceiling fan being tested. The experimental set-up is shown in Figure 2 of this appendix.

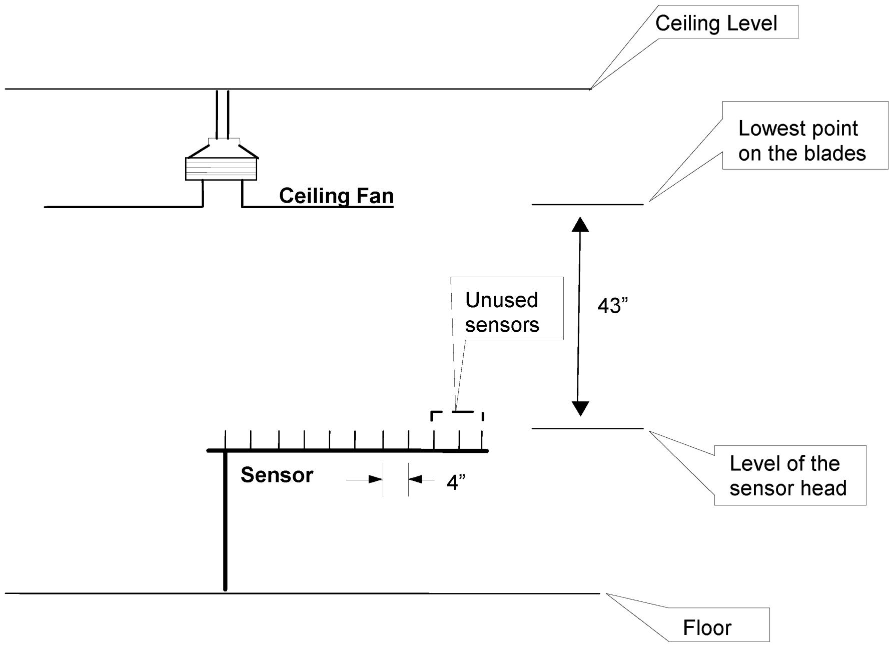

Figure 2 to Appendix U to Subpart B of Part 430: Air Delivery Room Set-Up for Small-Diameter Ceiling Fans

(7) Table 1 of this appendix shows the appropriate number of sensors needed per each of four axes (including the first sensor at the intersection of the axes) for common fan sizes.

TABLE 1 TO APPENDIX U TO SUBPART B OF PART 430: SENSOR SELECTION REQUIREMENTS

Fan blade span * (inches)	Number of sensors
36	6
42	7
44	7
48	7
52	8
54	8
56	8
60	9
72	10
84	12

* The fan sizes listed are illustrative and do not restrict which ceiling fan sizes can be tested.

(8) Install an RPM (revolutions per minute) meter, or tachometer, to measure RPM of the ceiling fan blades.

(9) Use an RMS sensor capable of measuring power with an accuracy of ±1% to measure ceiling fan power consumption. If the ceiling fan operates on multi-phase power input, measure the active (real) power in all phases simultaneously. Measure test voltage within 6'' of the connection supplied with the ceiling fan.

(10) Complete any conditioning instructions provided in the ceiling fan's instruction or installation manual must be completed prior to conducting testing.

3.2.3. *Multi-Head Ceiling Fan Test Set-Up*

Hang a multi-headed ceiling fan from the ceiling such that one of the ceiling fan heads is centered directly over sensor 1 (*i.e.,* at the intersection of axes A, B, C, and D). The distance between the lowest point any of the fan blades of the centered fan head can reach and the air velocity sensors is to be such that it is the same as for all other small-diameter ceiling fans (see Figure 2 of this appendix). If the multi-head ceiling fan has an oscillating function (*i.e.,* the fan heads change their axis of rotation relative to the ceiling) that can be switched off, switch it off prior to taking airflow measurements. If any multi-head fan does not come with the blades preinstalled, install fan blades only on the fan head that will be directly centered over the intersection of the sensor axes. (Even if the fan heads in a multi-head ceiling fan would typically oscillate when the blades are installed on all fan heads, the ceiling fan is subject to this test procedure if the centered fan head does not oscillate when it is the only fan head with the blades installed.) If the fan blades are preinstalled on all fan heads, measure airflow in accordance with section 3.3 except only turn on the centered fan head. Measure the power consumption measurements are to be made separately, with the fan blades installed on all fan heads and with any oscillating function, if present, switched on.

3.2.4. Test Set-Up for Ceiling Fans with Airflow Not Directly Downward

For ceiling fans where the airflow is not directly downward, adjust the ceiling fan head such that the airflow is as vertical as possible prior to testing. For ceiling fans where a fully vertical orientation of airflow cannot be achieved, orient the ceiling fan (or fan head, if the ceiling fan is a multi-head fan) such that any remaining tilt is aligned along one of the four sensor axes. Instead of measuring the air velocity for only those sensors directly beneath the ceiling fan, the air velocity is to be measured at all sensors along that axis, as well as the axis oriented 180 degrees with respect to that axis. For example, if the tilt is oriented along axis A, air velocity measurements are to be taken for all sensors along the A–C axis. No measurements would need to be taken along the B–D axis in this case. All other aspects of test set-up remain unchanged from sections 3 through 3.2.2.

3.3. Active mode test measurement for low-speed small-diameter and high-speed small-diameter ceiling fans.

3.3.1. *Test conditions to be followed when testing:*

(1) Maintain the room temperature at 70 degrees ± 5 degrees Fahrenheit and the room humidity at 50% ± 5% relative humidity during the entire test process.

(2) If present, the ceiling fan light fixture is to be installed but turned off during testing.

(3) If present, any heater is to be installed but turned off during testing.

(4) If present, turn off any oscillating function causing the axis of rotation of the fan head(s) to change relative to the ceiling during operation prior to taking airflow measurements. Turn on any oscillating function prior to taking power measurements.

(5) The supply voltage shall be:

(i) 120 V if the ceiling fan's minimum rated voltage is 120 V or the lowest rated voltage range contains 120 V,

(ii) 240 V if the ceiling fan's minimum rated voltage is 240 V or the lowest rated voltage range contains 240 V, or

(iii) The ceiling fan's minimum rated voltage (if a voltage range is not given) or the mean of the lowest rated voltage range, in all other cases. The test voltage shall not vary by more than ±1% during the tests.

(6) Test ceiling fans rated for operation with only a single- or multi-phase power supply with single- or multi-phase electricity, respectively. Measure active (real) power in all phases continuously when testing. Test ceiling fans capable of operating with single- and multi-phase electricity with single-phase electricity. DOE will allow manufacturers of ceiling fans capable of operating with single- and multi-phase electricity to test such fans with multi-phase power and make representations of efficiency associated with both single and multi-phase electricity if a manufacturer desires to do so, but the test results in the multi-phase configuration will not be valid to assess compliance with any amended energy conservation standard.

(7) Conduct the test with the fan connected to a supply circuit at the rated frequency.

(8) Measure power input at a point that includes all power-consuming components of the ceiling fan (but without any attached light kit or heater energized).

3.3.2. *Airflow and Power Consumption Testing Procedure:*

Measure the airflow (CFM) and power consumption (W) for HSSD ceiling fans until stable measurements are achieved, measuring at high speed only. Measure the airflow and power consumption for LSSD ceiling fans until stable measurements are achieved, measuring first at low speed and then at high speed. Airflow and power consumption measurements are considered stable if:

(1) The average air velocity for all axes for each sensor varies by less than 5% compared to the average air velocity measured for that same sensor in a successive set of air velocity measurements, and

(2) Average power consumption varies by less than 1% in a successive set of power consumption measurements. These stability criteria are applied differently to ceiling fans with airflow not directly downward. See section 4.1.2 of this appendix.

Step 1: Set the first sensor arm (if using four fixed arms) or single sensor arm (if using a single rotating arm) to the 0 degree Position (Axis A). If necessary, use a marking as reference. If using a single rotating arm, adjust the sensor arm alignment until it is at the 0 degree position by remotely controlling the antenna rotator.

Step 2: Set software up to read and record air velocity, expressed in feet per minute (FPM) in 1 second intervals. (Temperature does not need to be recorded in 1 second intervals.) Record current barometric pressure.

Step 3: Allow test fan to run 15 minutes at rated voltage and at high speed if the ceiling fan is an HSSD ceiling fan. If the ceiling fan is an LSSD ceiling fan, allow the test fan to run 15 minutes at the rated voltage and at low speed. Turn off all forced-air environmental conditioning equipment entering the chamber (*e.g.,* air conditioning), close all doors and vents, and wait an additional 3 minutes prior to starting test session.

Step 4: Begin recording readings. Take 100 airflow velocity readings (100 seconds run-time) and save these data. If using a rotating sensor arm, this is axis A. For all fans except multi-head fans and fans capable of oscillating, measure power during the interval that air velocity measurements are taken. Record the average value of the power measurement in watts (W).

Step 5: Similarly, take 100 air velocity readings (100 seconds run-time) for Axes B, C, and D; save these data as well. Measure power as described in Step 4. If using four fixed sensor arms, take the readings for all sensor arms simultaneously.

Step 6: Repeat Steps 4 and 5 until stable measurements are achieved.

Step 7: Repeat steps 1 through 6 above on high fan speed for LSSD ceiling fans. Note: Ensure that temperature and humidity readings are maintained within the required tolerances for the duration of the test (all tested speeds). Forced-air environmental conditioning equipment may be used and doors and vents may be opened between test sessions to maintain environmental conditions.

Step 8: If testing a multi-mount ceiling fan, repeat steps 1 through 7 with the ceiling fan in the ceiling fan configuration (associated with either hugger or standard ceiling fans) not already tested.

If a multi-head ceiling fan includes more than one category of ceiling fan head, then test at least one of each unique category. A fan head with different construction that could affect air movement or power consumption, such as housing, blade pitch, or motor, would constitute a different category of fan head.

Step 9: For multi-head ceiling fans, measure active (real) power consumption in all phases simultaneously at each speed continuously for 100 seconds with all fan heads turned on, and record the average value at each speed in watts (W).

For ceiling fans with an oscillating function, measure active (real) power consumption in all phases simultaneously at each speed continuously for 100 seconds with the oscillating function turned on. Record the average value of the power measurement in watts (W).

For both multi-head ceiling fans and fans with an oscillating function, repeat power consumption measurement until stable power measurements are achieved.

3.4. Test apparatus for large-diameter ceiling fans:

The test apparatus and instructions for testing large-diameter ceiling fans must conform to the requirements specified in sections 3 through 7 of AMCA 230–15 (incorporated by reference, see § 430.3), with the following modifications:

3.4.1. The test procedure is applicable to large-diameter ceiling fans up to 24 feet in diameter.

3.4.2. A ''ceiling fan'' is defined as in 10 CFR 430.2.

3.4.3. The supply voltage shall be (1) 120 V if the ceiling fan's minimum rated voltage is 120 V or the lowest rated voltage range contains 120 V, (2) 240 V if the ceiling fan's minimum rated voltage is 240 V or the lowest rated voltage range contains 240 V, or (3) the ceiling fan's minimum rated voltage (if a voltage range is not given) or the mean of the lowest rated voltage range, in all other cases.

3.4.4. Test ceiling fans rated for operation with only a single- or multi-phase power supply with single- or multi-phase electricity, respectively. Test ceiling fans capable of operating with single- and multi-phase electricity with multi-phase electricity. DOE will allow manufacturers of ceiling fans capable of operating with single- and multi-phase electricity to test such fans with single-phase power and make representations of efficiency associated with both single and multi-phase electricity if a manufacturer desires to do so, but the test results in the single-phase configuration will not be valid to assess compliance with any amended energy conservation standard.

3.5. Active mode test measurement for large-diameter ceiling fans:

(1) Calculate the airflow (CFM) and measure the active (real) power consumption (W) in all phases simultaneously for ceiling fans at the speeds specified in Table 2.

TABLE 2 TO APPENDIX U TO SUBPART B OF PART 430—SPEEDS TO BE TESTED FOR LARGE-DIAMETER CEILING FANS

Available speeds	Number of speeds to test	Which speeds to test	Efficiency metric weighting for each speed ** (%)
1	All	All	100
2	All	All	50
3	All	All	33
4	All	All	25
5	All	All	20
6+ (discrete)	5	5 fastest speeds	20

TABLE 2 TO APPENDIX U TO SUBPART B OF PART 430—SPEEDS TO BE TESTED FOR LARGE-DIAMETER CEILING FANS—Continued

Available speeds	Number of speeds to test	Which speeds to test	Efficiency metric weighting for each speed ** (%)
Infinite (continuous) *	5	High speed 80% speed 60% speed 40% speed 20% speed	20

* This corresponds to a ceiling fan, such as a ceiling fan with a variable-frequency drive (VFD) that operates over a continuous (rather than discrete) range of speeds.

** All tested speeds are to be weighted equally. Therefore, the weighting shown here for a ceiling fan with three available speeds is approximate.

(2) When testing at speeds other than high speed (*i.e.,* X% speed where X is 80, 60, 40, or 20) for ceiling fans that can operate over an infinite number of speeds (*e.g.,* ceiling fans with VFDs), ensure the average measured RPM is within the greater of 1% of the average RPM at high speed or 1 RPM. For example, if the average measured RPM at high speed is 50 RPM, for testing at 80% speed the average measured RPM should be between 39 RPM and 41 RPM. If the average measured RPM falls outside of this tolerance, adjust the ceiling fan speed and repeat the test. Calculate the airflow and measure the active (real) power consumption in all phases simultaneously in accordance with the test requirements specified in sections 8 and 9, AMCA 230–15 (incorporated by reference, see § 430.3), with the following modifications:

3.5.1. Measure active (real) power consumption in all phases simultaneously at a point that includes all power-consuming components of the ceiling fan (but without any attached light kit or heater energized).

3.5.2. Measure active (real) power consumption in all phases simultaneously continuously at the rated voltage that represents normal operation over the time period for which the load differential test is conducted.

3.6. Test measurement for standby power consumption.

(1) Measure standby power consumption if the ceiling fan offers one or more of the following user-oriented or protective functions:

□□o The ability to facilitate the activation or deactivation of other functions (including active mode) by remote switch (including remote control), internal sensor, or timer.

□ Continuous functions, including information or status displays (including clocks), or sensor-based functions.

(2) Measure standby power consumption after completion of active mode testing and after the active mode functionality has been switched off (*i.e.,* the rotation of the ceiling fan blades is no longer energized). The ceiling fan must remain connected to the main power supply and be in the same configuration as in active mode (*i.e.,* any ceiling fan light fixture should still be attached). Measure standby power consumption according to sections 4 and 5.3.1 through 5.3.2 of IEC 62301–U (incorporated by reference, see § 430.3) with the following modifications:

3.6.1. Allow 3 minutes between switching off active mode functionality and beginning the standby power test. (No additional time before measurement is required.)

3.6.2. Simultaneously in all phases, measure active (real) power consumption continuously for 100 seconds, and record the average value of the standby power measurement in watts (W).

3.6.3. Determine power consumption according to section 5.3.2 of IEC 62301–U, or by using the following average reading method. Note that a shorter measurement period may be possible using the sample method in section 5.3.2 of IEC 62301–U.

(1) Connect the product to the power supply and power measuring instrument.

(2) Select the mode to be measured (which may require a sequence of operations and could require waiting for the product to automatically enter the desired mode) and then monitor the power.

(3) Calculate the average power using either the average power method or the accumulated energy method. For the average power method, where the power measuring instrument can record true average power over an operator selected period, the average power is taken directly from the power measuring instrument. For the accumulated energy method, determine the average power by dividing the measured energy by the time for the monitoring period. Use units of watt-hours and hours for both methods to determine average power in watts.

4. Calculation of Ceiling Fan Efficiency From the Test Results:

(1) The efficacy of a ceiling fan is the *ceiling fan efficiency* (as defined in section 1 of this appendix). Calculate two ceiling fan efficiencies for multi-mount ceiling fans: One efficiency corresponds to the ceiling fan mounted in the configuration associated with the definition of a hugger ceiling fan, and the other efficiency corresponds to the ceiling fan mounted in the configuration associated with the definition of a standard ceiling fan.

(2) Calculate fan efficiency using the average of both sets of airflow and power measurements from the successive sets of measurements that meet the stability criteria.

(3) To calculate the measured airflow for HSSD and LSSD ceiling fans, multiply the average air velocity measurement at each sensor from section 3.3 of this appendix (for high speed for HSSD ceiling fans, and for high and low speeds for LSSD ceiling fans) with the sensor's effective area (explained below), and then sum the products to obtain the overall measured airflow at the tested speed. Using the airflow and the power consumption measurements from sections 3.3 and 3.5 of this appendix (for all tested settings for large-diameter ceiling fans) calculate the efficiency for any ceiling fan as follows:

$$\textit{Ceiling Fan Efficiency}\ (CFM/W) = \frac{\sum_i (CFM_i \times OH_i)}{W_{Sb} \times OH_{Sb} + \sum_i (W_i \times OH_i)} \qquad \textbf{Eq. 1}$$

Where:

CFM_i = airflow at speed *i,*

OH_i = operating hours at speed *i,*

W_i = power consumption at speed *i,*

OH_{Sb} = operating hours in standby mode, and

W_{Sb} = power consumption in standby mode.

(4) Table 3 of this appendix specifies the daily hours of operation to be used in calculating ceiling fan efficiency:

TABLE 3 TO APPENDIX U TO SUBPART B OF PART 430—DAILY OPERATING HOURS FOR CALCULATING CEILING FAN EFFICIENCY

	No standby	With standby
Daily Operating Hours for LSSD Ceiling Fans		
High Speed	3.4	3.4
Low Speed	3.0	3.0
Standby Mode	0.0	17.6
Off Mode	17.6	0.0
Daily Operating Hours for HSSD Ceiling Fans		
High Speed	12.0	12.0
Standby Mode	0.0	12.0
Off Mode	12.0	0.0
Daily Operating Hours for Large-Diameter Ceiling Fans		
Active Mode *	12.0	12.0
Standby Mode	0.0	12.0
Off Mode	12.0	0.0

* The active mode hours must be apportioned equally across the number of active mode speeds tested (*e.g.,* if four speeds are tested, 25% of the active mode hours are apportioned to each speed).

(5) Calculate the effective area corresponding to each sensor used in the test method for small-diameter ceiling fans with the following equations:

(6) For sensor 1, the sensor located directly underneath the center of the ceiling fan, the effective width of the circle is 2 inches, and the effective area is:

$$Effective\ Area\ (sq.ft.) = \pi\left(\frac{2}{12}\right)^2 = 0.0873 \qquad \text{Eq. 2}$$

(7) For the sensors between sensor 1 and the last sensor used in the measurement, the effective area has a width of 4 inches. If a sensor is a distance *d,* in inches, from sensor 1, then the effective area is:

$$Effective\ Area\ (sq.ft.) = \pi\left(\frac{d+2}{12}\right)^2 - \pi\left(\frac{d-2}{12}\right)^2 \qquad \text{Eq. 3}$$

(8) For the last sensor, the width of the effective area depends on the horizontal displacement between the last sensor and the point on the ceiling fan blades furthest radially from the center of the fan. The total area included in an airflow calculation is the area of a circle 8 inches larger in diameter than the ceiling fan blade span (as specified in section 3 of this appendix).

(9) Therefore, for example, for a 42-inch ceiling fan, the last sensor is 3 inches beyond the end of the ceiling fan blades. Because only the area within 4 inches of the end of the ceiling fan blades is included in the airflow calculation, the effective width of the circle corresponding to the last sensor would be 3 inches. The calculation for the effective area corresponding to the last sensor would then be:

$$Effective\ Area\ (sq.ft.) = \pi\left(\frac{d+1}{12}\right)^2 - \pi\left(\frac{d-2}{12}\right)^2 = \pi\left(\frac{24+1}{12}\right)^2 - \pi\left(\frac{24-2}{12}\right)^2 = 3.076 \qquad \text{Eq. 4}$$

(10) For a 46-inch ceiling fan, the effective area of the last sensor would have a width of 5 inches, and the effective area would be:

$$Effective\ Area\ (sq.ft.) = \pi\left(\frac{d+3}{12}\right)^2 - \pi\left(\frac{d-2}{12}\right)^2 = \pi\left(\frac{24+3}{12}\right)^2 - \pi\left(\frac{24-2}{12}\right)^2 = 5.345 \qquad \text{Eq. 5}$$

4.1.1. *Ceiling fan efficiency calculations for multi-head ceiling fans*

To determine the airflow at a given speed for a multi-head ceiling fan, sum the measured airflow for each fan head included in the ceiling fan (a single airflow measurement can be applied to identical fan heads, but at least one of each unique fan head must be tested). The power consumption is the measured power consumption with all fan heads on. Using the airflow and power consumption measurements from section 3.3 of this appendix, calculate ceiling fan efficiency for a multi-head ceiling fan as follows:

$$Ceiling\ Fan\ Efficiency\ (CFM/W) = \frac{\sum_i (CFM_i \times OH_i)}{W_{Sb} \times OH_{Sb} + \sum_i (W_i \times OH_i)} \qquad \textbf{Eq. 6}$$

Where:

CFM_i = sum of airflow at a given speed for each head,

OH_i = operating hours at a given speed,

W_i = total power consumption at a given speed,

OH_{Sb} = operating hours in standby mode, and

W_{Sb} = power consumption in standby mode.

4.1.2. *Ceiling fan efficiency calculations for ceiling fans with airflow not directly downward*

Using a set of sensors that cover the same diameter as if the airflow were directly downward, the airflow at each speed should be calculated based on the continuous set of sensors with the largest air velocity measurements. This continuous set of sensors must be along the axis that the ceiling fan tilt is directed in (and along the axis that is 180 degrees from the first axis). For example, a 42-inch fan tilted toward axis A may create the pattern of air velocity shown in Figure 3 of this appendix. As shown in Table 1 of this appendix, a 42-inch fan would normally require 7 active sensors. However because the fan is not directed downward, all sensors must record data. In this case, because the set of sensors corresponding to maximum air velocity are centered 3 sensor positions away from the sensor 1 along the A axis, substitute the air velocity at A axis sensor 4 for the average air velocity at sensor 1. Take the average of the air velocity at A axis sensors 3 and 5 as a substitute for the average air velocity at sensor 2, take the average of the air velocity at A axis sensors 2 and 6 as a substitute for the average air velocity at sensor 3, etc. Lastly, take the average of the air velocities at A axis sensor 10 and C axis sensor 4 as a substitute for the average air velocity at sensor 7. Stability criteria apply after these substitutions. For example, air velocity stability at sensor 7 are determined based on the average of average air velocity at A axis sensor 10 and C axis sensor 4 in successive measurements. Any air velocity measurements made along the B–D axis are not included in the calculation of average air velocity.

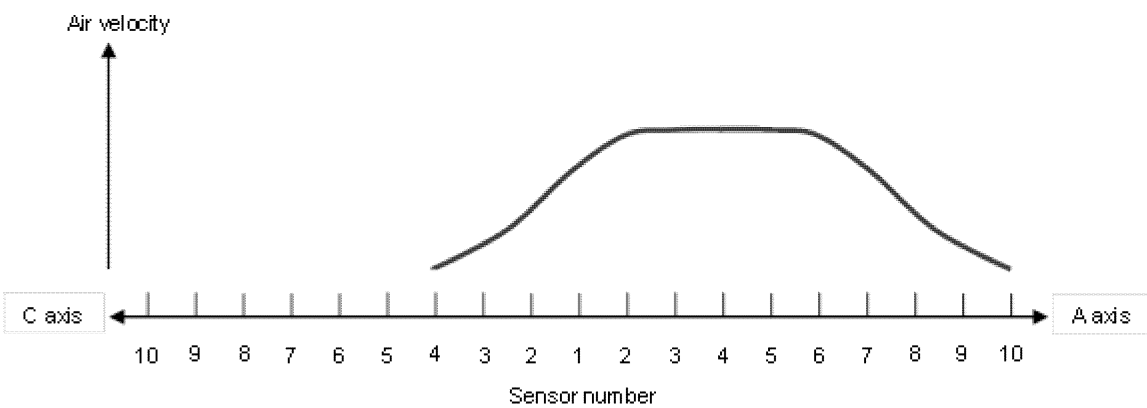

Figure 3 to Appendix U to Subpart B of Part 430: Example Air Velocity Pattern for Airflow Not Directly Downward

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