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10 CFR Part 431
Energy Conservation Program: Test Procedures for Electric Motors;
Final Rule

DEPARTMENT OF ENERGY

10 CFR Part 431

[Docket No. EERE–2012–BT–TP–0043]

RIN 1904–AC89

Energy Conservation Program: Test Procedures for Electric Motors

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

ACTION: Final rule.

SUMMARY: The U.S. Department of Energy (DOE) is amending the energy efficiency test procedures for electric motors to allow currently unregulated motors to be tested by clarifying the test setup requirements that are needed to facilitate testing of these types of electric motors. In addition, DOE is adopting definitions, which will determine the applicability of DOE's regulations to various types of electric motors. The amendments would clarify the scope of coverage for electric motors and not otherwise affect the test procedure.

DATES: The effective date of this rule is January 13, 2014.

The incorporation by reference of certain publications listed in this rule is approved by the Director of the Federal Register on January 13, 2014. The incorporation by reference of other publications listed in this rule were approved by the Director of the Federal Register on May 4, 2012.

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 *www.regulations.gov*. All documents in the docket are listed in the *www.regulations.gov* index. However, some documents listed in the index, such as those containing information that is exempt from public disclosure, may not be publicly available.

A link to the docket Web page can be found at: *http://www1.eere.energy.gov/buildings/appliance_standards/rulemaking.aspx/ruleid/74*. This Web page will contain a link to the docket for this notice on the regulations.gov site. The regulations.gov Web page will contain simple instructions on how to access all documents, including public comments, in the docket.

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

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SUPPLEMENTARY INFORMATION: This final rule incorporates by reference into subpart B of 10 CFR part 431, the following industry standards:

NEMA Standards Publication MG 1–2009 (''NEMA MG 1–2009''), Motors and Generators, 2009, Paragraphs 12.62 and 12.63.

Copies of NEMA MG 1–2009 can be obtained from the National Electrical Manufacturers Association, 1300 17th St. N., Suite 900, Arlington, VA 22209, (703) 841–3200, or *http://www.nema.org*.

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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'') sets forth a variety of provisions designed to improve energy efficiency. (All references to EPCA refer to the statute as amended through the American Energy Manufacturing Technical Corrections Act (AEMTCA), Public Law 112–210 (December 18, 2012)). Part C of title III, which for editorial reasons was redesignated as Part A–1 upon incorporation into the U.S. Code, establishes an energy conservation program for certain industrial equipment, which includes electric motors, the subject of today's notice. (42 U.S.C. 6311(1)(A), 6313(b)).

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 the Department of Energy (DOE) that their products comply with the applicable energy conservation standards adopted under EPCA, and (2) making representations about the energy or water consumption of those products. Similarly, DOE must use these test procedures when testing products to determine whether they comply with the applicable standards promulgated pursuant to EPCA.

In the Energy Policy Act of 1992, Public Law 102–486 (October 24, 1992)

(EPACT 1992), Congress amended EPCA to establish energy conservation standards, test procedures, compliance certification, and labeling requirements for certain electric motors. (When used in context, the term ''motor'' refers to ''electric motor'' in this document.) On October 5, 1999, DOE published a final rule to implement these requirements. 64 FR 54114. In 2007, section 313 of the Energy Independence and Security Act (EISA 2007) amended EPCA by: (1) Striking the definition of ''electric motor,'' (2) setting forth definitions for ''general purpose electric motor (subtype I)'' and ''general purpose electric motor (subtype II),'' and (3) prescribing energy conservation standards for ''general purpose electric motors (subtype I),'' ''general purpose electric motors (subtype II), ''fire pump electric motors,'' and ''NEMA Design B general purpose electric motors'' with a power rating of more than 200 horsepower but not greater than 500 horsepower. See 42 U.S.C. 6311(13) and 6313(b)). Consequently, on March 23, 2009, DOE updated the corresponding regulations at 10 CFR part 431 consistent with these changes. 74 FR 12058. On December 22, 2008, DOE proposed to update the test procedures under Title 10 of the Code of Federal Regulations, part 431 (10 CFR part 431) for both electric motors and small electric motors. 73 FR 78220. After considering comments from interested parties, DOE finalized key provisions related to small electric motor testing in a 2009 final rule (see 74 FR 32059 (July 7, 2009)) and further updated the test procedures for electric motors and small electric motors. See 77 FR 26608 (May 4, 2012).

On June 26, 2013, DOE published a notice of proposed rulemaking (NOPR) focused on electric motors that proposed adding certain definitions along with specific testing set-up instructions and clarifications to the current test procedures under subpart B of 10 CFR part 431 that would address a wider variety of electric motor categories (or types) than what DOE currently regulates. 78 FR 38456. DOE proposed these amendments because the additional testing set-up instructions and clarifications were designed to permit manufacturers of these ''unregulated'' motors to test these motors using one of the prescribed test methods listed in 10 CFR part 431. The addition of these set-up instructions will more readily enable a manufacturer to consistently measure the losses and determine the efficiency of a wider variety of motor categories than what is regulated under the current energy conservation standards laid out in 10 CFR 431.25.[1] Related to today's rulemaking, DOE is also considering prescribing standards for some electric motor categories addressed in this notice through a parallel energy conservation standards-related activity. See 78 FR 73590 (Dec. 6, 2013). See also 76 FR 17577 (March 30, 2011) (detailing DOE's request for information regarding electric motor coverage) and 77 FR 43015 (July 23, 2012) (announcing DOE's preliminary analysis for potential standards related to electric motors).

By way of background, DOE notes that section 343(a)(5)(A) of EPCA, 42 U.S.C. 6314(a)(5)(A), initially required that the test procedures to determine electric motor efficiency shall be those procedures specified in two documents: National Electrical Manufacturers Association (NEMA) Standards Publication MG 1–1987 [2] and Institute of Electrical and Electronics Engineers (IEEE) Standard 112 (Test Method B) for motor efficiency, as in effect on the date of enactment of EPACT 1992. Section 343(a)(5)(B)–(C) of EPCA, 42 U.S.C. 6314(a)(5)(B)–(C), provides in part that if the NEMA- and IEEE-developed test procedures are amended, the Secretary of Energy (the Secretary) shall so amend the test procedures under 10 CFR part 431, unless the Secretary determines, by rule, that the amended industry procedures would not meet the requirements for test procedures to produce results that reflect energy efficiency, energy use, and estimated operating costs of the tested motor, or would be unduly burdensome to conduct. (42 U.S.C. 6314(a)(2)–(3), (a)(5)(B)) DOE has updated 10 CFR part 431 consistent with this requirement as newer versions of the NEMA and IEEE test procedures for electric motors were published and used by industry. See, e.g. 64 FR 54114 (October 5, 1999) (reflecting changes introduced by MG 1–1993 and IEEE Standard 112–1996). DOE also added Canadian Standards Association (CSA) CAN/CSA C390–93, ''Energy Efficiency Test Methods for Three-Phase Induction Motors'' as an equivalent and acceptable test method, which aligns with industry practices. Id.

Further, on May 4, 2012, DOE incorporated by reference the updated versions of NEMA MG 1–2009, IEEE 112–2004, and CAN/CSA C390–10. 77 FR 26608, 26638 (the ''2012 final test procedure''). DOE made the updates to ensure consistency between 10 CFR part 431 and current industry procedures and related practices. Since publication of the 2012 final test procedure, NEMA Standards Publication MG 1 has been updated to MG 1–2011. The updates, however, did not affect the sections that DOE had proposed to incorporate by reference from MG 1–2009 and, subsequently, declines to adopt MG 1–2011.

II. Summary of the Final Rule

In this final rule, DOE:

(1) Defines a variety of electric motor configurations (i.e., types) that are currently regulated under 10 CFR 431.25, but are not currently defined under 10 CFR part 431.12;

(2) Defines a variety of electric motor configurations (i.e., types) that are not currently regulated under 10 CFR 431.25 and are not currently defined under 10 CFR 431.12; and

(3) Clarifies the necessary testing ''set-up'' procedures to facilitate the testing of certain motor types that are not currently regulated for energy efficiency by DOE.

This final rule was precipitated by DOE's ongoing electric motors standards rulemaking. DOE published its ''Framework Document for Commercial and Industrial Electric Motors'' (the ''2010 framework document'') (75 FR 59657) on September 28, 2010. Public comments filed in response urged DOE to consider regulating the efficiency of certain definite and special purpose motors. DOE, in turn, published an Request for Information (RFI) seeking information regarding definite and special purpose motors (the ''March 2011 RFI''). See 76 FR 17577 (March 30, 2011). In its December 6, 2013 energy conservation standards NOPR, DOE proposed expanding the scope of its regulatory program to include all continuous duty, single speed, squirrel-cage, polyphase alternating-current, induction motors, with some narrowly defined exceptions. See 78 FR 73589. Today's final rule addresses test procedure issues potentially arising from the proposed scope of DOE's energy efficiency requirements to include certain motor types that are not currently required to meet energy conservation standards. In particular,

[1] EPCA, as amended by EPACT 1992, had previously defined an ''electric motor'' as any motor which is a general purpose T-frame, single-speed, foot-mounting, polyphase squirrel-cage induction motor of the National Electrical Manufacturers Association, Design A and B, continuous rated, operating on 230/460 volts and constant 60 Hertz line power as defined in NEMA Standards Publication MG1–1987. (42 U.S.C. 6311(13)(A) (1992)) Through subsequent amendments to EPCA made by EISA 2007, Congress removed this definition and added language denoting two new subtypes of general purpose electric motors. (See 42 U.S.C. 6311(13)(A)–(B) (2012)).

[2] NEMA MG1 does not contain the actual methods and calculations needed to perform an energy efficiency test but, rather, refers the reader to the proper industry methodologies in IEEE Standard 112 and CSA C390–10.

today's final rule includes, among other things, definitions for those motor types that DOE may consider regulating. DOE has coordinated today's test procedure final rule with its parallel efforts to examine proposed energy conservation standards for electric motors. To the extent possible, DOE has considered all relevant comments pertaining to these activities.[3]

In addition to including new definitions, today's final rule adds set-up procedures for the applicable test procedures contained in appendix B to subpart B of 10 CFR part 431, to accommodate certain electric motors that DOE has proposed to regulate. Because the amendments are limited to those steps necessary to facilitate testing under the currently incorporated test procedures found at 10 CFR 431.16, DOE does not anticipate that this rule would affect the actual measurement of losses and the subsequent determination of efficiency for any of the electric motors within the scope of the conservation standards rulemaking.

The revisions are summarized in the table below and addressed in detail in the following sections. Note that all citations to various sections of 10 CFR part 431 throughout this preamble refer to the current version of 10 CFR part 431. The regulatory text follows the preamble to this final rule.

TABLE II–1—SUMMARY OF CHANGES AND AFFECTED SECTIONS OF 10 CFR PART 431

Existing section in 10 CFR part 431	Summary of proposed modifications
Section 431.12—Definitions	• Adds new definitions for: ○ Air-over electric motor. ○ Brake electric motor. ○ Component set. ○ Electric motor with moisture resistant, sealed or encapsulated windings. ○ IEC Design H motor. ○ IEC Design N motor. ○ Immersible electric motor. ○ Inverter-capable electric motor. ○ Inverter-only electric motor. ○ Liquid-cooled electric motor. ○ NEMA Design A motor. ○ NEMA Design C motor. ○ Partial electric motor. ○ Submersible electric motor. ○ Totally enclosed non-ventilated (TENV) electric motor.
Appendix B to Subpart B—Uniform Test Method for Measuring Nominal Full Load Efficiency of Electric Motors.	• Updates test procedure set-up methods for: ○ Brake Electric motors. ○ Close-coupled pump electric motors and electric motors with single or double shaft extensions of non-standard dimensions or design. ○ Electric motors with non-standard endshields or flanges. ○ Electric motors with non-standard bases, feet or mounting configurations. ○ Electric motors with separately powered blowers. ○ Immersible electric motors. ○ Partial electric motors. ○ Vertical electric motors and electric motors with bearings incapable of horizontal operation.

DOE developed today's final rule after considering public input, including written comments, from a wide variety of interested parties. All commenters, along with their corresponding abbreviations and affiliation, are listed in Table II.2 below. The issues raised by these commenters are addressed in the discussions that follow.

TABLE II–2—SUMMARY OF FINAL RULE COMMENTERS

Company or organization	Abbreviation	Affiliation
Advanced Energy	AE	Testing Laboratory.
Appliance Standards Awareness Project	ASAP	Energy Efficiency Advocate.
American Council for an Energy-Efficient Economy	ACEEE	Energy Efficiency Advocate.
Alliance to Save Energy	ASE	Energy Efficiency Advocate.
Baldor Electric Co.	Baldor	Manufacturer.
Bluffton Motor Works	Bluffton	Manufacturer.
California Investor Owned Utilities	CA IOUs	Utilities.
Copper Development Association	CDA	Trade Association.
Motor Coalition *	MC	Energy Efficiency Advocates, Manufacturer Trade Association.
National Electrical Manufacturers Association	NEMA	Trade Association.
Natural Resource Defense Council	NRDC	Energy Efficiency Advocate.
Nidec Motor Corporation	Nidec	Manufacturer.
Northwest Energy Efficiency Alliance	NEEA	Energy Efficiency Advocate.
Regal Beloit	Regal Beloit	Manufacturer.
SEW–EURODRIVE, Inc.	SEWEUR	Manufacturer.
Siemens	Siemens	Manufacturer.

[3] See dockets at: *http://www.regulations.gov/#!docketDetail;D=EERE-2010-BT-STD-0027* and *http://www.regulations.gov/#!docketDetail;D=EERE-2012-BT-TP-0043.*

TABLE II–2—SUMMARY OF FINAL RULE COMMENTERS—Continued

Company or organization	Abbreviation	Affiliation
Underwriters Laboratories, Inc.	UL	Testing Laboratory.
WEG Electric Corp.	WEG	Manufacturer.

*The members of the Motor Coalition include: National Electrical Manufacturers Association, American Council for an Energy-Efficient Economy, Appliance Standards Awareness Project, Alliance to Save Energy, Earthjustice, Natural Resources Defense Council, Northwest Energy Efficiency Alliance, Northeast Energy Efficiency Partnerships, and Northwest Power and Conservation Council.

III. Discussion

A. Expanding the Scope of Coverage of Energy Conservation Standards

As noted in DOE's recent energy conservation standards rulemaking proposal, changes brought about by the Energy Independence and Security Act of 2007 (Pub. L. 110–140 (Dec. 19, 2007) and the American Energy Manufacturing Technical Corrections Act. Public Law 112–210, Sec. 10 (Dec. 18, 2012) have enabled the Agency to consider an expanded scope of motors for regulatory coverage. See 78 FR at 73603.

Based on its analysis of this discrete group of ''expanded-scope'' motors, DOE believes that the existing IEEE Standard 112 (Test Method B) and CSA C390–10 test procedures can be used to accurately measure their losses and determine their energy efficiency because all of the motor types under consideration are single-speed, polyphase induction motors with electromechanical characteristics similar to those currently subject to energy conservation standards. While some of these motor types require additional testing set-up instructions prior to testing, all can be tested using the same methodology provided in those industry-based procedures DOE has already incorporated into its regulations.

Testing an electric motor using IEEE Standard 112 (Test Method B) or CSA C390–10 requires some basic electrical connections and physical configurations. To test an electric motor under either procedure, the electric motor is first mounted on a test bench, generally in a horizontal position. In this orientation, this means that the motor shaft is horizontal to the test bench and the motor is equipped with antifriction bearings that can withstand operation while in a horizontal position.[4] Instruments are then connected to the power leads of the motor to measure input power, voltage, current, speed, torque, temperature, and other input, output, and performance characteristics. Thermocouples are attached to the motor to facilitate temperature measurement. Stator winding resistance is measured while the motor is at ambient, or room, temperature. No-load measurements are recorded while the motor is operating, both temperature and input power have stabilized, and the shaft extension is free from any attachments. After ambient temperature and no-load measurements are taken, a dynamometer is attached to the motor shaft to take ''loaded'' measurements. A dynamometer is a device that simultaneously applies and measures torque for a motor. The dynamometer applies incremental loads to the shaft, typically at 25, 50, 75, 100, 125, and 150 percent of the motor's total rated output horsepower. This allows the testing laboratory to record motor performance criteria, such as power output and torque, at each incremental load point. Additional stator winding resistance measurements are taken to record the temperature at the different load points.

In this final rule, DOE has added clarifying instructions it believes are necessary to test some of the expanded-scope motors should DOE decide at some point to set standards for these motors. Some motors will require modifications before they can operate continuously and be tested on a dynamometer in a manner consistent with the current DOE test procedure. For example, a partial electric motor may be engineered for use without one or both endshields, including bearings, because it relies on mechanical support from another piece of equipment. Without these components, the motor would be unable to operate as a stand-alone piece of equipment. To address this issue, DOE has added instructions to facilitate consistent and repeatable procedures for motors such as these. These additions are based on testing and research conducted by DOE along with technical consultations with subject matter experts (SMEs), manufacturers, testing laboratories, various trade associations, and comments from stakeholders in response to the June 2013 NOPR. Table III–7 lists those electric motors that are covered under current energy conservation standards or that DOE is analyzing for potential new energy conservation standards. In each case, the table identifies whether DOE is addressing a given motor through the use of new definitions, test procedure instructions, or both.

TABLE III–1—MOTOR TYPES CONSIDERED FOR REGULATION IN DOE PROPOSED STANDARDS RULEMAKING

Motor type	Currently subject to standards?	Under consideration for potential standards?	New definition established?	Additional set-up instructions established?
NEMA Design A Motors	Yes	Yes	Yes	No.
NEMA Design C Motors	Yes	Yes	Yes	No.
IEC Design N Motors	Yes	Yes	Yes	No.
IEC Design H Motors	Yes	Yes	Yes	No.
Electric Motors with Moisture-resistant, Sealed, or Encapsulated Windings.	No	Yes	Yes	No.
Inverter-Capable Electric Motors	Yes	Yes	Yes	No.
Totally Enclosed Non-Ventilated Electric Motors	No	Yes	Yes	No.
Immersible Electric Motors	No	Yes	Yes	Yes.
Electric Motors with Contact Seals	Yes	Yes	No	No.

[4] DOE is aware of some types of bearings that cannot operate while the motor is in a horizontal position. DOE addresses such bearings in later sections of this notice.

TABLE III–1—MOTOR TYPES CONSIDERED FOR REGULATION IN DOE PROPOSED STANDARDS RULEMAKING—Continued

Motor type	Currently subject to standards?	Under consideration for potential standards?	New definition established?	Additional set-up instructions established?
Brake Electric Motors	Yes[5]	Yes	Yes	Yes.
Partial Electric Motors	No	Yes	Yes	Yes.
Electric Motors with Non-Standard Endshields or Flanges	No	Yes	No	Yes.
Close-Coupled Pump Electric Motors	Yes	Yes	No	Yes.
Electric Motors with Special Shafts	No	Yes	No	Yes.
Vertical Solid Shaft Motors	Yes	Yes	No	Yes.
Vertical Hollow-Shaft Motors	No	Yes	No	Yes.
Electric Motors with Thrust Bearings	No	Yes	No	Yes.
Electric Motors with Sealed Bearings	Yes	Yes	No	Yes.
Electric Motors with Roller Bearings	No	Yes	No	Yes.
Electric Motors with Sleeve Bearings	Yes	Yes	No	Yes.
Electric Motors with Non-Standard Bases	No	Yes	No	No.
Air-Over Electric Motors	No	No	Yes	No.
Component Sets	No	No	Yes	No.
Liquid-cooled Electric Motors	No	No	Yes	No.
Submersible Electric Motors	No	No	Yes	No.
Inverter-Only Electric Motors	No	No	Yes	No.
Electric Motors with Separately Powered Blowers	No	Yes	No	Yes.

On the scope of coverage, the advocates commented that the NOPR shows that DOE takes the August 2012 Motor Coalition ''Joint Petition to Adopt Joint Stakeholder Proposal As it Relates to the Rulemaking on Energy Conservation Standards for Electric Motors'' (the ''Petition''),[6] seriously and contemplates proposing standards based on the Petition. (ASAP et al., No. 12 at p. 1) CDA strongly supported DOE's intention to expand the scope of covered electric motors described in the written Joint Petition and proposed in the NOPR. However, CDA urged DOE to consider including electric motors greater than 500 hp in the future standards rulemaking since they account for 27% of total power consumption in the U.S. (CDA, No. 9 at p. 3) Conversely, Regal Beloit suggested that the definitions and test procedures in this rulemaking be extended to include small electric motors. (Pub. Mtg. Tr., No. 7 at pp. 166–168).

DOE notes that its final rule simply provides a standardized means to test certain other types of electric motors that DOE does not currently regulate. The applicability of the proposed energy conservation standards was discussed in the NOPR and will be determined as part of that rulemaking. Any basic model of electric motors distributed in commerce that is subject to DOE's current or amended energy conservation standards will need to be tested in accordance with the test methods being adopted in this final rule. See the effective date discussion below regarding the timing requirements for representations and compliance.

B. Electric Motor Types for Which DOE Is Not Amending Existing Definitions

Prior to EISA 2007, section 340(13)(A) of EPCA, as amended, defined the term ''electric motor'' as any motor which is a general purpose T-frame, single-speed, foot-mounting, polyphase squirrel-cage induction motor of the National Electrical Manufacturers Association, Design A and B, continuous rated, operating on 230/460 volts and constant 60 Hertz line power as defined in NEMA Standards Publication MG 1–1987. (42 U.S.C. 6311(13) (2006)) EISA 2007, section 313(a)(2) struck out that definition, replacing it with an ''electric motor'' heading, and adding two subtypes of electric motors: General purpose electric motor (subtype I) and general purpose electric motor (subtype II). (42 U.S.C. 6311(13)). Additionally, section 313(b)(2) of EISA 2007 established energy conservation standards for four types of electric motors: General purpose electric motor (subtype I) with a power rating of 1 to 200 horsepower; fire pump motors[7]; general purpose electric motor (subtype II) with a power rating of 1 to 200 horsepower; and NEMA Design B, general purpose electric motors with a power rating of more than 200 horsepower, but less than or equal to 500 horsepower. (42 U.S.C. 6313(b)(2)) The term ''electric motor'' was left undefined at this point.

On May 4, 2012 DOE published a final rule test procedure for electric motors that further updated the definitional structure for electric motors. 77 FR 26608. DOE noted that while EISA 2007 struck the definition for electric motor, EPCA, as amended by EISA, continued to reference ''electric motors,'' causing confusion and ambiguity. As DOE has the statutory authority to regulate motors beyond the subtypes of motors for which Congress had established energy conservation standards in EISA 2007, DOE chose to define ''electric motor'' broadly, eliminating the process of having to continually update the definition each time the Department set energy conservation standards for a new subset of motors. The 2012 final test procedure defined ''electric motor'' as ''a machine that converts electrical power into rotational mechanical power.'' 77 FR 26633.

EISA 2007 also established definitions for ''general purpose electric motor (subtype I)'' and ''general purpose electric motor (subtype II).'' (42 U.S.C. 6311(13)) During the last test procedure rulemaking process, DOE made some clarifying changes to these definitions, noting that electric motors built according to International Electrotechnical Commission (IEC) standards and that otherwise meet the proposed definition of ''general purpose electric motor (subtype I),'' are covered

[5] Some motors (i.e., ''non-integral'') that fall under the new definition for ''brake electric motors'' are currently required to meet standards and others (i.e., ''integral'') are not.

[6] Motor Coalition, EERE–2010–BT–STD–0027–0035.

[7] For the most part, DOE understands that a fire pump electric motor is a NEMA Design B motor, except it does not have a thermal limit switch that would otherwise preclude multiple starts. In other words, a NEMA Design B electric motor has a thermal limit switch that protects the motor, whereas a fire pump electric motor does not have such a thermal limit switch to ensure that the motor will start and operate to pump water to extinguish a fire.

motors under EPCA, as amended by EISA 2007, even though the NEMA-equivalent frame size was discontinued. Outside of these small changes, the definitions for subtype I and subtype II motors have remained largely unchanged.

In the 2012 final test procedure, DOE also amended the definition of ''general purpose motor'' in 10 CFR part 431 by adding the word ''electric'' to clarify that a general purpose motor is a type of electric motor. 77 FR 26633.

In the June 2013 NOPR, DOE proposed a number of new definitions for types of motors that it is considering regulating in its concurrent standards rulemaking. While many of these motors are ''special purpose'' or ''definite purpose'' motors, DOE did not alter these definitions in its regulations. Furthermore, DOE did not update its definitions for ''electric motor,'' ''general purpose electric motor,'' ''general purpose electric motor (subtype I),'' or ''general purpose electric motor (subtype II).'' Rather, it laid out the nine criteria mentioned earlier in this rulemaking (i.e., single-speed, polyphase, etc.), that a motor must meet to be considered for coverage in DOE's concurrent standards rulemaking process, regardless of whether a given motor is special purpose, definite purpose, etc. 78 FR 38460.

DOE chose the definition structure that it chose because the now proposed standards rulemaking develops a coverage structure based on a motor meeting both the simple ''electric motors'' definition and the nine referenced criteria. Because the standards NOPR was under initial development at the time of the final test procedure development, DOE could not share this now proposed coverage structure. Therefore, many of NEMA's comments on electric motor definitions are made irrelevant by the recent standards NOPR. Nevertheless, NEMA's definitional concerns are listed here as they were provided as comments on the test procedure rulemaking.

In response to the NOPR, NEMA urged DOE to add clarity to the definition of ''electric motor'' and ''general purpose electric motor subtype I,'' and add new definitions for ''motor,'' ''definite purpose electric motor,'' and ''special purpose electric motor.'' NEMA pointed out that the term ''motor'' has not been defined in the NOPR. (Pub. Mtg. Tr., No. 7 at pp. 76–77). NEMA recommended defining ''motor'' as ''a machine that converts electrical power into rotational mechanical power.'' (NEMA, No. 10 at p. 7) Further, NEMA noted that the definition of ''electric motor'' needs to be clearer and more complete for regulatory purposes and suggested that the proposed definition of electric motor should include the nine characteristics describing construction and performance of the motor. (Pub. Mtg. Tr., No. 7 at pp. 15–22; Pub. Mtg. Tr., No. 7 at p. 76; NEMA, No. 10 at pp. 2,3,6,7) NEMA stated that if these characteristics are not included in the definition of ''electric motor'', then these would need to be included in the definitions of all electric motor types such as ''special purpose electric motor with moisture resistant windings,'' ''special purpose electric motor with encapsulated windings,'' and ''special purpose electric motor with sealed windings.'' (NEMA, No. 10 at p. 15). With that in mind, NEMA suggested that an electric motor be defined as a motor that:

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

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

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

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

(ii) Is built in an enclosed 56 NEMA frame size (or IEC metric equivalent);

(5) Has performance in accordance with NEMA Design A (MG 1) or B (MG 1) characteristics or equivalent designs such as IEC Design N (IEC); and

(6) Operates on polyphase alternating current 60-hertz sinusoidal power. (NEMA, No. 10 at pp. 2, 3, 6, 7)

NEMA recommended changing the definition of ''general purpose electric motor (subtype I)'' as a general purpose electric motor that:

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

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

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

(3) Includes, but is not limited to, explosion-proof construction.''(NEMA, No. 10 at p. 7)

DOE understands the intention of NEMA's proposal was to establish a definitional structure that would clearly delineate which motors were covered and which motors were excluded from coverage. By essentially using pulling the nine criteria DOE laid out in the June 2013 NOPR for the definition for ''electric motor,'' NEMA is proposing that any motor that falls under the definition of ''electric motor'' would be a covered motor. But following the approach suggested by NEMA would undercut the long-term stability that DOE had sought to provide when it developed a broad definition for the term ''electric motor'' by requiring DOE to continually update the definition each time DOE updates its scope of coverage. In addition, as is evident in the standards NOPR, the nine criteria that NEMA is suggesting for the ''electric motor'' definition are the same criteria that DOE proposes using to define the scope of coverage in its proposed standards rulemaking so, in effect, DOE's proposal has the same effect as NEMA's ''electric motor'' definition as far as defining broadly the motor types that DOE is considering for coverage (as well as those that are already covered.)

Retaining the definition for ''electric motor'' renders unnecessary NEMA's suggestion to add a definition for ''motor;'' this suggestion would simply reclassify what are currently defined as ''electric motors'' to be ''motors.''

NEMA's recommended that DOE retain the definitions for ''general purpose electric motor'' and ''general purpose electric motor (subtype II).'' DOE agrees that changes to these definitions are unnecessary and has made no changes to these definitions for the final rule.

NEMA recommended that the definition for ''general purpose electric motor (subtype I)'' be modified by removing clauses from that definition that would overlap with the criteria that DOE listed earlier in this rule,[8] and which NEMA proposed be added to the definition of ''electric motor.'' However, as DOE is choosing not to change the definition of ''electric motor'' at this time, DOE believes it is essential to leave these clauses in the definition for ''general purpose electric motor (subtype I)'' to fully define this type of motor. Therefore, DOE has elected to not update the definition for ''general purpose electric motor (subtype I)'' at this time.

NEMA also suggested editing the existing definitions of special and definite purpose motors. NEMA suggested that DOE define a ''definite purpose electric motor'' as any electric motor that:

(1) Is rated at 600 volts or less; and

(2) Cannot be used in most general purpose applications and is designed either:

(i) To standard ratings with standard operating characteristics or standard mechanical construction for use under

[8] E.g., single-speed, induction, continuous-duty, squirrel-cage rotor, etc.

service conditions other than usual, such as those specified in NEMA MG 1–2009, paragraph 14.3, ''Unusual Service Conditions,'' (incorporated by reference, see 431.15); or

(ii) For use on a particular type of application.'' (NEMA, No. 10 at p. 8)

NEMA suggested defining a ''special purpose electric motor'' as any electric motor, other than a general purpose electric motor or definite purpose electric motor, that:

(1) Is rated at 600 volts or less; and

(2) Has special operating characteristics or special mechanical construction, or both, designed for a particular application.'' (NEMA, No. 10 at p. 8)

DOE had opted not to update the definitions for ''special purpose motor'' and ''definite purpose motor'' in the NOPR because these definitions would apply broadly to cover a group of motors, irrespective of whether each motor category within that group is required to meet energy conservation standards. However, DOE does agree with NEMA that ''special purpose motors'' and ''definite purpose motors'' should be defined within the context of the broader term ''electric motors.'' In the 2012 final rule test procedure for electric motors DOE made a similar decision to update the term ''fire pump motor'' to ''fire pump electric motor.'' 77 FR 26616. For this final rule, DOE has therefore revised the terms ''special purpose motor'' and ''definite purpose motor'' to be ''special purpose electric motor'' and ''definite purpose electric motor''[9] while retaining the previously established definitions.

C. International Electrotechnical Commission IP and IC Codes

As discussed in section III.A.2, International Electrotechnical Commission (IEC), similar to NEMA, produces industry standards that contain performance requirements for electric motors. In the NOPR, DOE incorporated the term 'IEC motor equivalents' in the proposed definitions of NEMA-based electric motor types included in 10 CFR part 431 to ensure that IEC motors equivalents would be treated in a similar and consistent manner as NEMA-based electric motors.

In response to the NOPR, NEMA raised concerns that the IEC does not use the same identifiers as NEMA to characterize the motor types. Instead, IEC generally uses specific ''IP'' (protection provided by enclosure) and ''IC'' codes (method of cooling) to identify the motor types. Therefore, NEMA requested that DOE include appropriate IP and IC codes to properly include IEC-equivalent electric motors within the proposed definitions (NEMA, No. 10 at p. 9)

DOE will consider issuing separate guidance regarding these codes and their interplay with those motors built in accordance with NEMA specifications. As part of that process, the agency will afford the public with an opportunity to comment on any proposed guidance that the agency decides to issue.

D. Motor Type Definitions and Testing Set-Up Instructions

In the course of the 2012 final test procedure rulemaking, some interested parties questioned why DOE defined the term ''NEMA Design B motor'' but not ''NEMA Design A motor'' or ''NEMA Design C motor.'' DOE explained at the time that a definition for ''NEMA Design B motor'' was necessary because the application section in MG 1 (paragraph 1.19.1.2 in both MG 1–2009 and MG 1–2011) contained a typographical error that required correcting for purposes of DOE's regulations, which exactly implemented a standard for NEMA Design B motors that are general purpose electric motors with a power rating of more than 200 horsepower, but less than or equal to 500 horsepower. See 10 CFR 431.25(d). At that time, DOE also noted that it may incorporate a corrected version of the ''NEMA Design C motor'' definition in a future rulemaking because that definition, which is found in NEMA MG 1–2009, paragraph 1.19.1.3, also contains a typographical error. DOE did not, however, intend to add definitions for NEMA Design A and IEC Design N, as the existing definitions found in MG 1 are correct as published. 77 FR at 26616 and 26634 (May 4, 2012).

Given DOE's current intention to consider establishing energy conservation standards for an expanded scope of motors, however, DOE now believes it is necessary to clarify the terms and definitions pertaining to Design A and Design N motors as well. DOE understands that many terms and definitions applicable to motors are used in common industry parlance for voluntary standards and day-to-day business communication but are not necessarily defined with sufficient clarity for regulatory purposes. At this time, DOE is making changes designed to provide more precise definitions for these terms to sufficiently capture the particular characteristics attributable to each definition. Both DOE and manufacturers should use these definitions to determine whether a particular basic model is covered by DOE's regulations for electric motors. DOE notes, however, that the presence of a given definition in this document does not obligate DOE to establish energy conservation standards for the motor type defined.

1. National Electrical Manufacturers Association Design A and Design C Motors

NEMA MG 1–2009's definitions include the following three types of polyphase, alternating current, induction motors: NEMA Designs A, B, and C. NEMA MG 1–2009 establishes the same pull-up, breakdown, and locked-rotor torque requirements for both NEMA Design A and NEMA Design B motors.[10] However, a NEMA Design A motor must be designed such that its locked-rotor current exceeds the maximum locked-rotor current established for a NEMA Design B motor. Unless the application specifically requires the higher locked-rotor current capability offered by a NEMA Design A motor, a NEMA Design B motor (which has the same specified minimum torque characteristics as the NEMA Design A motor) is often used instead because of the additional convenience offered by these motors when compared to Design A motors. (See NEMA, EERE–2010–BT–STD–0027–0054 at 36 (noting the additional convenience offered by Design B motors over Design A motors with respect to selecting disconnecting methods and in satisfying National Electrical Code and UL requirements.)) In addition, DOE understands that NEMA Design B motors are frequently preferred because the user can easily select the motor control and protection

[9] In the recent standards NOPR, the special or definite purpose distinctions evaporate based on the proposed regulatory structure. Therefore, at some point in the future, DOE intends to remove these definitions from DOE regulations. DOE is retaining the definitions for now to help manufacturer's meet the current energy conservation standards and delineating between general purpose versus definite or special purpose electric motors.

[10] *Locked-rotor torque* is the torque that a motor produces when it is at rest or zero speed and initially turned on. A higher locked-rotor torque is important for hard-to-start applications, such as positive displacement pumps or compressors. A lower locked-rotor torque can be accepted in applications such as centrifugal fans or pumps where the start load is low or close to zero. *Pull-up torque* is the torque needed to cause a load to reach its full rated speed. If a motor's pull-up torque is less than that required by its application load, the motor will overheat and eventually stall. *Breakdown torque* is the maximum torque a motor can produce without abruptly losing motor speed. High breakdown torque is necessary for applications that may undergo frequent overloading, such as a conveyor belt. Often, conveyor belts have more product or materials placed upon them than their rating allows. High breakdown torque enables the conveyor to continue operating under these conditions without causing heat damage to the motor.

equipment that meets the applicable requirements of the National Fire Protection Association (NFPA) National Electrical Code (NFPA 70). These motors are also listed by private testing, safety, or certification organizations, such as CSA International or UL. (NEMA, EERE–2010–BT–STD–0027–0054 at p. 36)

Unlike NEMA Design A and B motors, a NEMA Design C motor requires a minimum locked-rotor torque per NEMA MG 1–2009, Table 12–3, which is higher than either the NEMA Design A or Design B minimum locked-rotor torque required per NEMA MG 1–2009, Table 12–2.

In view of the above, DOE proposed to incorporate a definition for both ''NEMA Design A motor'' and ''NEMA Design C motor'' to improve the clarity between these two terms. As DOE had already adopted a definition for ''NEMA Design B motor'' at 10 CFR 431.12, it believed that providing definitions for other motor types would provide consistency in the treatment of all considered motors. 78 FR 38462. The proposed definitions for NEMA Design A and Design C motors were based on the definitions in NEMA MG 1–2009, paragraphs 1.19.1.1 and 1.19.1.3, respectively. DOE proposed to define a ''NEMA Design A motor'' as ''a squirrel-cage motor designed to withstand full-voltage starting and that develops locked-rotor torque, pull-up torque, breakdown torque, and locked-rotor current as specified in NEMA MG 1–2009–and with a slip at rated load of less than 5 percent for motors with fewer than 10 poles.'' DOE also proposed to define a ''NEMA Design C motor'' as ''a squirrel-cage motor designed to withstand full-voltage starting and that develops locked-rotor torque for high-torque applications, pull-up torque, breakdown torque, and locked-rotor current as specified in NEMA MG 1–2009—and with a slip at rated load of less than 5 percent.''

NEMA requested that DOE modify its proposed definitions of NEMA Design A and Design C motors and urged that the definitions be consistent when referencing to the NEMA MG 1–2009 tables. (Pub. Mtg. Tr., No. 7 at p. 41, 44, 45) [11] NEMA acknowledged an error in the definition of NEMA Design C in NEMA MG 1–2009, paragraph 1.19.1.3 and suggested that the phrase ''up to the values'' in reference to the level of locked rotor torque and breakdown torque should be replaced with ''not less than the values'' because the limits in the referenced tables are the minimum values. NEMA suggested that the proper statements can be found in the actual standards in the referenced clauses of NEMA MG 1–2009 paragraph 12.37 and NEMA MG 1–2009 paragraph 12.39. (NEMA, No.10 at p. 13) WEG asserted that since DOE's procedure would apply only to 60 Hertz (Hz) motors, DOE should omit references to 50 Hz motors in the definitions. (Pub. Mtg. Tr., No. 7 at p. 43)

DOE has re-evaluated its proposed definitions for NEMA Design A motors and NEMA Design C motors after receiving the comments above. Regarding the NEMA Design C definition, DOE recognizes the error in its proposed definition and is modifying the definition to read ''not less than the values'' instead of ''up to the values.'' The remainder of the proposed Design C definition is being adopted. DOE did not receive any other specific comments regarding the definition of NEMA Design A motors, so DOE is adopting the definition proposed in the NOPR without modifications. Regarding the clause for ''50 Hz'' motors, DOE notes that the definition for NEMA Design B motors already present in 10 CFR part 431 contains this phrase, and to maintain consistency between the three definitions, DOE has retained it for the NEMA Design A and NEMA Design C definitions. DOE also notes that NEMA's MG 1–2009 includes both 60 Hz and 50 Hz in its Design A, B and C definitions. Under the regulatory scheme outlined in the standards NOPR, however, DOE's proposed standards would only apply to 60 Hz motors because of the nine criteria that define the scope of coverage.

2. International Electrotechnical Commission Designs N and H Motors

The European International Electrotechnical Commission (IEC), produces industry standards that contain performance requirements for electric motors similar to those produced by NEMA. Analogous to NEMA Designs B and C are IEC Designs N and H. IEC Design N motors have similar performance characteristics to NEMA Design B motors, while IEC Design H motors are similar to NEMA Design C motors. Because many motors imported into the U.S. are built to IEC specifications instead of NEMA specifications, DOE proposed to include a definition for IEC Design N and IEC Design H motor types to ensure that these functionally similar motors were treated in a manner consistent with equivalent NEMA-based electric motors and to retain overall consistency with the existing definitional framework.

DOE's proposed definition for ''IEC Design N motor'' incorporated language from IEC Standard 60034–12 (2007 Ed. 2.1) (IEC 60034) with some modifications that would make the definition more comprehensive. IEC 60034 defines IEC Design N motors as being ''normal starting torque three-phase cage induction motors intended for direct-across the line starting, having 2, 4, 6 or 8 poles and rated from 0.4 kW to 1600 kW,'' with torque characteristics and locked-rotor characteristics detailed in subsequent tables of the standard.[12] A similar approach for IEC Design H motors is taken in IEC 60034, but with references to different sections and slightly different wording. DOE proposed including all references to tables for torque characteristics and locked-rotor characteristics as part of these definitions to improve their comprehensiveness. As detailed in the NOPR, DOE proposed to define an ''IEC Design N motor'' as ''an induction motor designed for use with three-phase power with the following characteristics: A cage rotor, intended for direct-on-line starting, having 2, 4, 6, or 8 poles, rated from 0.4 kW to 1600 kW at a frequency of 60 Hz, and conforming to IEC specifications for torque characteristics, locked rotor apparent power, and starting.'' DOE proposed to define a ''IEC Design H motor'' as ''an induction motor designed for use with three-phase power with the following characteristics: A cage rotor, intended for direct-on-line starting, with 4, 6, or 8 poles, rated from 0.4 kW to 1600 kW, and conforming to IEC specifications for starting torque, locked rotor apparent power, and starting.''

In response to these proposed definitions, interested parties made several suggestions. NEMA requested removal of the parenthetical statement ''(as demonstrated by the motor's ability to operate without an inverter)'' because, in its view, it is unnecessary and not included in the present definition of NEMA Design B motor nor in the proposed definitions of NEMA Designs A and C motors. (Pub. Mtg. Tr., No. 7 at p. 45, 46) NEMA further suggested that the rating range of 0.4 kW to 1600 kW be replaced with 0.75 kW to 373 kW as applicable to all defined electric motors and as given in the

[11] (In this and subsequent citations, the document number refers to the number of the comment in the Docket for the DOE rulemaking on test procedures for electric motors, Docket No. EERE–2012–BT–TP–0043; and the page references refer to the place in the document where the statement preceding appears.)

[12] Across-the-line (or direct-on-line) starting is the ability of a motor to start directly when connected to a polyphase sinusoidal power source without the need for an inverter.

present 10 CFR 431.25.[13] Baldor commented that the 1 to 500 horsepower range should be included in the definition, which presumably would align with the scope of coverage proposed in DOE's standards NOPR. (Pub. Mtg. Tr., No. 7 at p. 52) SEW pointed out that the definition for IEC Design H includes ''at a frequency of 60 Hz'' while the definition for IEC design N does not include it. (Pub. Mtg. Tr., No. 7 at p. 52)

NEMA commented that, depending on the level of apparent locked rotor power, an IEC Design N electric motor may be equivalent to a NEMA Design B or NEMA Design A electric motor. Moreover, the marking requirements in IEC 60034–1 do not require that a design type or locked rotor apparent power be marked on IEC design motors. Therefore, NEMA requested that DOE consider these factors (but made no specific suggestions on how) while including IEC standards in terms of the level of equivalency to the NEMA MG 1 standard in the proposed definitions. (NEMA, No. 10 at p. 13) Regal Beloit requested that DOE address the scope and design of IEC Design N motors with high inrush locked rotor current. (Pub. Mtg. Tr., No. 7 at pp. 166–168).

DOE notes that its objective in defining IEC Design H and IEC Design N motors is to define what characteristics and features comprise these types of motors, so that manufacturers designing to the IEC standards can easily tell whether their motor is subject to DOE's regulatory requirements. While DOE currently regulates motors that have a power rating between 0.75 kW to 373 kW, DOE does not believe it needs to limit the definitions to this power range to describe whether a given motor falls under Design H or Design N. DOE agrees with NEMA regarding the need to provide additional clarity about how to determine NEMA and IEC equivalent motors to determine the applicability of DOE's regulations to IEC-rated motors. Consequently, DOE intends to issue a separate guidance document that will help describe the process that both DOE and manufacturers should use to determine whether IEC-rated motors are subject to DOE's regulations.

As Baldor noted, DOE also acknowledges that its inclusion of the clause ''at a frequency of 60 hz'' in the definition for IEC Design H motor and not for IEC Design N may create some ambiguity. For the final rule, DOE is modifying the definition of an IEC Design N motor and maintaining the definition of an IEC Design H motors, both to specify applicability to motors at a frequency of 60 hz.

DOE generally agrees that removing the parenthetical statement ''(as demonstrated by the motor's ability to operate without an inverter)'' from the definition of IEC Design H and IEC Design N motors is unnecessary, and has rewritten the definition such that it is not needed. DOE understands that the coverage of IEC motors and NEMA motors should comport with one another to help ensure that manufacturers follow a consistent set of requirements. It does not make sense to have a clause for the definitions of IEC Design H and IEC Design N motors and not have it for definitions of NEMA Design A and B. In an effort to maintain consistency with DOE's existing, NEMA-based definitions, DOE has removed the clause ''as demonstrated by the motor's ability to operate without an inverter'' from the two IEC definitions DOE has also replaced the term ''intended'' with ''capable'' because the former does not definitively establish the capability of motor for direct online starting.

Electric motors that meet the IEC Design N or Design H requirements and otherwise meet the definitions of general purpose electric motor (subtype I) or (subtype II) are already required to satisfy DOE's energy conservation standards at the specified horsepower ranges prescribed in 10 CFR 431.25. Because these IEC definitions stipulate a set of performance parameters that do not inhibit an electric motor's ability to be tested, DOE did not propose any additional test procedure amendments in the NOPR.

At the NOPR public meeting, Regal Beloit suggested that DOE add an alternate test plan per the IEC 60034–2–1 because even though there are slight differences relative to IEEE 112 (Test Method B), industry accepts it as equivalent. It pointed out that this test plan would be the IEC equivalent of IEEE 112 (Test Method B) and, because DOE was opting to define IEC motor types, it would seem pertinent to include an IEC test method. (Pub. Mtg. Tr., No. 7 at p. 166–168). While DOE understands Regal Beloit's view, the inclusion of IEC motors that are equivalent to motors built in accordance with NEMA specifications is not a new concept. These ''IEC-equivalent'' motors are already subject to regulation are currently subject to standards. To date, DOE is unaware of any difficulties in testing IEC-equivalent motors but will consider any appropriate changes to its procedures if any such problems arise.

3. Electric Motors With Moisture-resistant, Sealed or Encapsulated Windings

All electric motors have ''insulation systems'' that surround the various copper winding components in the stator. The insulation, such as a resin coating or plastic sheets, serves two purposes. First, it helps separate the three electrical phases of the windings from each other and, second, it separates the copper windings from the stator lamination steel. Electric motors with encapsulated windings have additional insulation that completely encases the stator windings, which protects them from condensation, moisture, dirt, and debris. This insulation typically consists of a special material coating, such as epoxy or resin that completely seals the stator's windings. Encapsulation is generally found on open-frame motors, where the possibility of contaminants getting inside the motor is higher than for an enclosed-frame motor.

In the electric motors preliminary analysis TSD,[14] DOE set forth a possible definition for the term ''encapsulated electric motor'' that was based on a NEMA's definition for the term ''Machine with Sealed Windings.'' DOE intended to address those motors containing special windings that could withstand exposure to contaminants and moisture—and whose efficiency is currently unregulated. Commenting on this approach, NEMA and Baldor noted that NEMA MG 1–2009 does not specify a single term that encompasses a motor with encapsulated windings. Instead, NEMA MG 1–2009 provides two terms: one for a ''Machine with Sealed Windings'' and one for a ''Machine with Moisture Resistant Windings.'' A definition for the term ''Machine with Encapsulated Windings'' has not appeared in MG 1 since the 1967 edition.

After reviewing the two pertinent definitions, the comments from Baldor and NEMA, and DOE's own research on these types of motors, DOE proposed that motors meeting either definition would be addressed by the expanded scope of the test procedure and accompanying definitions under consideration. The ability for a motor's windings to continue to function properly when the motor is in the presence of moisture, water, or contaminants, as is the case when a motor meets one of these two definitions, does not affect its ability to

[13] These are the metric figures for 1 and 500 horsepower, respectively.

[14] The preliminary TSD published in July 2012 is available at: *http://www.regulations.gov/#!documentDetail;D=EERE-2010-BT-STD-0027-0023.*

be connected to a dynamometer and be tested for efficiency. Additionally, this ability does not preclude a motor from meeting the nine criteria that DOE preliminarily used to characterize those electric motors whose energy efficiency are not currently regulated but that fall within the scope of DOE's regulatory authority. Therefore, in the NOPR, DOE proposed two definitions based on the NEMA MG 1–2009 definitions of a ''Machine with Moisture Resistant Windings'' and a ''Machine with Sealed Windings.''

DOE's proposed definitions were based on modified versions of the NEMA MG 1–2009 definitions in order to eliminate potential confusion and ambiguities. The proposed definitions emphasized the ability of motors to pass the conformance tests for moisture and water resistance, thereby identifying them as having special or definite purpose characteristics. As detailed in the NOPR analysis, DOE proposed to define ''electric motor with moisture resistant windings'' as ''an electric motor engineered to pass the conformance test for moisture resistance as specified in NEMA MG 1–2009.'' DOE proposed to define an ''electric motor with sealed windings'' as ''an electric motor engineered to pass the conformance test for water resistance as specified in NEMA MG 1–2009.'' 78 FR 38455.

In response to the June 2013 NOPR, NEMA pointed out that the proposed definitions refer to NEMA MG 1–2009, paragraphs 12.62 and 12.63 as incorporated by reference in 10 CFR 431.15. DOE's regulations currently do not include references to these paragraphs and DOE did not propose to add them. (Pub. Mtg. Tr., No. 7 at p. 54; NEMA, No. 10 at p. 13) As suggested by NEMA, however, DOE is incorporating these two paragraphs into 10 CFR 431.15, since both paragraphs are necessary to these definitions. DOE notes that no interested parties at either the public meeting or in written comments opposed this suggested approach.

In the proposed definitions of electric motor with moisture resistant windings and electric motor with sealed windings, NEMA commented that the phrase ''engineered for passing,'' should be replaced with ''capable of passing'' as stated in the NEMA MG 1–2009 standard. Finally NEMA suggested that DOE define an ''electric motor with moisture resistant windings'' based on paragraph 1.27.1 of NEMA MG 1–2009:

''Special purpose electric motor with moisture resistant windings means a special purpose electric motor that has motor windings that have been treated such that exposure to a moist atmosphere will not readily cause malfunction. This type of machine is intended for exposure to moisture conditions that are more excessive than the usual insulation system can withstand. A motor with moisture resistant windings is capable of passing the conformance test for moisture resistance described in NEMA MG 1–2009, paragraph 12.63, (incorporated by reference, see 431.15) as demonstrated on a representative sample or prototype.''

Based on paragraph 1.27.2 of NEMA MG 1–2009, NEMA proposed that the definition for special purpose electric motor with sealed windings be:

''Special purpose electric motor with sealed windings means a special purpose electric motor that has an insulation system which, through the use of materials, processes, or a combination of materials and processes, results in windings and connections that are sealed against contaminants. This type of machine is intended for environmental conditions that are more severe than the usual insulation system can withstand. A motor with sealed windings is capable of passing the conformance test for water resistance described in NEMA MG 1–2009, paragraph 12.62, (incorporated by reference, see 431.15) as demonstrated on a representative sample or prototype.'' (NEMA, No. 10 at p. 13–14)

NEMA and Baldor requested that DOE consider an additional third type of motors—''special purpose electric motor with encapsulated windings.'' These motors are included in NEMA MG 1–2009, paragraph 12.62 and also identified in DOE's 1997 policy statement. NEMA proposed that the following definition of this type be considered for 10 CFR 431.12: ''Special purpose electric motor with encapsulated windings means a special purpose electric motor that has motor windings that are fully enclosed in an insulating material that protects the windings from detrimental operating environments (moisture, dust, dirt, contamination, etc.). The encapsulate material may fully enclose not only the motor windings but the wound stator core. A motor with encapsulated windings is capable of passing the conformance test for water resistance described in NEMA MG 1–2009, paragraph 12.62, (incorporated by reference, see 10 CFR Part 431.15) as demonstrated on a representative sample or prototype.'' (NEMA, No. 10 at p. 14, Pub. Mtg. Tr., No. 7 at p. 55)

DOE has evaluated the suggestions made on these definitions. DOE notes that while a motor may be engineered to comply with a parameter, the final product may not meet the standards. To address this issue, DOE has adjusted these two definitions to read as ''capable of passing'' rather than ''engineered for passing.'' DOE prefers to leave the definition broad, incorporating all motors that pass the conformance tests in NEMA MG 1–2009 paragraphs 12.62 and 12.63, rather than further specifying, as NEMA suggested in its definition. However, DOE has decided to avoid any confusion regarding these motors types and, therefore, has adopted three definitions.

For the final rule, DOE is adopting the following definition: ''Electric motor with moisture-resistant windings means an electric motor that is capable of passing the conformance test for moisture resistance generally described in NEMA MG 1–2009, paragraph 12.63 (incorporated by reference, see 431.15).'' DOE is also adopting the following definition for ''Electric motor with sealed windings'' and for ''Electric motor with encapsulated windings'': ''. . . an electric motor capable of passing the conformance test for water resistance described in NEMA MG 1–2009, paragraph 12.62 (incorporated by reference, see 431.15).''

In addition to proposing a definition for these motor types, DOE also considered difficulties that may arise during testing when following IEEE Standard 112 (Test Method B) or CSA C390–10 or any potential impacts on efficiency caused by encapsulation of the windings. Prior to the NOPR, DOE conducted its own research and found no evidence that electric motors with specially insulated windings could not be tested using the existing DOE test procedures without further modification.. Therefore, DOE did not propose any test procedure amendments tailored for electric motors with moisture resistant windings or electric motors with sealed windings in the NOPR.

Bluffton Motors highlighted the challenges associated with testing encapsulated windings motors in its comments. Bluffton commented that the thermocouples cannot be used to measure winding temperature and that measuring the temperature through winding resistance is a difficult process, thus consistent, repeatable results may not be obtained. (Bluffton, No. 11 at p. 1)

Advanced Energy agreed with DOE's decision not to propose additional test procedures for electric motors with moisture resistant windings and electric motors with sealed windings. Advanced Energy commented that they could be fully tested using existing standard procedures. (Advanced Energy, No. 8 at p. 2)

DOE understands the comments made regarding testing motors with encapsulated windings. As a result of discussions with subject matter experts (SMEs) prior to the NOPR, and research performed after, DOE does not believe that the presence of specially insulated stator windings in an electric motor would interfere with DOE-prescribed test procedures. Because temperature measurements are taken by measuring the stator winding resistance, DOE does not believe that the insulation on the stator windings themselves will interfere with carrying out any part of IEEE Standard 112 (Test Method B) or CSA C390–10, both of which require temperature measurements to be taken during testing. The modifications made to stator windings have no impact on a motor's ability to be connected to a dynamometer because they are modifications to the internal portions of the motor. Therefore, DOE has retained the approach proposed in the NOPR and is not adopting an alternative test plan for these motor types.

4. Inverter-Capable Electric Motors

Current standards for electric motors apply to single speed motors with a 2-, 4-, 6-, or 8-pole configuration. 10 CFR 431.25. Each of these motors operates at a constant rotational speed, which is predicated by its pole configuration. This means that the motor shaft is engineered to rotate at the same speed, regardless of its application or required power. In addition to its pole configuration, a motor's rotational speed is partially determined by the frequency of its power source. The equation determining a motor's theoretical maximum speed (or synchronous speed) is:

$$Synchronous\ Speed\ of\ Motor = \frac{120 * (Frequency\ of\ Power\ Source)}{Number\ of\ Motor\ Poles}$$

Inverter drives (also called variable-frequency drives (VFDs), variable-speed drives, adjustable frequency drives, alternating-current drives, microdrives, or vector drives) operate by changing the frequency and voltage of the power source that feeds into an electric motor. The inverter is connected between the power source and the motor and provides a variable frequency power source to the motor. The benefit of the inverter is that it can control the frequency of the power source fed to the motor, which in turn controls the rotational speed of the motor. This allows the motor to operate at a reduced speed when the full, nameplate-rated speed is not needed. This practice can save energy, particularly for fan and pump applications that frequently operate at reduced loading points. Inverters can also control the start-up characteristics of the motor, such as locked-rotor current or locked-rotor torque, which allows a motor to employ higher-efficiency designs while still attaining locked-rotor current or locked-rotor torque limits standardized in NEMA MG 1–2009.[15]

DOE did not propose to exempt a motor suitable for use on an inverter from any applicable energy conservation standards because this type of motor operates like a typical, general purpose electric motor when not connected to an inverter. As detailed in the NOPR, DOE proposed to define an ''inverter-capable electric motor'' as an electric motor designed to be directly connected to polyphase, sinusoidal line power, but that is also capable of continuous operation on an inverter drive over a limited speed range and associated load. Because this motor type operates like a typical, general purpose electric motor when not connected to an inverter, DOE did not believe any test procedure amendments were needed. Under DOE's proposed approach, an inverter-capable electric motor would be tested without the use of an inverter and rely on the set-ups used when testing a general purpose electric motor.

In response to the NOPR, interested parties raised concerns regarding the proposed definition for inverter-capable electric motors. NEMA commented that the current definition is neither complete nor clear, noting that the definition is fairly wide open as far as the type of three-phase motors that could be connected to an inverter (Pub. Mtg. Tr., No. 7 at p. 58–59 ; NEMA, No. 10 at p. 15). CA IOUs requested that the definition for inverter-capable electric motor be specifically constrained to polyphase motors, but NEMA noted that if the definition for electric motor refers to polyphase, as it recommended in its comments, then the term ''polyphase'' need not be included in the definition of inverter-capable electric motors. (Pub. Mtg. Tr., No. 7 at p. 58; Pub. Mtg. Tr., No. 7 at p. 59). Finally, NEMA proposed that the following definition be adopted instead: ''Inverter-capable electric motor means a general purpose electric motor (subtype I) or general purpose electric motor (subtype II) that is also capable of continuous operation on an inverter control over a limited speed range and associated load.'' (NEMA, No. 10 at p. 15)

DOE does not agree with NEMA's suggestion to further limit the definition proposed in the NOPR. Specifically, DOE's intent with the proposed definition was to include all types of electric motors that were capable of working with an inverter, which encompass a wide variety of three-phase electric motors. These definitions should help manufacturers determine if a given basic model is covered and subject to DOE's regulations. DOE believes that NEMA is primarily concerned as to whether certain types of inverter capable motors will ultimately be subject to amended energy conservation standards. Whether a motor meets one of the definitions finalized today, however, does not necessarily mean that the motor type's efficiency will be regulated by DOE. For these reasons, DOE has maintained the proposed definition for ''inverter-capable electric motor'' in the final rule and NEMA should provide further comment in the standards rulemaking about the applicability of the proposed standards to these types of motors.

5. Totally Enclosed Non-Ventilated Electric Motors

Most enclosed electric motors are constructed with a fan attached to the shaft, typically on the end opposite the driven load, as a means of pushing air over the surface of the motor enclosure, which helps dissipate heat and reduce the motor's operating temperature. Totally enclosed non-ventilated (TENV) motors, however, have no fan blowing air over the surface of the motor. These motors rely, instead, on the conduction and convection of the motor heat into the surrounding environment for heat removal, which results in a motor that operates at higher temperatures than motors with attached cooling fans. TENV motors may be used in environments where an external fan

[15] Li, Harry. *Impact of VFD, Starting Method and Driven Load on Motor Efficiency.* 2011.Siemens Industry, Inc.

could clog with dirt or dust, or applications where the shaft operates at too low of a speed to provide sufficient cooling (i.e., a motor controlled by an inverter to operate at very low revolutions per minute). TENV motors may employ additional frame material as well as improved stator winding insulation so that the motor may withstand the increased operating temperatures. Extra frame material allows for more surface area and mass to dissipate heat, whereas higher-grade stator winding insulation may be rated to withstand the higher operating temperatures.

In view of the statutory definitional changes created by EISA 2007, and the support expressed by both industry and energy efficiency advocates in the Joint Petition submitted by the Motor Coalition, DOE is addressing TENV motors in the energy conservation standards rulemaking. (Motor Coalition, EERE–2010–BT–STD–0027–0035 at p. 19) As part of this effort, in the June 2013 NOPR, DOE proposed to add a definition for this motor type based on the definition of a ''totally enclosed nonventilated machine'' in paragraph 1.26.1 of NEMA MG 1–2009. DOE tentatively concluded that this definition is accurate and sufficiently clear and concise and proposed that the definition be adopted with minor alterations. The NOPR proposed to define a ''TENV electric motor'' as an electric motor built in a frame-surface cooled, totally enclosed configuration that is designed and equipped to be cooled only by free convection.

In addition to proposing a definition for these motors, DOE considered whether any test procedure set-up instructions would be necessary to test TENV motors. In response to the framework document,[16] ASAP and NEMA submitted comments suggesting that manufacturers could demonstrate compliance with the applicable energy conservation standards by testing similar models. (ASAP and NEMA, EERE–2010–BT–STD–0027–0012 at p. 7) Although NEMA and ASAP suggested this was a possible way to test these motors to demonstrate compliance, they did not state that this was necessary method because of difficulties testing these types of motors. Subsequently, after DOE published its electric motors preliminary analysis, NEMA stated that it was not aware of any changes that were required to use IEEE Standard 112 (Test Method B) when testing TENV motors. (NEMA, EERE–2010–BT–STD–0027–0054 at p. 16) Also, in response to the preliminary analysis, the Copper Development Association (CDA) commented that DOE may need to develop new test procedures for these motor types but did not explain why such a change would be necessary. (CDA, EERE–2010–BT–STD–0027–0018 at p. 2) CDA did not indicate whether the current procedures could be modified to test these motors or what specific steps would need to be included to test these types of motors. Additionally, DOE knew of no technical reason why a TENV motor could not be tested using either IEEE Standard 112 (Test Method B) or the CSA C390–10 procedure without modification. In view of NEMA's most recent comments suggesting that IEEE Standard 112 (Test Method B) was an appropriate means to determine the efficiency of these motors, and the fact that the CDA did not provide an explanation of why changes would be necessary, DOE did not propose any test procedure amendments for TENV electric motors in the NOPR.

In response to the June 2013 NOPR, Advanced Energy agreed with the proposed definition for TENV electric motors and with DOE's decision not to propose any clarifying set-up procedure. (Advanced Energy, No. 8 at p. 2) However, NEMA asserted that the proposed definition is inadequate. NEMA suggested that if DOE accepts NEMA's earlier recommendations on modifying the definition for ''motor'' and ''electric motor,'' the definition of TENV would be a ''totally enclosed non-ventilated (TENV) definite purpose electric motor means a definite purpose electric motor that is built in a frame-surface cooled, totally enclosed configuration that is designed and equipped to be cooled only by free convection.'' (NEMA, No. 10 at p. 15). NEMA further requested that DOE consider including IEC equivalents along with relevant IC and IP codes. (Pub. Mtg. Tr., No. 7 at p. 79; NEMA, No. 10 at p. 15–16)

During the NOPR public meeting, the CA IOUs noted that DOE's proposed definition for TENVs would overlap with the State of California's regulations pertaining to pool pump motors. Those regulations, in relevant part, prescribe an energy conservation standard for pool pump motors. (Pub. Mtg. Tr., No. 7 at p. 61–64). Regal Beloit indicated in response during the public meeting that the proposed test procedures may not apply to pool pump motors since the majority of those motors are single-phase motors; in contrast, TENV motors operate on polyphase power. (Pub. Mtg. Tr., No. 7 at p. 61–65)

DOE has addressed the addition of phrases such as ''definite purpose electric motor'' to the individual motors definitions in section G, and for the reasons discussed there, will not be adding this phrase to the definition for TENV motors. Outside of this change, NEMA's proposal matches that which was proposed by DOE in the NOPR. Based on this, DOE has maintained the NOPR proposed definition for this final rule. Having received no negative feedback on its proposal to not require set-up procedures for the testing of TENV motors, DOE is maintaining this approach in the final rule.

DOE understands NEMA's concerns about IEC equivalency and recognizes that including IP and IC codes for IEC-equivalent motors may help eliminate any ambiguity in the proposed definitions. As noted earlier in the section H, DOE conducted its own independent research and consulted with SMEs to identify proper IP and IC codes for IEC motors equivalents to the motor types that were proposed to be defined in 10 CFR part 431 in the NOPR and intends to develop guidance regarding the appropriate codes.

Regarding pool pump motors, DOE notes that, by statute, any electric motor could be regulated by DOE for energy efficiency. DOE is considering setting energy conservation standards as part of its ongoing standards rulemaking effort for a wider variety of motors than are currently covered. To the extent that those efforts lead to the promulgation of standards that would affect an electric motor used in a pool pump, those standards would preempt any State standards that are currently in effect.

6. Air-Over Electric Motor

Most enclosed electric motors are constructed with a fan attached to the shaft, typically on the end opposite the drive, as a means of providing cooling airflow over the surface of the motor frame. This airflow helps remove heat, which reduces the motor's operating temperature. The reduction in operating temperature prevents the motor from overheating during continuous duty operation and increases the life expectancy of the motor.[17] On the other hand, air-over electric motors do not have a factory-attached fan and, therefore, require a separate, external means of forcing air over the frame of the motor. Without an external means of cooling, an air-over electric motor could

[16] *http://www.regulations.gov/#!documentDetail;D=EERE-2010-BT-STD-0027-0002.*

[17] The temperature at which a motor operates is correlated to the motor's efficiency. Generally, as the operating temperature increases the efficiency decreases. Additionally, motor components wear our more slowly when operated at lower temperatures.

overheat during continuous operation and potentially degrade the motor's life. To prevent overheating, an air-over electric motor may, for example, operate in the airflow of an industrial fan it is driving, or it may operate in a ventilation shaft that provides constant airflow. The manufacturer typically specifies the required volume of air that must flow over the motor housing for the motor to operate at the proper temperature.

After the enactment of the EISA 2007 amendments, DOE performed independent research and consultation with manufacturers and SMEs. Through this work, DOE found that testing air-over electric motors would be complex. IEEE Standard 112 (Test Method B) and CSA C390–10 do not provide standardized procedures for preparing an air-over electric motor for testing, which would otherwise require an external cooling apparatus. Additionally, DOE was not aware of any standard test procedures that provide guidance on how to test such motors. Test procedure guidance that would produce a consistent, repeatable test method would likely require testing laboratories to be capable of measuring the cubic airflow of an external cooling fan used to cool the motor during testing. At the time of the NOPR publication, DOE believed that this is a capability that most testing laboratories do not have. Without the ability to measure airflow, one testing laboratory may provide more airflow to the motor than a different testing laboratory. Increasing or decreasing airflow between tests could impact the tested efficiency of the motor, which would provide inconsistent test results. Because of this difficulty, DOE stated that it has no plans to require energy conservation standards for air-over electric motors, making further test procedure changes unnecessary. 78 FR 38461.

Although DOE did not plan to apply energy conservation standards to air-over electric motors, it proposed to define them for clarity. DOE's proposed ''air-over electric motor'' definition was based on the NEMA MG 1–2009 definition of a ''totally enclosed air-over machine,'' with some modification to that definition to include air-over electric motors with open frames. DOE believed that air-over electric motors with either totally enclosed or open frame construction use the same methods for heat dissipation and, therefore, should be included in the same definition. As detailed in the NOPR, DOE proposed to define ''air-over electric motor'' as ''an electric motor designed to be cooled by a ventilating means external to, and not supplied with, the motor.'' 78 FR 38481.

In response to the NOPR, NEMA and ASAP commented that the proposed definition of air-over electric motor is inadequate. (Pub. Mtg. Tr., No. 7 at p. 70; NEMA, No. 10 at p. 33) NEMA commented that DOE's definition for air-over electric motor does not distinguish between air-over machines and pipe-ventilated machines, in which the ventilating means is external to the machine, but the air is ducted to and from and circulated through the machine. NEMA stated that the proposed definition should refer to the air as being free-flowing, which could be over an enclosed electric motor or through an open electric motor. Therefore, NEMA suggested that DOE define these motors as: ''[a]ir-over definite purpose motor means a definite purpose motor that is designed to be cooled by a free flow of air provided by a ventilating means external to, and not supplied with, the motor.'' (NEMA, No. 10 at p. 33) NEMA further commented that there is no need for any definition of ''air-over definite purpose motor'' or ''air-over definite purpose electric motor'' if efficiency standards are not established. (NEMA, No. 10 at p. 34)

DOE believes that NEMA's suggestion provides a useful conceptual starting point, but has concern that without more specificity, the suggestion could create an incentive to sell motors intended for general purpose use but labeled as air-over. DOE understands that most, or all, air-over motors are used in applications where they drive a fan or blower that provides airflow to a certain application. Rather that having traditional cooling fans, air-over motors depend on the larger airstream to stabilize temperature. Maintaining NEMA's suggestion to specify that the source of the cooling air not be supplied with the motor, DOE adopts the following definition for today's rule: ''An air-over motor is an electric motor rated to operate in and be cooled by the airstream of a fan or blower that is not supplied with the motor and whose primary purpose is providing airflow to an application other than the motor driving it.''

Regarding NEMA's contention that DOE does not need to define this motor type, as noted earlier, DOE does not intend to define only motors that it intends to regulate via the standards rulemaking.

DOE believed that the difficulties associated with testing air-over electric motors such as providing a standard flow of cooling air from an external source that provides a constant velocity under defined ambient temperature and barometric conditions over the motor were insurmountable at this time of the NOPR, and therefore, did not propose a test plan for these motors and did not plan to subject this motor type to standards in the standards rulemaking.

In response to the June 2013 test procedure NOPR, NEMA agreed with DOE's proposal to not require air-over electric motors to meet energy conservation standards, noting that the difficulties of testing to determine the efficiency of an air-over motor make the establishment of efficiency standards impractical. (NEMA, No. 10 at p. 34)

On the other hand, Advanced Energy urged DOE to consider implementing standards for air over electric motors. Advanced Energy expressed concern that if TENV motors are regulated and TEAO motors are not regulated, TENV motors that did not meet standards could be labeled and sold as TEAO motors. (Advanced Energy, No. 8 at p. 5)

In its NOPR comments, Advanced Energy recognized the following challenges with the testing of air-over motors: (1) Unstable temperature due to heat run,[18] (2) requirement of additional equipment to test airflow to motor, and (3) inconsistency in test results by different labs due to variation in the airflow. Advanced Energy suggested testing air-over motors by making modifications in the instructions for CSA 747–2009 and IEEE 114–2010. Both standards require test measurements at temperature within 70 °C–80 °C. (Advanced Energy, No. 8 at p. 6)

In an effort to substantiate its claims, Advanced Energy tested a 5hp, 4-pole TEFC motor following the IEEE 112 (Test Method B) procedure. The following six tests were conducted: Test A: With fan; Test B: Without fan and without blower; Test F: Without fan and with blower; Test E: With fan and a 1.25 service factor; Test D: Without fan, without blower and with a 1.25 service factor; and Test C: Without fan, with blower and with a 1.25 service factor. Advanced Energy observed the following results, shown in table Table III–2. (Advanced Energy, No. 8 at pp. 6–7)

[18] In other words, the winding temperature does not stabilize without a cooling, external airflow in which air-over motors are designed to operate.

TABLE III–2—TEST RESULTS OF TEFC MOTOR TESTING

Test	Rated load	Efficiency @ rated load (%)
Baseline (Test A)	5	89.3
Without Fan, Without Blower (Test B)	5	89.9
Without Fan, With Blower (Test F)	5	90.2
Baseline (Test E)	6.25	88.1
Without Fan, Without Blower (Test D)	6.25	89.0
Without Fan, With Blower (Test C)	6.25	88.6

Advanced Energy observed that the efficiency of the motor in tests B, C, D, and F increased compared to the respective baseline tests—tests A and E. It believes that the tests show that the standard test procedures can be modified to test air-over electric motors, especially when comparing tests D to C, or test B to F. Advanced Energy noted that the test without a fan (Test B), in which the thermal run was stopped to test between 70 degrees and 80 degrees Celsius, resulted in a measured efficiency comparable to the test where a blower was used to provide cooling airflow (Test F). (Advanced Energy, No. 8 at pp. 6–7)

Advanced Energy requested that DOE further investigate the test instructions for air-over electric motors and proposed test instructions stating: ''Air-over motors shall be tested at their rated conditions (horsepower, speed, voltage) by providing air from external means such that the motor winding temperature shall be between 70 °C–80 °C.'' (Advanced Energy, No. 8 at p. 8)

While DOE has considered the test data, DOE does not believe it has sufficient information at this time to support establishment of a test method for measuring air-over motor efficiency for regulatory purposes. DOE intends, however, to research other test procedure options for air-over electric motors to determine whether, in a future, separate rulemaking, DOE might propose a test procedure set-up for air-over electric motors and, possibly, an energy conservation standard for such motors.

E. Electric Motor Types Requiring Definitions and Test Procedure Instructions

In the June 2013 NOPR, DOE proposed define a number of electric motor types that were already, apparently, commonly understood, but not necessarily clearly defined, by the industry. DOE also proposed clarifying language for testing each of these motor types.

1. Immersible Electric Motors

Most electric motors are not engineered to withstand immersion in liquid (e.g., water, including wastewater). If liquid enters an electric motor's stator frame, it could create electrical faults between the different electrical phases or electrical steel and could impede rotor operation or corrode internal components. Immersible motors are electric motors that are capable of withstanding immersion in a liquid without causing damage to the motor. Immersible motors can withstand temporary operation in liquid, sometimes up to two weeks, but also run continuously outside of a liquid environment because they do not rely on the liquid to cool the motor. According to test 7 in Table 5–4 of NEMA MG 1–2009, for a motor to be marked as protected against the effects of immersion, a motor must prevent the ingress of water into the motor while being completely submerged in water for a continuous period of at least 30 minutes. Therefore, DOE has interpreted ''temporary'' to mean a period of time of no less than 30 minutes. Immersible motors can operate while temporarily submerged because they have contact seals that keep liquid and other contaminants out of the motor. Additionally, some immersible motors may have pressurized oil inside the motor enclosure, which is used in conjunction with contact seals to prevent the ingress of liquid during immersion. Finally, immersible motors are occasionally constructed in a package that includes another, smaller (e.g., ½ horsepower) motor that is used to improve cooling when the immersible motor is not submerged in water. In these cases, the two motors are constructed in a totally enclosed blower-cooled (TEBC) frame and sold together. The electric motors with separately powered blowers are discussed in a separate section III.F.6.

In responding to the October 15, 2010 framework document, NEMA and ASAP commented that greater clarification is needed with regard to immersible motors and how to differentiate them from liquid-cooled or submersible motors. (NEMA and ASAP, EERE–2010–BT–STD–0027–0012 at p. 9) DOE understands the general differences to be as follows:

1. Submersible motors are engineered to operate only while completely surrounded by liquid because they require liquid for cooling purposes;
2. liquid-cooled motors use liquid (or liquid-filled components) to facilitate heat dissipation but are not submerged in liquid during operation; and
3. immersible motors are capable of operating temporarily while surrounded by liquid, but are engineered to work primarily out of liquid.

In the June 2013 NOPR, DOE proposed to define an immersible electric motor as an electric motor primarily designed to operate continuously in free-air, but that is also capable of withstanding complete immersion in liquid for a continuous period of no less than 30 minutes.

In response to the definition for immersible electric motor proposed in NOPR, interested parties expressed several concerns. Advanced Energy commented that the phrase ''capable of withstanding complete immersion in a liquid for a continuous period of no less than 30 minutes'' implies that the motor can be put in the liquid indefinitely, stating that this phrase is more appropriate for test instruction but not for definition. Thus, Advanced Energy suggested that this phrase be modified with the word ''temporarily'' or an upper limit (e.g., two weeks) be provided for immersion. (Pub. Mtg. Tr., No. 7 at p. 135; Advanced Energy, No. 8 at p. 2). ASAP responded that since immersible electric motor is a covered motor, the temporal upper limit is not needed. (Pub. Mtg. Tr., No. 7 at pp. 135–136). WEG commented that the definition of immersible motors needs further addition, such as ''no less than 14 days,'' to differentiate it from the submersible motors. (Pub. Mtg. Tr., No. 7 at p. 137) NEMA commented that the proposed definition is inadequate as it is neither sufficiently complete nor clear. (NEMA, No. 10 at p. 20)

Finally, Advanced Energy proposed that the definition be modified to describe these motors as those that are ''primarily designed to operate continuously in free-air'' but that can ''temporarily withstand complete immersion in liquid for a continuous period of no less than 30 minutes.'' (Advanced Energy, No. 8 at p. 2) On the other hand, NEMA proposed to define this term as ''a definite purpose electric motor that is primarily designed to operate continuously in free-air, but is also capable of withstanding complete immersion in liquid for a continuous period of no less than 30 minutes, during which time any operation may or may not be inhibited.'' (NEMA, No. 10 at p. 20)

DOE's intention in the NOPR was to fully differentiate between three types of motors: Submersible, immersible, and liquid-cooled. DOE recognizes that without an upper limit on the submersion in liquid, the definition for immersible motors is very similar to that of submersible motors. However, as it noted in the proposal, immersible motors are ''primarily designed to operate continuously in free-air,'' while submersible motors are ''designed for operation only while submerged in liquid.'' DOE believes that these clauses should sufficiently differentiate between the two types of motors, but in an effort to further eliminate any confusion, DOE has added the word ''temporary'' to the definition, as suggested by Advanced Energy and defining an ''immersible electric motor'' as an electric motor ''primarily designed to operate continuously in free-air, but that is also capable of temporarily withstanding complete immersion in liquid for a continuous period of no less than 30 minutes.''

Regarding immersible motor testing, the contact seals used by immersible motors to prevent the ingress of water or other contaminants have an effect on tested efficiency that generally changes over time. New seals are stiff, and provide higher levels of friction than seals that have been used and undergone an initial break-in period.[19] DOE understands that as the seals wear-in, they will loosen and become more flexible, which will somewhat reduce friction losses. In its comments on the electric motors preliminary analysis, NEMA stated that immersible motors should be tested with their contact seals removed. (NEMA, EERE–2010–BT–STD–0027–0054 at p. 18)

DOE had previously discussed testing immersible electric motors with industry experts, SMEs, and testing laboratories, all of whom suggested that the seals should be removed prior to testing to eliminate any impacts on the tested efficiency. DOE sought to confirm the effects of contact seals by conducting its own testing. DOE procured a five-horsepower, two-pole, TENV motor for this purpose.[20] Upon receipt of the motor, DOE's testing laboratory followed IEEE Standard 112 (Test Method B) and tested the motor in the same condition as it was received, with the contact seals in place (test 1). After completing that initial test, the laboratory removed the contact seals and tested the motor again (test 2). Finally, the testing laboratory reinstalled the seals, ran the motor for an additional period of time such that the motor had run for a total of 10 hours with the contact seals installed (including time from the initial test) and then performed IEEE Standard 112 (Test Method B) again (test 3).

DOE's testing showed the potential impact that contact seals can have on demonstrated efficiency. In the case of the five-horsepower, two-pole, TENV motor, the motor performed with a higher efficiency with the contact seals removed, demonstrating a reduction in motor losses of nearly 20 percent. DOE's testing also demonstrated a decaying effect of the contact seals on motor losses as they break-in over time. In this instance, the effect of the contact seals on motor losses was reduced, but not eliminated, after 10 hours of running the motor. The results of DOE's immersible motor testing are shown below.

TABLE III–3—RESULTS OF IMMERSIBLE MOTOR TESTING

Motor type	Nameplate efficiency	Test 1	Test 2	Test 3
Immersible Motor (also TENV and a vertical solid-shaft motor)	89.5%	88.9%	91.0%	89.2%

Based on the limited testing conducted by DOE which showed that seals may have an impact on the tested efficiency of a given motor, DOE proposed that these motors be tested with the contact seals in place. In addition, DOE proposed an allowance of a maximum run-in period of 10 hours prior to performing IEEE Standard 112 (Test Method B). This run-in period was intended to allow the contact seals a sufficient amount of time to break-in such that test conditions were equal or very similar to normal operating conditions that would be experienced by a user. DOE's proposed 10-hour maximum was a preliminary estimate obtained through discussions with electric motors testing experts.

In response to the NOPR, several interested parties expressed concern with the proposed test procedure. Advanced Energy noted that the effect of a seal on motor efficiency, as well as its ''run-in'' time, would vary by motor, depending on the motor and type of seal used. Advanced Energy commented that there is no guarantee that a given motor will break-in within a specified time period of 10 hours, which is small compared to the lifetime of a motor. Based on these conditions, it continued to recommend that seals be removed during initial testing to verify the efficiency of the motor. (Advanced Energy, No. 8 at p. 3)

NEMA noted that DOE's tests on a sample immersible motor as received for testing, after an extended time of operation, and with the seals removed, illustrate the difficulty of determining the efficiency of electric motors relative to operating time with various types of seals. Therefore, NEMA continued to recommend that contact seals be removed prior to testing. In the alternative, NEMA asserted that efficiency standards for electric motors with contact seals or sealed bearings would need to be lower than those for the motors without contact seals or sealed bearings. It added that different standard levels may also be needed based on the different types of contact seals and sealed bearings used in a given motor. (NEMA, No. 10 at pp. 21–23)

[19] *Guide for the Use of Electric Motor Testing Methods Based on IEC 60034–2–1.* May 2011. Version 1.1. 4E, Electric Motors Systems, EMSA, available at: *http://www.motorsystems.org/files/otherfiles/0000/0113/guide_to_iec60034-2-1_may2011.pdf* and Neal, Michael J. *The Tribology Handbook Second Edition.* Page C26.5.

[20] The immersible motor tested by DOE was also a vertical, solid-shaft motor. The testing laboratory was able to orient the motor horizontally without any issues, enabling the lab to test the motor per IEEE 112 Test Method B.

NEMA noted that the NOPR refers to 200 hours as the possible time during which the efficiency losses from seals will continue to decrease. NEMA commented that the run-in time depends on the type of contact seals used. However, it commented that 200 hours would seem to be a short run-in estimate for a continuous duty electric motor that DOE assumed in its testing has an average mechanical lifetime of up to 108,398 hours. NEMA expressed concern with the proposed requirement of a 10-hour run-in period to represent the efficiency level of the electric motor with seals when averaged over the total period of use. It also pointed out that for labs that operate on a standard eight-hour workday, a 10-hour run-in period could place undue hardship on the lab, or require unmonitored conditions. NEMA further pointed out that DOE does not indicate if the run-in testing is to be performed with the motor unloaded or at its rated load. NEMA continued to recommend that the contact seals be removed prior to testing. (NEMA, No. 10 at pp. 22–23; Pub. Mtg. Tr., No. 7 at pp. 138–139)

Bluffton commented that motors with seals in them should be tested without the seals because of the inability to obtain consistent results from motor to motor because of the difference in mechanical pressure on the seal from one motor to the next. It noted that if the goal is to reduce power consumption on an overall basis, the differential will be the same regardless of whether the starting point is with or without seals. Moreover, the friction of the seal may change over the entire life of the motor. Thus, testing with seals may not give consistent and repeatable measurements. (Bluffton, No. 11 at p. 1)

WEG and Nidec also recommended that the seals be removed for testing (Pub. Mtg. Tr., No. 7 at pp. 139–140; Pub. Mtg. Tr., No. 7 at p. 143) CDA acknowledged that there are valid arguments for both the inclusion and the exclusion of seals during testing. It suggested an additional allowance for these seal losses be included within the allowable testing results in these specific categories. (CDA, No. 9 at p. 2)

Based on the responses to the NOPR, and additional investigation following publication, DOE has reconsidered its NOPR proposal. At this time, DOE does not believe it has enough information to determine the extent of the impact seals may have on a motor's efficiency when installed in the field over time. Seals can be made of rubber (with varying degrees of hardness and pliability), ceramic material, or metal. Each of these materials has a different impact on an electric motor's performance and may or may not ''break in'' over time to reduce the overall level of friction that a motor may encounter while operating. Due to the variety of designs and materials offered and used by motor manufacturers, and the variety of impacts that these differences may have, DOE is unable at this time to quantify a specific break-in period to help determine the point in time where the losses contributed by the seals would be considered ''representative.'' Furthermore, DOE understands that each motor type, size, and configuration will be affected differently by seals, and various types of seals can be used. Without additional data, applying a particular break-in period or adjustment factor to account for the additional friction added by seals would be premature. Therefore, in light of this uncertainty, DOE is, at this time, requiring that test labs remove seals when testing immersible motors but make no other modifications. This approach is also consistent with the suggestions made by NEMA and the energy efficiency advocates. DOE may continue to explore the effect of seals on motor performance and may revise this requirement in the future.

NEMA also noted that even though the title of the proposed 4.3 in Appendix B to Subpart B is ''Immersible Electric Motors and Electric Motors with Contact Seals,'' the actual test procedure appears to apply to immersible electric motors only. (NEMA, No. 10 at p. 23)

In response to NEMA's comment DOE has adjusted the heading of this section to read ''Immersible Electric Motors'' for clarification purposes.

2. Brake Electric Motors

In most applications, electric motors are not required to stop immediately; instead, electric motors typically slow down and gradually stop after power is removed from the motor, due to a buildup of friction and windage from the internal components of the motor. However, some applications require electric motors to stop quickly. Such motors may employ a brake component that, when engaged, abruptly slows or stops shaft rotation. The brake component attaches to one end of the motor and surrounds a section of the motor's shaft. During normal operation of the motor, the brake is disengaged from the motor's shaft—it neither touches nor interferes with the motor's operation. However, under these conditions, the brake is drawing power from the electric motor's power source and may be contributing to windage losses, because the brake is an additional rotating component on the motor's shaft. When power is removed from the electric motor (and brake component), the brake component de-energizes and engages the motor shaft, quickly slowing or stopping rotation of the rotor and shaft components.

In its Joint Petition, the Motor Coalition proposed to define the term ''integral brake electric motor'' as ''an electric motor containing a brake mechanism either inside of the motor endshield or between the motor fan and endshield such that removal of the brake component would require extensive disassembly of the motor or motor parts.'' (Motor Coalition, EERE–2010–BT–STD–0027–0035 at p. 19) After receiving the petition, DOE spoke with some of the Motor Coalition's manufacturers and its own SMEs. Based on these conversations, DOE believed that the Motor Coalition's definition is consistent with DOE's understanding of the term. In the electric motors preliminary analysis, DOE presented a definition of the term ''integral brake motor'' consistent with the definition proposed by the Motor Coalition. (For additional details, see Chapter 3 of the electric motors preliminary analysis Technical Support Document). However, upon further consideration, DOE believed that there may be uncertainty regarding certain aspects of the definition, particularly, what constitutes ''extensive disassembly of the motor or motor parts.'' Therefore, in the NOPR, DOE proposed a new definition that would remove this ambiguity. The proposed rule defined an ''integral brake electric motor'' as an electric motor containing a brake mechanism either inside of the motor endshield or between the motor fan and endshield.

Conversely, the brake component of a non-integral brake motor is usually external to the motor and can be easily detached without disassembly or adversely affecting the motor's performance. DOE proposed a new definition for ''non-integral brake electric motor'' that paralleled its proposed definition for ''integral brake electric motor.'' DOE believed that the new definition was clearer because it relied solely on the placement of the brake and not what level of effort is needed to remove it. Additionally, DOE believed that the structure of its two definitions encompassed all brake motors by requiring them to meet one definition or the other. As detailed in the NOPR, DOE's proposed definition for a ''non-integral brake electric motor'' was an electric motor containing a brake mechanism outside of the endshield, but not between the motor fan and endshield.

As discussed in the NOPR, DOE conducted its own testing on both integral and non-integral brake motors. DOE described the details of this testing in the NOPR along with the results. DOE generally found that testing the brake component attached, but powered by a source separate from the motor, resulted in demonstrated efficiencies equivalent to testing a motor with the brake component completely removed. As a result of its testing of integral and non-integral brake electric motors, DOE proposed the same test instructions for both motors types. DOE proposed to include instructions that would require manufacturers to keep the brake mechanism attached to the motor, but to power it externally while performing IEEE Standard 112 (Test Method B). DOE believed that this was the best approach because it allows the test laboratory to isolate the motor losses, which includes the friction and windage produced by the rotating brake mechanism. DOE believed that powering the motor and the brake mechanism separately during testing would ensure that the power consumed to keep the brake mechanism disengaged is not counted against the motor's tested efficiency. The power consumed to keep the brake mechanism disengaged represents useful work performed by the motor and should not be construed as losses, but it should be measured and reported. DOE believed this information is pertinent for brake motor consumers who wish to understand the energy consumption of their motor. Furthermore, when conducting the testing, DOE's test laboratory was able to splice connections and externally power the brake on multiple integral and non-integral brake motors, so DOE preliminarily believed that this process would not be unduly burdensome. 78 FR 38468.

In response to the June 2013 NOPR, NEMA noted in its comments that as DOE is proposing the same test plan for both types of motors, the location of the brake assembly is not important in determining the efficiency of the motor. NEMA suggested that DOE use a single definition of ''special purpose electric motor with brake'' that would refer to ''a special purpose electric motor that contains a brake mechanism either within the motor enclosure or external to the motor enclosure.'' NEMA stated that it understood that defining both types of brake motors into a single definition would include integral brake electric motors as covered products, whereas the Joint Petition suggested that these motors continue to be exempted from any testing or efficiency requirements. (NEMA, No. 10 at p. 16).

In the alternative, NEMA suggested that if DOE used two separate definitions, the two proposed definitions should be modified. (Pub. Mtg. Tr., No. 7 at p. 144 ; NEMA, No. 10 at p. 16) NEMA suggested that DOE re-classify and define integral brake electric motor as an ''integral brake special purpose electric motor'' and define it as ''a special purpose electric motor that contains a brake mechanism either within the motor enclosure or between a motor fan, when present, and the nearest endshield.'' (NEMA, No. 10 at p. 17; Pub. Mtg. Tr., No. 7 at p.149) NEMA suggested that a non-integral brake motor be classified as a ''non-integral brake special purpose electric motor'' which would be defined as ''a special purpose electric motor that contains a brake mechanism outside of the endshield, but not between the motor fan and endshield.'' (NEMA, No. 10 at p. 17)

As addressed previously, the facts available to DOE indicate that it is unnecessary to note that these motors are special purpose because whether a motor is special or definite purpose does not exclude it from consideration under DOE's standards rulemaking. However, DOE does agree that two separate definitions are unnecessary because DOE is adopting the same test procedure for both motors. The test results include mechanical losses of the brake components which are not impacted by the location of the brake. A single definition for brake motors will avoid any confusion. Therefore, for the final rule DOE is adopting the following definition: ''Brake electric motor means a motor that contains a dedicated mechanism for speed reduction, such as a brake, either within or external to the motor enclosure.''

Regarding the proposed test procedure, Advanced Energy agreed with DOE's proposed approach for both motors. (Pub. Mtg. Tr., No. 7 at p. 147; Advanced Energy, No. 8 at p. 2) Advanced Energy commented that by powering the brake through external means, the brake will have no impact on the power consumption and avoid the potential difficulties during no-load testing and the risk associated withimproper re-assembly of the motor. (Advanced Energy, No. 8 at p. 2) Highlighting that this proposed method for testing brake motors deviated from the earlier Joint Petition, the advocates agreed with DOE's proposal that integral and non-integral brake motors be tested in the same manner. The advocates stated that this approach will enable the coverage of integral brake motors, further increasing the scope of covered motors. (ASAP et al., No. 12 at pp. 1–2)

However, NEMA expressed concern with the proposed test procedure for integral and non-integral brake electric motors. It commented that the test procedure needs to clearly state that the efficiency determined for the electric motor is not to include any power that may be required to disengage the brake. The test procedure should also provide for manually releasing the brake when such an option is available. NEMA commented that when developing the energy conservation standards for electric motors, any testing DOE conducts with the brakes in place as proposed, should take into account the mechanical losses of the brake components which are significant relative to the losses of the motor components. (NEMA, No. 10 at p. 16)

If NEMA's earlier proposal to have a single definition for ''integral brake special purpose electric motor'' and ''non-integral brake special purpose electric motor'' is accepted, then NEMA suggested a single test procedure for a ''special purpose electric motor with brake.'' NEMA commented that DOE should not require that the testing lab measure electrical power to the brake in 10-minute intervals. It suggested that the determination of efficiency of the electric motor should be based on measurements of the electrical input power to just the electric motor and should not include any power which may be supplied to the brake. NEMA suggested that the connections need to be separated in those cases where the power leads for the brake are interconnected with the stator winding or electric motor leads. The brake should be disengaged during testing by either supplying electrical power to the brake at its rated voltage or through the use of a mechanical release, when available. The required power should be measured and recorded when electrical power is supplied to the brake for the purpose of disengaging the brake. (NEMA, No. 10 at pp. 17–18)

DOE's own testing showed that during normal operation the brake will not be engaged—and will not significantly impact energy consumption. Under the approach laid out in the final rule, testing must be performed with the brake powered separately from the motor such that it does not activate during testing. Only power used to drive the motor is included in the efficiency calculation; power supplied to prevent the brake from engaging is not used. The rule provides that if the brake may be disengaged mechanically, if such a mechanism exists and if the use of this mechanism does not yield a different efficiency value than when separately powering the brake electrically.

3. Partial Electric Motors

Most general purpose electric motors have two endshields,[21] which support the bearings and shaft while also allowing the shaft to rotate during operation. DOE understands that ''partial electric motors,'' also called ''partial ¾ motors,'' or ''¾ motors,'' are motors that are sold without one or both endshields and the accompanying bearings. When partial electric motors are installed in the field, they are attached to another piece of equipment, such as a pump or gearbox. The equipment to which the motor is mated usually provides support for the shaft, allowing the shaft to rotate and drive its intended equipment. The equipment may also provide support for a shaft. When a partial electric motor is mated to another piece of equipment it is often referred to as an ''integral'' motor.[22] For example, an ''integral gearmotor'' is the combination of a partial electric motor mated to a gearbox. The gearbox provides a bearing or support structure that allows the shaft to rotate.

DOE is aware that there are many different industry terms used to describe a partial electric motor. DOE proposed to define the term ''partial electric motor'' in the NOPR to distinguish them from component sets, which, alone, do not comprise an operable electric motor. See Section III.D.1. Additionally, because DOE considered integral gearmotors to be a subset of partial electric motors, this definition also applied to integral gearmotors. Therefore, the NOPR defined ''partial electric motor'' as an assembly of motor components necessitating the addition of no more than two endshields, including bearings, to create an operable motor. The term ''operable motor'' means an electric motor engineered for performing in accordance with the applicable nameplate ratings.

In response to the NOPR, NEMA suggested that DOE include the concept of ''partial'' as a design element within other definitions rather than as a separate type of electric motor. NEMA commented that the definition should be for ''partial motor,'' rather than a ''partial electric motor.'' NEMA commented that the phrase ''engineered for performing'' in the proposed definition should be replaced with ''capable of operation'' because the engineering of a motor does not imply that a motor can operate. Therefore, NEMA suggested that partial motor means an assembly of motor components necessitating the addition of no more than two endshields, including bearings, to create an operable motor. For the purpose of this definition, the term ''operable motor'' means a motor capable of operation in accordance with the applicable nameplate ratings. (NEMA, No. 10 at pp. 18–19)

DOE explains in section III.B of this document why it will not change the definition of ''electric motor'' and DOE is declining to adopt NEMA's suggestion. Furthermore, while it recognizes that adding this clause would, as NEMA pointed out, cover partial motors of all types of motors that are a part of NEMA's proposal, the proposed definition would permit a ''partial motor'' to be any type of electric motor. Consequently, a partial motor, by definition, could be any type of electric motor (e.g. multispeed, single speed, polyphase, etc.). While DOE's approach is a broad one, it does not signal DOE's intention to regulate the efficiency of all types of partial motors. The types of electric motors whose efficiency DOE intends to regulate will be addressed in the energy conservation standards rulemaking.

DOE has, however, adjusted the phrase ''engineered for performing'' as it understands the ambiguity related with this phrase; it is difficult to establish conclusively what, exactly, a motor is engineered for and is clearer to discuss what a motor is ''capable of'' or its rating. For this final rule, DOE is adopting the following definition: ''partial electric motor means an assembly of motor components necessitating the addition of no more than two endshields, including bearings, to create an electric motor capable of operation in accordance with the applicable nameplate ratings.''

DOE is aware that partial electric motors require modifications before they can be attached to a dynamometer for testing. Prior to the NOPR, DOE discussed stakeholder comments and additional testing options with SMEs, testing laboratories, and motor industry representatives. Some interested parties suggested that the motor manufacturer could supply generic or ''dummy'' endplates equipped with standard ball bearings, which would allow for testing when connected to the partial electric motor. Alternatively, testing laboratories had considered machining the ''dummy'' endplates themselves, and supplying the properly sized deep-groove, ball bearings for the testing. Various testing laboratories indicated they had the ability to perform this operation, but some added that they would require design criteria for the endplates from the original manufacturer of the motor. These laboratories noted that machining their own endplates could create motor performance variation between laboratories because it may impact airflow characteristics (and therefore thermal characteristics) of the motor.

DOE procured an integral gearmotor to determine the feasibility of testing partial electric motors. For this investigation, DOE purchased and tested one five-horsepower, four-pole, TEFC electric motor. DOE tested the motor twice, first with an endplate obtained from the manufacturer and second with an endplate machined in-house by the testing laboratory. The results of these tests are shown below.

TABLE III–4—RESULTS OF PARTIAL ELECTRIC MOTOR TESTING

Motor type	Nameplate efficiency	Test 1	Test 2
Partial Electric Motor	81.0%	83.5%	82.9%

DOE found a variation in efficiency because of the endplate used during testing. DOE believes that the variation seen in tested efficiency was likely the result of varying the material used for the endplate. The endplate provided by the manufacturer was made of cast iron, while the endplate provided by the testing laboratory was machined from steel. The testing laboratory was not equipped to cast an iron endshield and thus was not able to replace the

[21] Endshields are metal plates on each end of the motor that house the motor's bearings and close off the internal components of the motor from the surrounding environment.

[22] DOE notes that integral brake motors are not considered integral or partial motors.

manufacturer's endshield with one of the original material. Additionally, DOE knows of no testing laboratory (other than a motor manufacturer), with such capability. DOE believes that the variance in the magnetic properties of steel likely produced small eddy currents in the endshield which resulted in added losses within the motor.[23] Consequently, DOE believes that frame material consistency is needed in order to prevent such variances in future testing.

At the time of the NOPR, because of the possible variance that DOE found through its testing, DOE proposed that an endplate be provided by the manufacturer of the motor and that the motor be tested with that endplate in place. If bearings are also needed, the test laboratory would use what DOE views as a ''standard bearing,'' a 6000-series, open, single-row, deep groove, radial ball bearing. DOE selected this set of specifications because it is a common bearing type capable of horizontal operation.

In response to DOE's proposal on endshields required for testing, NEMA suggested that the manufacturer should not be required to provide endshields that they may not normally produce, use, nor easily obtain, especially if the manufacturer is an importer. See 42 U.S.C. 6311(5), (7) and 6291(10) (treating importers as manufacturers for purposes of EPCA). Instead, the manufacturer should be given the option to provide the endshields, if possible. If the manufacturer declined to do so and instead agreed to let the test laboratory provide the endshields, then the test laboratory should provide the endshields for testing and consult with the manufacturer to determine the critical characteristics of the endshields. (NEMA, No. 10 at pp. 19–20)

DOE has considered NEMA's suggestion and has decided to allow the manufacturer to authorize the lab to machine endplates for testing of partial motors if the manufacturer chooses not to provide the endplate. The lab should consult with the manufacturer before constructing the endshields to determine the endshields' critical characteristics. Manufacturers should of course realize that the use of any lab machined endplate is likely to result in more losses than one machined by the manufacturer given the limited availability of certain materials (e.g. cast iron) at labs that a manufacturer may have more readily available on-hand. DOE notes that endshield specifications are found in NEMA MG–1 (2009) Section I, Part 4—see paragraphs 4.1, 4.2.1, 4.2.2, 4.3, 4.4.1, 4.4.2, 4.4.4, 4.4.5, and 4.4.6; Figures 4–1, 4–2, 4–3, 4–4, 4–5, and 4–6; and Table 4–2—and in IEC 60072–1 (1991).

F. Electric Motor Types Requiring Only Test Procedure Instructions

DOE proposed to add additional instructions to its test procedure that would affect a number of motor types for which DOE is considering new energy conservation standards. DOE did not propose any definitions for these terms because DOE believed the terms were self-explanatory or already readily understood in the industry. These motor types are discussed below.

1. Electric Motors With Non-Standard Endshields or Flanges

Most electric motors are attached to a mounting surface by ''mounting feet'' or other hardware attached to the motor's housing, oftentimes on the bottom of the motor. However, some motors are mounted by directly attaching the motor's endshield, also called a faceplate, to a piece of driven equipment. If a motor's endshield protrudes forward to create a smooth mounting surface it may also be referred to as a flange, such as a Type D-flange or Type P-flange motor, as described in NEMA MG 1–2009. Attaching a motor to the shaft of the driven equipment in this manner generally involves bolting the motor to the equipment through mounting holes in the flange or faceplate of the motor.

NEMA MG 1–2009, paragraphs 1.63.1, 1.63.2, and 1.63.3 define Type C face-mounting, Type D flange-mounting, and Type P flange-mounting motors, respectively. These definitions provide reference figures in NEMA MG 1–2009, section I, part 4 (''Dimensions, Tolerances, and Mounting'') that contain specifications for the standard mounting configurations and dimensions for these three motor types. The dimensions designate standard locations and dimensions for mounting holes on the faceplates or flanges of the motors. DOE is aware that some electric motors may have special or customer-defined endshields, faceplates, or flanges with mounting-hole locations or other specifications that do not necessarily conform to NEMA MG 1–2009, Figure 4–3, ''Letter Symbols for Type C Face-Mounting Foot or Footless Machines,'' Figure 4–4, ''Letter Symbols for Type D Flange-Mounting Foot or Footless Machines,'' or Figure 4–5, ''Letter Symbols for Vertical Machines.''

As previously explained, DOE is considering setting energy conservation standards for electric motors with non-standard endshields. This potential change to the scope of energy conservation standards for electric motors would mean that the dimensions of a motor's endshields or flanges—neither of which impacts the efficiency or the ability to measure the efficiency of the motor—would no longer dictate whether a given motor would be required to meet energy conservation standards. Hence, DOE believed that an actual definition for such motors would be unnecessary.

In evaluating the possibility of requiring these motor types to meet potential energy conservation standards, DOE assessed whether these motors could be tested using non-standard flanges or endshields. DOE had received comments concerning the testing of these motor types. In response to the March 2011 RFI (76 FR 17577), ASAP and NEMA commented that motors with customer-defined endshields and flanged special motors should have their efficiency verified by testing a motor with an equivalent electrical design that could more easily be attached to a dynamometer. (ASAP and NEMA, EERE–2010–BT–STD–0027–0020 at p. 4) NEMA added that testing motors with non-standard endshields may require a substitution of the special endshields with more conventional endshields. (NEMA, EERE–2010–BT–STD–0027–0054 at p. 15)

In the NOPR, DOE recognized that it may not be possible to attach motors with non-standard endshields to a testing laboratory's dynamometer. If such occurs and a test laboratory is unable to reconfigure the motor without removal of the endplate such that attachment to a dynamometer is possible, DOE proposed that the custom endshield be replaced with one that has standard (i.e., in compliance with NEMA MG–1) dimensions and mounting configurations. DOE proposed that, as with partial electric motors, such a replacement would be required to be obtained through the manufacturer and be constructed of the same material as the original endplate.

In response to the NOPR, several interested parties raised concerns that requiring a manufacturer to provide a ''standard endshield in compliance with NEMA MG 1,'' of the same material as the ''original end-plate'' may place an undue burden on the manufacturer. (Pub. Mtg. Tr., No. 7 at p. 105–107, 111,116–118; Advanced Energy, No. 8 at p. 4; NEMA, No. 10 at pp. 24–25) NEMA noted that the proposed test plan may have several difficulties: (1) A manufacturer may not have (or be unable to make available) end shields of

[23] Eddy currents are circulating currents induced in conductors (e.g., steel) by changing magnetic fields.

the appropriate design; (2) in the case of imported motors, it is unlikely that the importer could provide the required endshield or flange; (3) it may not be possible to obtain an endshield or flange of the same material, especially if the motor is made of a special material; and (4) replacing the original endshield with a standard dimension endshield may require different shaft construction, resulting in a completely new assembly of shaft and rotor. For situations where an electric motor with a non-standard enshield or flange cannot be connected to the dynamometer, NEMA recommended that DOE permit a testing lab to use an endshield or flange that meets the NEMA or the IEC specifications. NEMA further suggested that the manufacturer should be contacted to determine the appropriateness of replacement endshield or flange. If the replacement endshield or flange is not available then the testing laboratory may construct the same in consultation with the manufacturer. NEMA also argued that the test procedure should also allow testing of a general purpose electric motor of equivalent electrical design and enclosure, as an alternative. (NEMA, No. 10 at pp. 24–25)

Advanced Energy agreed with DOE that non-standard endshields and flanges be replaced with standard ones for testing purposes. However, Advanced Energy noted that the term ''original'' in the proposed test procedure is ambiguous because it indicated that the motor was initially designed with an endshield, which may not be the case. It suggested that the term ''original'' be replaced with ''conventional.'' Advanced Energy also expressed concern that requiring a manufacturer to provide a ''standard endshield in compliance with NEMA MG 1'' of the same material as ''original endplate'' is too strict. It suggested that manufacturers be allowed to use an alternative material for the endshield that will not impact the airflow and energy performance. It also commented that a provision should be included that allows test labs the option of fabricating suitable endshields if the need arises. (Advanced Energy, No. 8 at p. 4). UL requested that DOE consider modifying the proposed language to permit the endshield to be modified or fabricated as necessary to facilitate coupling to the dynamometer without affecting the results.'' (Pub. Mtg. Tr., No. 7 at pp. 105–107; Pub. Mtg. Tr., No. 7 at p. 111) WEG suggested that in situations where the motor cannot be tested at all, an equivalent motor with similar electrical design and a standard endshield can be tested. (Pub. Mtg. Tr., No. 7 at pp. 114–115) CDA opined that the customers can provide end covers for testing to match actual use conditions and that allowance for additional friction should be allowed for accuracy in test results. (CDA, No. 9 at p. 2)

DOE has considered these comments and decided to take slightly differing approaches for testing conducted on behalf of manufacturers (for purposes of representations and certification of compliance) and for DOE-initiated testing (for purposes of determining compliance). In both instances, if it is not possible to connect the electric motor to a dynamometer with the non-standard endshield or flange in place, the testing laboratory shall replace the non-standard endshield or flange with an endshield or flange that meets the NEMA or IEC endshield specifications. DOE notes that endshield specifications are found in NEMA MG–1 (2009) Section I, Part 4—see paragraphs 4.1, 4.2.1, 4.2.2, 4.3, 4.4.1, 4.4.2, 4.4.4, 4.4.5, and 4.4.6; Figures 4–1, 4–2, 4–3, 4–4, 4–5, and 4–6; and Table 4–2—and in IEC 60072–1 (1991). If possible, the manufacturer should provide the endshield or flange. The manufacturer may authorize the lab to machine replacement endplates or flanges for testing if the manufacturer chooses not to provide it. The lab should consult with the manufacturer before constructing these components to determine their critical characteristics.

2. Close-Coupled Pump Electric Motors and Electric Motors With Single or Double Shaft Extensions of Non-Standard Dimensions or Design

Close-coupled pump motors are electric motors used in pump applications where the impeller is mounted directly on the motor shaft. Such motors are typically built with different shafts (usually longer) than generic general-purpose electric motors. Section I, part 4 of NEMA MG 1–2009 and IEC Standard 60072–1 (1991) specify standard tolerances for shaft extensions, diameters, and keyseats that relate to the fit between the shaft and the device mounted to the shaft. However, sometimes manufacturers provide shafts with a special diameter, length, or design because of a customer's application.[24] In 2011, DOE considered clarifying its treatment of these types of motors and included a table with allowable shaft variations. 76 FR 648, 671–72 (January 5, 2011) This guidance table was intended to enumerate the deviations from standard shaft dimensions that DOE would allow while still considering the motor to be a general purpose motor subject to energy conservation standards.

However, in view of the EISA 2007 and AEMTCA 2012 amendments, DOE's scope of regulatory coverage extends beyond the initial scope set by EPCA prior to these two amendments. DOE believes that a motor's shaft alone, no matter what its dimensions or type, does not exclude a motor from having to satisfy any applicable energy conservation standards. Further, DOE believes that it is not necessary to explicitly define a close-coupled pump electric motor or an electric motor with a single or double shaft extension of non-standard dimensions or additions because whether a shaft is built within the shaft tolerances defined by NEMA and IEC is unambiguous.

In considering applying standards to these types of motors, DOE assessed whether motors with non-standard shaft dimensions or additions can be tested using accepted and established procedures. DOE received feedback concerning the testing of these motor types during and after the October 18, 2010, framework document public meeting. NEMA and ASAP submitted a joint comment noting that DOE could allow testing of a ''similar model'' motor with a standard shaft to enable the motor to be more easily tested on a dynamometer. (NEMA and ASAP, EERE–2010–BT–STD–0027–0012 at p. 8) In its comments about the electric motors preliminary analysis, NEMA added that special couplings or adapters may be needed to test motors with special shaft extensions, but noted that a motor's shaft extension has little to no effect on its efficiency. (NEMA, EERE–2010–BT–STD–0027–0054 at p. 14)

DOE investigated the feasibility of using coupling adapters for motors with extended shafts or shafts of unique design. To do this, DOE procured a close-coupled pump motor with an extended shaft. When this motor was received, DOE's testing laboratory had no problems attaching the motor to its dynamometer. The use of an adapter was not needed in this case. However, DOE also conferred with experts at its testing laboratory and learned that coupling adapters were needed for motors with extended shafts or shafts of unique design, which it had tested in the past. As such, DOE is not aware of any motor shaft design that has prevented DOE's test laboratory from performing a proper test according to IEEE 112 (Test Method B). Therefore, DOE proposed to include instructions for special couplings or adapters. In

[24] For example, see Baldor's marketing materials at: *http://www.baldor.com/support/Literature/Load.ashx/BR401?LitNumber=BR401.*

other words, if a testing facility cannot attach a motor to its dynamometer because of the motor's shaft extension, that facility should use a coupling or adapter to mount and test the motor. DOE understood that a motor's shaft configuration has minimal, if any, impact on overall motor efficiency, and believed that this approach was technologically feasible and would not result in any distortion of a motor's inherent efficiency when tested.

In response to the NOPR, the interested parties agreed with DOE's decision to not define motors with non-standard shaft dimensions or additions. However, NEMA suggested replacing the term ''additions'' with ''non-standard designs'' to provide better clarity. (NEMA, No. 10 at p. 26)

To avoid any ambiguity regarding this motor type, DOE has modified the term to be ''Electric Motors with Single or Double Shaft Extensions of Non-Standard Dimensions or Design.'' DOE believes that this change to the description of this motor type is broad enough to characterize all electric motors with non-standard shafts without unintentionally limiting this motor type to those with shaft additions. In view of its own research and consensus among interested parties, DOE is continuing to not define these electric motor types.

3. Vertical Electric Motors

Although most electric motors are engineered to run while oriented horizontally, some operate in applications that require a vertical orientation. A horizontally oriented motor has a shaft parallel to the floor (or perpendicular to the force of gravity), while a vertically oriented motor has a shaft perpendicular to the floor (or parallel to the force of gravity). Relative to horizontal motors, vertical motors have different designs made with different construction techniques so that the electric motor can be operated in a vertical position. These different designs can include modifications to the mounting configuration, bearing design, and bearing lubrication (a discussion regarding bearings can be found in the following section, III.F.4). Additionally, vertical motors can come with various shaft configurations, including with a solid or hollow shaft. An example of a typical application requiring a vertical motor is a pump used in a well or a pit.

DOE did not propose a definition for any terms related to vertical electric motors. DOE believed definitions were not needed because there is no industry confusion or ambiguity in whether an electric motor is a vertical electric motor. Furthermore, whether an electric motor has a solid shaft or a hollow shaft is also unambiguous and unnecessary to clarify. Although defining a vertically mounted electric motor did not appear necessary, DOE believed instructions detailing how to configure and mount a vertical motor for testing in a horizontal position, including the motor's orientation and shaft characteristics, would be helpful in ensuring a proper and consistent testing set-up.

EISA 2007 classified vertical solid-shaft motors as subtype II motors and required them to be tested in a ''horizontal configuration.'' (42 U.S.C. 6311(13)(B)(v)) Prior to the NOPR, NEMA, ASAP, and the Motor Coalition submitted comments, noting that vertical motors cannot be tested on a standard dynamometer because most dynamometers are designed to test electric motors in horizontal orientation. (NEMA, EERE–2010–BT–STD–0027–0013 at p. 5; NEMA and ASAP, EERE–2010–BT–STD–0027–0012 at p. 3; Motor Coalition, EERE–2010–BT–STD–0027–0035 at pp. 18 and 30) DOE confirmed this assertion with its test laboratory and SMEs. In view of the statutory requirement and current dynamometer testing configuration limits, DOE proposed in the NOPR to test motors, which are otherwise engineered to operate vertically, in a horizontal position when determining efficiency.

Another consideration was the shaft of a vertical motor and whether it was solid or hollow. If a vertical motor has a solid shaft, DOE proposed no further adjustments after considering orientation, unless the motor contained a special shaft. For vertical motors with a hollow shaft, (i.e., an empty cylinder that runs through the rotor and typically attaches internally to the end opposite the drive of the motor with a special coupling) additional instructions were proposed.

DOE conducted testing prior to the NOPR publication to gauge the feasibility of testing a vertical, hollow-shaft motor. For its investigation, DOE purchased a five-horsepower, two-pole, TEFC vertical motor with a hollow shaft. Upon receipt of the motor, the testing laboratory found that the motor's bearing construction was sufficient for horizontal operation and no replacement would be needed. However, the motor did require a shaft extension to be machined. After a solid shaft was constructed, it was inserted into the hollow shaft and attached via welding to the lip of the hollow shaft. The testing laboratory encountered no further problems and was able to properly test the motor according to IEEE Standard 112 (Test Method B).

After conducting this testing, DOE believed that, as long as the attached solid-shaft maintained sufficient clearance through the drive end of the motor to enable the motor to be attached to the dynamometer, this approach would be feasible to test vertical hollow-shaft motors. Aside from the addition of a shaft extension, DOE did not believe that testing a vertical hollow-shaft motor in a horizontal configuration would add undue testing burden when compared to testing a solid-shaft vertical motor.

In response to the March 2011 RFI, NEMA suggested that vertical motors rated 1–500 horsepower be tested according to section 6.4 of IEEE Standard 112 (Test Method B—*Input-output with segregation of losses and indirect measurement of stray-load loss*), if bearing construction permits; otherwise, it suggested testing vertical motors according to section 6.6 of IEEE Standard 112 (Test Method E—*Electric power measurement under load with segregation of losses and direct measurement of stray-load loss*), as specified in NEMA MG 1–2009 paragraph 12.58.1 ''Determination of Motor Efficiency and Losses.'' [25] (NEMA, EERE–2010–BT–STD–0027–0019 at p. 4)

DOE consulted with testing laboratories about whether IEEE Standard 112 (Test Method E) would be an appropriate procedure to use when testing vertical motors. DOE understood that the primary difference between IEEE Standard 112's Test Method B and Test Method E is that Test Method E uses a different method to calculate stray-load loss relative to Test Method B. Test Method B measures motor output power and uses this number as part of the calculation for stray-load loss. However, Test Method E does not require the measurement of output power, and, therefore, uses a different method to find the stray-load loss. By not requiring the measurement of output power, Test Method E can be conducted on motors installed in an area or in

[25] ''Efficiency and losses shall be determined in accordance with IEEE Std 112 or Canadian Standards Association Standard C390. The efficiency shall be determined at rated output, voltage, and frequency. Unless otherwise specified, horizontal polyphase, squirrel-cage medium motors rated 1 to 500 horsepower shall be tested by dynamometer (Method B) (or CSA Std C390 Method 1) as described in Section 6.4 of IEEE Std 112. Motor efficiency shall be calculated using form B of IEEE Std 112 or the equivalent C390 calculation procedure. Vertical motors of this horsepower range shall also be tested by Method B if bearing construction permits; otherwise they shall be tested by segregated losses (Method E) (or CSA Std Method 2) as described in Section 6.6 of IEEE Std 112, including direct measurement of stray-loss load.'' NEMA Standards Publication MG1—2009, *Motors and Generators,* paragraph 12.58.1.

equipment that cannot be attached to a dynamometer. Although Test Method E may reduce some testing burden for manufacturers of vertical motors, DOE was concerned that Test Method E could produce results that were inconsistent and inaccurate relative to testing comparable motors under Test Method B. Therefore, DOE declined to propose the use of Test Method E for vertical motors.

In response to the NOPR, there were several comments regarding the definitions and test setups for vertical motors. Assuming that DOE intended to set standards eventually for vertical motors generally (beyond those already applicable to general purpose subtype II motors), NEMA suggested that newly-covered vertical motors be considered as either definite purpose electric motors or special purpose electric motors and their features be incorporated in a definition for vertical motors to clearly identify the type included in the covered electric motors. (NEMA, No. 10 at p. 29)

As described earlier, in the NOPR, DOE did not intend to define ''covered motors.'' Rather, it was DOE's intention to define subsets of motors that would have the potential to be covered in a standards rulemaking. In the case of vertical motors, DOE did not believe that a definition was necessary because it is always obvious whether a motor is intended for vertical operation. Being defined as a vertical motor would not, then, necessarily mean a vertical motor was subject to energy conservation standards. The current energy conservation standards rulemaking is intended to determine coverage parameters for defined motor types. Based on these facts, DOE does not believe it is necessary to state whether a vertical motor is special or definite purpose (as neither distinction would change the fact that the motor is vertical), and has not updated its decision from the NOPR to leave vertical motors undefined.

In regard to testing, NEMA commented that IEEE 112 (Test Method E) is a standard method for testing vertical motors when the vertical motor cannot be tested in horizontal position due to bearing construction (which may require that vertical load be exerted on the bearings). NEMA suggested that because vertical electric motors other than vertical solid shaft normal thrust general purpose electric motors (subtype II) would be included in the scope of covered products (and which may require testing in vertical orientation), IEEE 112 (Test Method E) be added as a valid test procedure in paragraph 2 of Appendix B to Subpart B and all other paragraphs in Subparts B and U where it is necessary to identify the applicable test standards for vertical motors. (NEMA, No. 10 at p. 32) NEMA noted that there will be a difference in efficiency when a vertical motor is tested in vertical position with no modification as compared to the vertical motor tested in horizontal position after changing the bearings. NEMA suggested that this difference in efficiency levels should be considered while establishing standards for vertical motors. (NEMA, No. 10 at pp. 31–32)

Based on the present definitions in 10 CFR 431.12, and those proposed in the NOPR, and assuming that vertical motors of various types are to be included, NEMA recommended that the proposed test procedure be revised to permit the testing of vertical electric motors in a horizontal or vertical configuration according to the equipment available at the testing facility and the construction of the motor. If the vertical motor cannot operate in a horizontal position due to its bearing construction or due to the requirement that a vertical load be applied to the shaft, then the bearings should be replaced with the standard bearings during testing. NEMA further suggested that a coupling or other adapter may be required to connect the vertical electric motor to the test equipment to provide sufficient clearance. (NEMA, No. 10 at p. 32)

DOE has reevaluated its test instructions for vertical electric motors following the comments received in response to the NOPR. It understands that there was confusion prior to the NOPR regarding which types of vertical motors were being defined, and earlier comments were based on this misunderstanding. After the NOPR, DOE verified the claims in the comments with SMEs and determined that testing vertically and testing horizontally would result in similar efficiencies. However, for reasons stated earlier, DOE continues to decline the use of IEEE 112 (Test Method E). For this final rule, while vertical solid shaft normal thrust general purpose electric motors (subtype II) shall be tested in a horizontal configuration in accordance with IEEE 112 (Test Method B), the test instructions for other types of vertical electric motors are amended to allow test labs to choose between vertical and horizontal orientation for testing, as provided for by the lab's equipment, with preference given to testing in the motor's native orientation when either is possible.

4. Electric Motor Bearings

Electric motors usually employ anti-friction bearings that are housed within the endshields to support the motor's shaft and provide a low-friction means for shaft rotation. Anti-friction bearings contain rolling elements, which are the components inside the bearings that ''roll'' around the bearing housing and provide the reduced-friction means of rotation. Rolling elements can be spherical, cylindrical, conical, or other shapes. The design of the rolling element is selected based on the type and amount of force the shaft must be capable of withstanding. The two primary types of loads imposed on motor bearings are radial and thrust. Radial loads are so named because the load is applied along the radius of the shaft (i.e., perpendicular to the shaft's axis of rotation). Bearings may be subject to radial loads if the motor's shaft is horizontal to the floor (i.e., horizontally oriented). These bearings are called ''radial bearings.'' ''Thrust bearings'' are bearings capable of withstanding thrust loads, which are loads with forces parallel to the ''axis'' of the shaft (i.e., parallel to the shaft's axis of rotation) and may be encountered when the shaft is vertical to the floor (i.e., vertically oriented). However, either radial or axial shaft loads can be encountered in any orientation.

In addition to the type of force, bearings are also chosen based on the magnitude of the force they can withstand. While most applications use spherical rolling-elements, some motors employ cylindrical-shaped rolling-elements inside the bearings. These cylindrical-shaped rolling elements are called ''rollers,'' and this bearing type is referred to as a ''roller bearing.'' Roller bearings can withstand higher loads than spherical ball bearings because the cylindrically shaped rolling-element provides a larger contact area for transmitting forces. However, the larger contact area of the rolling element with the bearing housing also creates more friction and, therefore, may cause more losses during motor operation.

Regardless of the rolling element used, bearings must be lubricated with either grease or oil to further reduce friction and prevent wear on the bearings. Open or shielded bearing construction allows for the exchange of grease or oil during motor operation. Sealed bearings, unlike shielded or open bearings, do not allow the free exchange of grease or oil during operation. Sealed bearings incorporate close-fitting seals that prevent the exchange of oil or grease during the bearing's operational lifetime. Such bearings may be referred to as ''lubed-for-life'' bearings because the user purchases the bearings with the intention of replacing the bearing before it requires re-lubrication. Shielded bearings differ from open bearings in that shielded bearings contain a cover, called a ''shield,'' which allows the flow of oil or grease into the inner portions of the bearing casing, but restricts dirt or debris from contacting the rolling elements. Preventing dirt and debris from contacting the bearing prevents wear and increases the life of the bearing.

Certain vertical motors use oil-lubricated bearings rather than the grease-lubricated bearings that are typically found in horizontal motors. If a vertical motor contains an oil-lubricated system, problems can occur when the motor is reoriented into a horizontal position and attached to a dynamometer for testing. Because oil has a lower viscosity than grease, it could pool in the bottom of the now horizontally oriented (vertical motor) bearing.[26] Such pooling, or loss of proper lubrication to the bearings, could adversely affect the motor's performance, damage the motor, and distort the results of testing.

Because of the various construction and lubrication types, DOE understands that motors may contain bearings only capable of horizontal operation, vertical operation, or, in some limited cases, both horizontal and vertical operation. For those motors equipped with thrust bearings only capable of vertical orientation, DOE stated in the NOPR that reorienting the motor could cause physical damage to the motor. For motors equipped with such bearings, DOE proposed to add testing instructions that would require the testing laboratory to replace the thrust bearing with a ''standard bearing,'' which DOE defined as a 6000 series, open, single-row, deep groove, radial ball bearing, because that is the most common type of bearing employed on horizontally oriented motors. For any electric motor equipped with bearings that are capable of operating properly (i.e., without damaging the motor) when the motor is oriented horizontally, DOE proposed that the motor should be tested as is, without replacing the bearings. DOE believed that this was the most appropriate approach because it would provide the truest representation of the energy use that will be experienced by the user.

[26] Viscosity is the measure of a liquid's resistivity to being deformed. An example of a material with high viscosity is molasses and an example of a material with low viscosity is water.

NEMA agreed that thrust bearings should be replaced with standard bearings if the motor is tested in an orientation different from the normal one. However, NEMA stated that the motor manufacturer should be consulted before any modification is made. This is because some bearings may require oil or other lubricants for normal use. (NEMA, No. 10 at pp. 28, 32–33)

Advanced Energy agreed with the proposed approach of testing electric motors with bearings capable of horizontal orientation. However, for motors with bearings not capable of horizontal orientation, Advanced Energy proposed that thrust bearings be replaced with shielded bearings with already packed grease to prevent over-filling of grease and to reduce lead time of installation of bearings. (Advanced Energy, No. 8 at p. 5) Advanced Energy requested that DOE replace ''should'' with ''may,'' in the proposed testing instruction for ''electric motors with bearings incapable of horizontal operation'' so that the testing instruction for states: ''may replace the thrust bearing'' and ''may be tested as is''. (Pub. Mtg. Tr., No. 7 at p. 130)

DOE notes NEMA's and Advanced Energy's comment that different bearings may require different lubricants (e.g., oil, grease), which should be considered when the bearings of a motor are replaced with standard bearings for testing. Considering NEMA's and Advanced Energy's comments, DOE has modified the definition of standard bearings to include a grease lubricated double shielded bearing. Furthermore, while DOE understands Advanced Energy's suggestions regarding the language, the language is written such that only motors whose bearings cannot be operated horizontally ''shall be'' replaced for testing. DOE believes that this renders this suggested wording change unnecessary. Motors whose bearings do not permit horizontal operation but which must be tested horizontally due to test equipment availability must have their bearings replaced in order to yield accurate results.

In response to the preliminary analysis, DOE received comment specifically about testing electric motors with sleeve bearings. Sleeve bearings are another type of bearing that do not use typical rolling elements, but rather consist of a lubricated bushing, or ''sleeve,'' inside of which the motor shaft rotates. The shaft rotates on a film of oil or grease, which reduces friction during rotation. Sleeve bearings generally have a longer life than anti-friction ball bearings, but they are more expensive than anti-friction ball bearings for most horsepower ratings.[27] Both ASAP and NEMA asserted that a motor with sleeve bearings should have its efficiency verified by testing a motor of equivalent electrical design and that employs standard bearings.[28] (ASAP and NEMA, EERE–2010–BT–STD–0027–0020 at p. 4) However, NEMA later revised its position in separately submitted comments to the electric motors preliminary analysis public meeting. NEMA stated that further review of pertinent test data indicated that sleeve bearings do not significantly impact the efficiency of a motor, and that a motor having sleeve bearings is not sufficient reason to exclude it from meeting energy conservation standards. (NEMA, EERE–2010–BT–STD–0027–0054 at p. 17) NEMA also commented that it is not aware of any reason that a motor cannot be tested with sleeve bearings, but that DOE should also provide the option to test sleeve bearing motors with the sleeve bearing swapped out for anti-friction ball bearings. (NEMA, EERE–2010–BT–STD–0027–0054 at p. 17)

DOE separately consulted with testing laboratories, SMEs, and manufacturers and reviewed a pertinent technical paper.[29] As a result of this collective research, at the time of the NOPR, DOE tentatively determined that sleeve bearings do not significantly degrade efficiency when compared to spherical, radial ball bearings. DOE also did not believe that it was more difficult to attach a motor with sleeve bearings to a dynamometer than a standard, general purpose electric motor equipped with radial ball bearings. Additionally, DOE believed that swapping sleeve bearings with spherical, radial ball bearings may be time consuming and otherwise present unforeseen or undue difficulties because of the overall design of the motor that operates with the sleeve bearings. Motors that employ sleeve bearings have significantly different bearing-support configurations than motors that employ spherical, radial ball bearings, and DOE was not certain that sleeve bearings could be readily

[27] William R. Finley and Mark M. Hodowanec. *Sleeve Vs. Anti-Friction Bearings: Selection of the Optimal Bearing for Induction Motors.* 2001. IEEE. USA.

[28] Neither NEMA nor ASAP elaborated on what ''standard'' bearings are. DOE is interpreting ''standard'' bearings to mean spherical, radial ball bearings, because this is the most common type of bearing used for general purpose, horizontally oriented motors.

[29] William R. Finley and Mark M. Hodowanec. *Sleeve Vs. Anti-Friction Bearings: Selection of the Optimal Bearing for Induction Motors.* 2001. IEEE. USA.

swapped with standard ball bearings without significant, costly motor alterations. Therefore, because it may be impracticable to swap them out with other bearings, DOE proposed that motors with sleeve bearings be tested as-is and with the sleeve bearings installed.

In response to the NOPR, NEMA agreed with DOE's proposal to test motors with sleeve bearings intact. NEMA stated that testing the motor with sleeve bearings in place will result in a decrease of efficiency due to losses associated with sleeve bearings. In its view, the efficiency measure will thus represent normal consumer operation. NEMA further added that the normal IEEE 112 (Test Method B) or (Test Method E), where applicable, is sufficient for testing electric motors with sleeve bearings. (NEMA, No. 10 at pp. 27–28, 32–33)

As no stakeholders presented reasons why motors with sleeve bearings should not be tested with the bearings in place, and the available facts indicate that the presence of sleeve bearings does not affect efficiency testing, DOE has retained this approach for this final rule.[30] As these sleeve bearings will already be in place when the motor arrives for testing, and the bearings will not be replaced, if the shield bearings are not already have packed grease in place, it will not be used for testing.

5. Electric Motors With Non-Standard Bases, Feet or Mounting Configurations

DOE has not yet regulated special or definite purpose motors, or general purpose motors with ''special bases or mounting feet,'' because of the limits prescribed by the previous statutory definition of ''electric motor.'' That definition included a variety of criteria such as ''foot-mounting'' and being built in accordance with NEMA ''T-frame'' dimensions, which all narrowed the scope of what comprised an electric motor under the statute. (See 42 U.S.C. 6311(13)(A) (1992)) As a result of EISA 2007 and related amendments that established energy conservation standards for two subtypes of general purpose electric motors (subtype I and subtype II), among other motor types, the statutory meaning of the term ''general purpose motor'' was broadened to include, for example, ''footless motors.'' Similarly, because definite and special purpose motors now fall under the broad statutory heading of ''electric motors,'' DOE is now considering whether to set standards for electric motors with non-standard bases, feet, or mounting configurations in the standards rulemaking.

Part 4 of section I in NEMA MG 1–2009 provides general standards for dimensions, tolerances, and mounting for all types of electric motors. In that section, figures 4–1 through 4–5 identify the letter symbols associated with specific dimensions of electric motors with various bases, feet, and mounting configurations. Accompanying these figures are tables throughout part 4 of section I that specify dimensions, explain how a particular dimension is measured and detail the applicable measurement tolerances. This collective information is used to standardize the dimensions associated with specific frame sizes, given a certain base, feet, or mounting configuration. The IEC provides similar information in its standard, IEC Standard 60072–1, ''Dimensions and output series for rotating electrical machines.'' Although the majority of motors are built within these specifications, DOE is aware that some motors may have feet, bases, or mounting configurations that do not necessarily conform to the industry standards. These are the motors—i.e. those not conforming to NEMA or IEC standards for bases, feet, or mounting configurations—that DOE is considering regulating under the standards NOPR.

DOE believed that a definition was not needed for this particular type of electric motor because whether a motor has a mounting base, feet, or configuration that is built in compliance with the standard dimensions laid out in NEMA MG 1–2009 or IEC Standard 60072–1 was unambiguous. Also, DOE believed that additional testing set-up instructions for these types of electric motors were not necessary because such mounting characteristics are not explicitly addressed either in IEEE Standard 112 (Test Method B) or CSA C390–10, other than how mounting conditions will affect the vibration of a motor under IEEE Standard 112, paragraph 9.6.2, ''Mounting configurations.''

In response to the March 2011 RFI, ASAP and NEMA asserted that a motor with a special base or mounting feet, as well as a motor of any mounting configuration, should have its efficiency verified by testing a model motor with an equivalent electrical design that could more easily be attached to a dynamometer. (ASAP and NEMA, EERE–2010–BT–STD–0027–0020 at p. 4)

DOE believed testing a ''similar model'' to show compliance would likely create difficulties in ensuring the accuracy and equivalence of claimed efficiency ratings. Additionally, DOE believed that testing motors with non-standard bases or mounting feet would not present an undue burden or insurmountable obstacle to testing. The test benches used for testing electric motors can have, for example, adjustable heights to accommodate the wide variety of motor sizes and mechanical configurations that commonly exist. Therefore, because the mounting feet will not necessarily affect how a motor is mounted to a dynamometer, but simply the positioning of the shaft extension, DOE believed non-standard mounting feet would present no additional testing burdens. As was done for the vertical electric motor that DOE had tested and which did not have a standard horizontal mounting configuration, a testing laboratory would likely treat these motors as a typical general purpose electric motor and adjust the test bench as applicable for the unit under test.

Finally, DOE understood that an electric motor's mounting base, feet, or configuration would have no impact on its demonstrated efficiency. An electric motor's mounting base, feet, or configuration does not affect a motor's operating characteristics because this is a feature external to the core components of the motor. It is also a feature that will not impact friction and windage losses because this feature does not involve any rotating elements of the motor. An electric motor's mounting base, feet, or mounting configuration only affects how a motor is physically installed in a piece of equipment. DOE's approach was premised on these facts.

While NEMA agreed with DOE's proposed approach not to define electric motors with non-standard base, feet or mounting configurations, it suggested that additional test instructions for these electric motor types were needed in view of testing difficulties. (NEMA, No. 10 at p. 26) In the case of special mounting configurations or footless motors, particularly TENV types, NEMA stated that mounting configuration may affect the free convection cooling of the motor. For instance, some testing facilities may use a V-shape or U-shape block with straps to hold the movement of a footless motor. The design of the block(s) can inhibit free convection over TENV motor and can cover ventilation openings in case of open motors. Thus, NEMA recommended that DOE consider adding language for testing of an electric motor with non-standard bases, feet, or mounting configurations to ensure that the method of mounting ''does not have an adverse effect on the performance of the electric motor'' particularly on

[30] William R. Finley and Mark M. Hodowanec. *Sleeve Vs. Anti-Friction Bearings: Selection of the Optimal Bearing for Induction Motors.* 2001. IEEE. USA.

cooling of the motor due to use of adaptive mounting fixtures. (NEMA, No. 10 at p. 27).

DOE notes NEMA's concern and understands that the current procedures to test electric motors with a non-standard base, feet, or mounting configuration, as described by NEMA, may affect the cooling of the motor and impact the efficiency ratings of the motor. In order to achieve accuracy in the efficiency measures, because bases, feet, and mounting arrangements can alter tested efficiency, DOE has adopted the following test procedure for electric motors with a non-standard base, feet, or mounting configuration: ''Some adaptive fixtures may be required to mount a motor on the test equipment when testing an electric motor with a non-standard base, feet, or mounting configuration. The method of mounting or use of adaptive mounting fixtures should not have an adverse impact on the performance of the electric motor, particularly on the cooling of the motor.''

6. Electric Motors With Separately-Powered Blowers

In the NOPR, DOE addressed a subset of immersible motors it referred to as being built in a ''TEBC'' (totally enclosed blower cooled—i.e., with cooling airflow provided by a separate blower driven by a separate, auxiliary motor) configuration. These motors were not only immersible, but had a separately powered blower as part of their assembly. For these motors, DOE proposed requiring the testing laboratory to power the smaller blower motor from a power source separate from the one used for the electric motor being tested for efficiency. Following this approach would allow the testing laboratory to isolate the performance of the motor under test while continuing to provide the necessary cooling from the blower motor.

Advanced Energy concurred with separately powering the blower motor of an immersible motor configured in a TEBC configuration. (Advanced Energy, No. 8 at p. 3) However, NEMA requested that DOE reconsider the requirement of ''separate power source'' in the proposed definition because a test facility may have only one power source. NEMA also stated that this requirement is not necessary because all that matters is that the test equipment used to measure the electrical power flowing into the motor is connected only to the motor leads and not to both the motor leads and blower leads. Also, in its view, the proper voltage should be applied to the blower when the voltage to the motor is to be reduced as a part of the IEEE 112 Method B or Method E test procedure. NEMA commented that it was unclear why the requirement to exclude the input power to the blower in the measurement of the motor power would apply only to blower cooled ''immersible'' motors if the test procedure is intended to apply to any electric motor with contact seals. The test procedure should also clearly state that the input power to the separately powered blower is not to be included in the determination of the efficiency of the immersible definite purpose electric motor, or, in general, for any electric motor with a separately powered blower furnished as a part of the total assembly. (NEMA, No. 10 at pp. 23–24)

Following the NOPR, DOE raised this issue with stakeholders and SMEs. From those discussions, DOE acknowledges that at least some non-immersible motors that were furnished with separately-powered blowers exist would also meet the nine criteria that DOE is considering applying with respect to its standards rulemaking efforts. It was not DOE's intention to omit guidance on testing these motors; DOE agrees with NEMA that a test plan for ''blower-cooled'' electric motors should not be limited only to those motors that are also immersible. Therefore, in this final rule, DOE is adding separate test set-up instructions for an ''electric motor with a separately-powered blower.'' This set-up will be applicable to any electric motor that has this particular design element, regardless of whether this electric motor is also immersible. As DOE did not receive comments in the NOPR asking DOE to define this motor type, the Department believes that stakeholders understand what motor types were covered by this test set-up, and DOE has opted not to define this motor type at this time.

Regarding the use of the term ''separate power source,'' DOE recognizes that test labs may use a variety of power supplies to facilitate testing. DOE believes that NEMA's suggested plan of measuring the two sources of power separately (rather than powering them separately) can work, provided it is done such that it accurately characterizes the power going into the tested motor. In either arrangement, the objective is to exclude the power to the blower's motor from any calculations of efficiency for the tested motor. For these reasons and based on the comments received, DOE has added instructions to the procedure to exclude the losses attributable to the motor powering a separately-powered blower. Under this change, the blower's motor can be powered by a source separate from the source powering the electric motor under test or by connecting leads such that they only measure the power of the motor under test. This instruction follows from DOE's proposal ''to isolate the performance of the motor under test while continuing to provide the necessary cooling from the blower motor.'' 78 FR 38466. In this final rule, DOE extends those instructions to all motors with separately-powered blowers rather than limiting it to immersible motors in recognition of the fact that the qualities of being immersible and having a separately-powered blower are technologically independent and should be treated as such.

G. Electric Motor Types Requiring Only Definitions

There are several electric motor types whose energy efficiency DOE is not proposing to regulate as part of the recently published energy conservation standards proposal but that DOE is defining in today's rule to provide manufacturers regulatory clarity when the final standards rule is published. More details regarding the specific motor types are discussed below.

1. Component Set of an Electric Motor

Electric motors are comprised of several primary components that include: A rotor, stator, stator windings, stator frame, two endshields, two bearings, and a shaft. As described in the NOPR, a component set of an electric motor comprises any combination of these motor parts that does not form an operable motor. 78 FR 38466. For example, a component set may consist of a wound stator and rotor component sold without a stator housing, endshields, or shaft. These components may be sold with the intention of having the motor parts mounted inside other equipment, with the equipment providing the necessary mounting and rotor attachments for the components to operate in a manner similar to a stand-alone electric motor. Component sets may also be sold with the intention of a third party using the components to construct a complete, stand-alone motor. In such cases, the end manufacturer that ''completes'' the motor's construction must certify that the motor meets any pertinent standards. (See 42 U.S.C. 6291(1)(10) (defining ''manufacture'' to include manufacture, produce, assemble, or import.)) This approach was supported by NEMA in its comments on the electric motors preliminary analysis. (NEMA, EERE–2010–BT–STD–0027–0054 at pp. 15–16)

DOE understands that a component set does not constitute a complete, or near-complete, motor that could be tested under IEEE Standard 112 (Test Method B) or CSA C390–10, because it would require major modifications before it can operate as a motor. In view of its examination of motor component sets, DOE understands that some of them would require the addition of costly and fundamental parts for the motor to be capable of continuous-duty operation, as would be required under either test procedure. The parts that would need to be added to the component set, such as a wound stator or rotor, are complex components that directly affect the performance of a motor and can only be provided by a motor manufacturer. Without the fundamental components, there is no motor. Therefore, DOE believes that a single testing laboratory would have insurmountable difficulty machining motor parts, assembling the parts into an operable machine, and testing the motor in a way that would be manageable, consistent, and repeatable by other testing laboratories. Because DOE is not aware of any test procedures or additional test procedure instructions that would accommodate the testing of a component set in a manageable, consistent, and repeatable manner, it declined to consider component sets for energy conservations standards in the NOPR.

In terms of defining a ''component set,'' DOE was aware of some confusion regarding what constitutes a ''component set'' of a motor, especially about the difference between a ''component set'' and a ''partial'' motor. No technical standard currently defines these terms. To bring a common definition for these generally understood, but undefined, concepts, DOE proposed to define a ''component set'' as a ''combination of motor parts that require the addition of more than two endshields to create an operable motor.'' 78 FR 38469. Under the proposed definition, these parts may consist of any combination of a stator frame, wound stator, rotor, shaft, or endshields and the term ''operable motor'' would refer to an electric motor engineered for performing in accordance with nameplate ratings. 78 FR 38469.

In response to the NOPR, Nidec suggested that the definition of component set be clearer so that it can be differentiated from a partial motor. It criticized the proposed definition for not being clear enough to distinguish a component set from a partial motor. (Pub. Mtg. Tr., No. 7 at p. 31) NEMA, on the other hand, recommended that DOE not define this term, noting that the clearer definition of partial motor should be sufficient to distinguish it from a component set. (NEMA, No. 10 at p. 34)

In DOE's view, defining what a ''component set'' is, and distinguishing it from a ''partial electric motor'' is critical. Furthermore, as explained earlier, DOE does not intend to define only those motors for which it is proposing energy conservation standards in the parallel rulemaking. Rather, motors that need to be defined in order to clearly outline coverage in the standards rulemaking will be defined. By defining a ''component set,'' DOE can clearly state whether a given motor would be affected in a particular standards rulemaking.

Nidec also raised concerns regarding where bearings fit into the definition (i.e. whether the presence or absence of bearings factored into the classification of equipment as a compenent set or partial electric motor), In recognition of the fact that bearings are often specifically designed to match endplates, DOE is modifying its proposed definition by adding the phrase ''and their associated bearings'' to the ''component set'' definition. to better distinguish it from a partial motor. To mitigate the risk of confusion, DOE is defining a component set as referring to ''a combination of motor parts that require the addition of critical componentry in excess of two endshields (and their associated bearings) to create an operable motor.'' In view of its own research and consensus among interested parties, DOE is maintaining its NOPR proposal.

2. Liquid-Cooled Electric Motor

While most electric motors are air-cooled and many use a fan attached to the shaft on the end opposite the drive to blow air over the surface of the motor to dissipate heat during the motor's operation, liquid-cooled electric motors rely on a special cooling apparatus that pumps liquid into and around the motor housing. The liquid is circulated around the motor frame to dissipate heat and prevent the motor from overheating during continuous-duty operation. A liquid-cooled electric motor may use different liquids or liquids at different temperatures, which could affect the operating temperature of the motor and, therefore, the efficiency of the motor. This variability could present testing consistency and reliability problems.

Neither IEEE Standard 112 (Test Method B) nor CSA C390–10 provide a standardized methodology for testing the energy efficiency of a liquid-cooled electric motor. Additionally, as NEMA noted in its comments, these motors are typically used in space-constrained applications, such as mining applications, and require a high power density, which somewhat limits their efficiency potential. (NEMA, NEMA, EERE–2010–BT–STD–0027–0054 at p. 42) In view of these likely testing consistency problems, DOE noted its intent to not propose energy conservation standards for these motors at this time. 78 FR 38475.

At least two key issues were raised in the context of these motors: First, how to test them while accounting for temperature differences and second, how to differentiate these motors from certain other motor types.

a. Temperature Conditions

In response to the NOPR, NEMA commented that it is very difficult to simulate the various environments in a testing facility where the tested motor is required to be connected to a dynamometer. In order to maintain acceptable temperature levels, some motors operating in an open environment may rely on both free convection and liquid cooling, motors operating in a confined space may rely only on liquid cooling and other motors may be operated in an area with externally supplied ventilating air and liquid cooling. (NEMA, No. 10 at p. 36). Thus, NEMA argued that energy conservation standards should not be established for liquid-cooled electric motors. As noted earlier, NEMA commented that the liquid-cooled electric motors are used in specialized applications that require high power density within a limited size. Different physical sizes may be used for the same power rating for different applications for different speed-torque performance, as needed. This fact also makes it difficult to establish any particular energy conservation standard for a rating. (NEMA, No. 10 at pp. 35–36).

No standardized methodology for testing the energy efficiency of a liquid-cooled electric motor, the consensus among stakeholders on how to treat these motors, and liquid-cooled electric motors are likely to be used in specialized applications with high power density requirements. Because of that, it is difficult to established a procedure that can be confidently said to be representative of energy use experienced by consumers. For that reason, DOE is not establishing energy conservation standards for liquid-cooled electric motors at this time.

b. Differentiating From Other Motor Types

In response to the October 15, 2010 energy conservation standards framework document, NEMA and ASAP commented that greater clarification is needed with regard to liquid-cooled electric motors and how to differentiate them from immersible or submersible electric motors. (NEMA and ASAP, EERE–2010–BT–STD–0027–0012 at p. 9) DOE proposed to define ''liquid-cooled electric motor'' to clarify DOE's view of which motors would be covered by this term but did not indicate it planned to set standards for them. DOE's proposed definition was based on the definition of a ''totally enclosed water-cooled machine'' found in paragraph 1.26.5 of NEMA MG 1–2009. Further, DOE proposed to remove ''totally enclosed'' from the definition to prevent any unintentional limitations of the definition due to frame construction; liquid-cooling may exist independently of degree of frame enclosure. DOE also planned to replace the term ''water'' with ''liquid'' to cover the use of any type of liquid as a coolant. Finally, per comments from NEMA, DOE proposed to modify the term ''water conductors'' to ''liquid-filled conductors'' to clarify that the conductors, themselves, are not made of liquid. (NEMA, EERE–2010–BT–STD–0027–0054 at p. 35) Consequently, DOEe proposed to define ''liquid-cooled electric motor'' as ''a motor that is cooled by circulating liquid with the liquid or liquid-filled conductors coming into direct contact with the machine parts.''

In response to the NOPR, NEMA commented that it does not see a need for a definition of ''liquid-cooled electric motor'' because these motor types are not covered under regulation. However, if DOE still decided there was a need to include a definition, NEMA suggested using and defining the term ''liquid-cooled definite purpose motor'' rather than ''liquid-cooled definite purpose electric motor''. In order to remove any confusion related to ''liquid filled conductors'', NEMA recommended the definition, if needed, be modified as: ''Liquid-cooled definite purpose motor means a motor that is cooled by circulating liquid with the liquid coming into direct contact with machine parts, typically the enclosure.'' (NEMA, No. 10 at p. 35)

As stated earlier, even if these motor types are not currently regulated, DOE intends to define these motor types for clarity. This decision is further described in section G. DOE has also considered NEMA's proposed addition to the definition of ''typically the enclosure'' and removal of the term ''liquid-filled conductors.'' For the final rule, DOE is maintaining the term ''liquid-filled conductors'' to maintain the broadness of the original definition and not limit the definition to only circulating liquid. Furthermore, DOE is opting not to add the term ''typically the enclosure'' as it does not believe that this phrase adds to the content of the definition and may only add confusion. DOE is including the term ''designated cooling apparatus'' to bring more clarity. For this final rule, DOE adopts the definition of ''liquid-cooled electric motor'' as ''a motor that is cooled by liquid circulated using a designated cooling apparatus such that the liquid or liquid-filled conductors come into direct contact with the parts of the motor.''

3. Submersible Electric Motor

As previously addressed, most motors are not engineered to operate while under water. Any liquid inside a stator frame could impede rotor operation and corrode components of the motor. However, a submersible electric motor is capable of complete submersion in liquid without damaging the motor. A submersible electric motor uses special seals to prevent the ingress of liquid into its enclosure. Additionally, DOE understands that a submersible electric motor relies on the properties of the surrounding liquid to cool the motor during continuous-duty operation. That is, submersible electric motors are only capable of continuous duty operation while completely submerged in liquid, as NEMA clarified in its comments on the energy conservation standards preliminary analysis. (NEMA, EERE–2010–BT–STD–0027–0054 at p. 37) Consequently, as detailed in the NOPR, DOE defined ''submersible electric motor'' as an electric motor designed for continuous operation only while submerged in liquid.

In response to the NOPR, NEMA commented that no definition of ''submersible electric motor'' is needed because these motor types are not covered under DOE's regulations. However, if DOE still decided there was a need to include a definition, in NEMA's view, the definition should be for that of a ''submersible definite purpose motor'' and not a ''submersible definite purpose electric motor.'' NEMA claimed that the term ''continuous'' was unnecessary as part of the definition since the motor is not intended to be operated outside of the liquid for any period of time. NEMA suggested that the term be defined as referring to a motor ''designed for operation only while submerged in liquid.'' (NEMA, No. 10 at p. 36)

As explained above, DOE is not adding the term ''definite purpose'' to any individual motor definitions at this time. However, DOE recognizes that it is necessary to distinguish submersible electric motors from electric motors with moisture-resistant, sealed or encapsulated windings. To clarify this distinction, in this final rule, DOE is defining ''submersible electric motor'' as an ''electric motor that (1) is intended to operate continuously only while submerged in liquid, (2) is capable of operation while submerged in liquid for an indefinite period of time, and (3) has been sealed to prevent ingress of liquid from contacting the motor's internal parts.''

At the time of the NOPR, DOE believed that testing submersible electric motors would be difficult because the motor must be submerged in a liquid to properly operate. After discussions with manufacturers and testing laboratories, DOE confirmed that no industry test procedures or potential modifications to the procedures currently under 10 CFR 431.16 could be used to consistently test (and reliably measure) a motor that relies on submersion in liquid for continuous-duty operation. Additionally, DOE was not aware of any testing facilities that are capable of testing a submerged motor. Consequently, DOE decided not to propose specific preparatory instructions for testing submersible electric motors in the NOPR. DOE requested stakeholder comment on whether there are facilities capable of conducting energy efficiency tests on submersible motors, along with any specific procedures that these facilities follow when attempting to rate the energy efficiency of this equipment. In its written comments, NEMA affirmed that they were unaware of any test facilities available for conducting an IEEE 112 (Method B) test on a motor while submerged in liquid. (NEMA, No. 10 at p. 37)

Therefore, DOE is only adopting a definition in today's final rule, which is consistent with DOE's continuing intention to exclude these motors from the proposed energy conservation standards.

4. Inverter-Only Electric Motor

DOE considered two types of electric motors related to the use of inverters, those that are engineered to work only with an inverter and those that are capable of working with an inverter, but also capable of general, continuous-duty operation without an inverter. This section addresses the former. Inverter-capable electric motors are addressed in section III.A.4.

In its electric motors preliminary analysis TSD, DOE sought to clarify that, in its view, inverter-only motors were motors that can operate continuously only by means of an inverter drive. DOE also explained that it preliminarily planned to continue to exclude these motors from energy conservation standards requirements, in large part because of the difficulties that were likely to arise from testing them. One such difficulty is the fact that they can be operated at a continuum of speeds with no established speed testing profile. Another is that motors may be optimized for different waveforms, which also have no established testing standards. It would be difficult to generate meaningful test results for products which may be designed for a wide variety of operating inputs. The breadth of specifications resists treatment with a single test procedure without extensive study. Additonally, the high frequency power signals may be difficult to measure accurately without specialized equipment that testing laboratories may not possess.

NEMA agreed with DOE's preliminary approach to define such motors but not require them, for the time being, to meet energy conservation standards. It suggested a more specific definition of an ''inverter-only motor,'' based on NEMA MG 1 part 31, ''Definite-Purpose Inverter-Fed Polyphase Motors,'' in place of the one previously considered by DOE. (NEMA, EERE–2010–BT–STD–0027–0054 at p. 35) DOE examined the suggested definition and proposed to adopt it, with minor modifications. DOE proposed not to require that a motor be marked as a ''definite-purpose, inverter-fed electric motor,'' but stated that it may consider such a requirement in the future. DOE also noted NEMA's concern with the characterization of these motors and changed the term to read as an ''inverter-only electric motor.'' DOE proposed to define an ''inverter-only electric motor'' as ''an electric motor that is designed for operation solely with an inverter, and is not intended for operation when directly connected to polyphase, sinusoidal line power.''

In response to the NOPR, NEMA contended that no definition is needed for ''definite purpose inverter fed electric motor'' because, in its view, a definition would be needed only if there was a clear indication that a motor designed for operation on inverter power appears to meet the definition of ''electric motor'' as recommended by NEMA. If DOE still needed to include a definition, NEMA asserted that the definition should be for an ''inverter-fed definite purpose motor'' and not a ''definite purpose inverter-fed electric motor.'' If, upon further consideration, DOE did decide that a definition was needed, NEMA recommended that DOE use the term ''inverter-fed definite-purpose motor'', which would refer to ''a definite purpose motor that is designed for operation solely with an inverter, and is not defined for across-the-line starting when directly connected to polyphase, sinusoidal line power.'' (NEMA, No. 10 at p. 37)

As noted earlier, DOE intends to define these motor types to clarify these terms. DOE has also explained that it is not including the terms definite purpose or special purpose in its individual motors definitions, even though ''definite-purpose'' was initially used in the definition of these motors, because ''definite-purpose'' is a term that has meaning in the context of many other motor types which DOE does not wish to be confused with those requiring inverters. DOE also wishes to define these motors in terms of their actual capabilities instead of design intent. Therefore, to clear up any confusion surrounding the use of the phrase ''definite-purpose'', DOE is changing the name of this motor type to be ''inverter-only electric motor.'' As a result, DOE is adopting the definition of ''inverter-only electric motor'' as ''an electric motor that is capable of rated operation solely with an inverter, and is not intended for operation when directly connected to polyphase, sinusoidal line power.''

As for testing an inverter-only electric motor, NEMA asserted that the industry-based procedures, which have already been incorporated by reference in DOE's regulations, require that a tested motor be capable of across-the-line starting. Inverter-only motors are incapable of meeting this requirement without the inverter. (See NEMA, at EERE–2010–BT–STD–0027–0054 at p. 35 and NEMA MG 1–2009, part 31 at paragraph 31.4.3.1, which elaborates that an ''inverter-only electric motor'' cannot perform across-the-line starting unless the motor is attached to the inverter.) In the NOPR, DOE noted it was not aware of an industry accepted test procedure specifying the speed or torque characteristics to use when testing an inverter-only motor. Furthermore, DOE was unable to develop a standardized test procedure for inverter-only electric motors at this time. Because inverters allow a motor to operate at a wide array of speeds for many different applications, there would be considerable difficulties in developing a single test procedure that produced a fair representation of the actual energy used by all electric motors connected to an inverter in the field.

Additionally, a single motor design may be paired with a wide variety of inverters, so properly selecting an inverter to use for the test such that an accurate representation of efficiency is obtained would prove extremely difficult. Inverters may also operate at frequencies that make accurate measurement of power difficult with the type of equipment used for conventional motors. Even if DOE intended to regulate such motors, testing them could be extremely challenging using the currently accepted industry test procedures. Therefore, DOE proposed to exclude these motors from consideration for energy conservation standards.

In response to the NOPR, NEMA and Regal Beloit agreed with DOE's decision not to establish energy conservation standards for motors intended for operation solely with an inverter. (NEMA, No. 10 at p. 38; Pub. Mtg. Tr., No. 7 at p. 78).

As noted earlier, one difficulty in testing inverter-only motors is the fact that they can be operated at a continuum of speeds with no established speed testing profile. Another is that motors may be optimized for different waveforms, which also have no established testing standards. It would be difficult to generate meaningful test results for products which may be designed for a wide variety of operating inputs. The breadth of specifications resists treatment with a single test procedure without extensive study. Additonally, the high frequency power signals may be difficult to measure accurately without specialized equipment that testing laboratories may not possess. In view of this consensus and DOE's own conclusions regarding test procedure difficulties, DOE has maintained this approach for the final rule and is not adopting a test procedure set-up for these motors, nor will these motors be considered for energy conservation standards at this time.

H. Effective Dates for the Amended Test Procedures and Other Issues

In the June 26, 2013 NOPR (78 FR 38455), DOE proposed that the amendments described in the sections below become effective 30 days after the publication of the final rule. Furthermore, at 180 days after publication, the NOPR stated that the manufacturers of those motors that would be affected by the proposal would need to make representations regarding energy efficiency based on results obtained through testing in accordance with the proposed amendments. Calculations based on a substantiated alternative efficiency determination method (AEDM) would also need to need reflect the same approach, as would any certifications of compliance with the applicable energy conservation standards.[31]

Responding to the proposal, NEMA commented that the effective date of any change in test procedures should coincide with the effective date of any remedial change in the standards provided to rectify the effect of the changes in the test procedures on the tested efficiency. (NEMA, No. 10 at pp. 11–13) [32] DOE understands NEMA's concern. Per DOE's ''Process Rule'' at appendix A to subpart C of 10 CFR part 430 and the requirements at 42 U.S.C. 6295(o)(3) and (r), DOE usually tries to finalize its test procedures before its energy conservation standards. This timeframe allows stakeholders to understand how the proposed standard will be calculated to apply to the covered equipment.

NEMA was also concerned that the test procedure effective date would mean that the test procedure applies to motor types that are to be covered under the parallel standards rulemaking over a year before standards are finalized for such motor types. (NEMA, No. 10 at pp. 11–13). It also made a number of miscellaneous comments related to clarifying the proposed requirements.

As described in the ''Note'' to Appendix B to Subpart B and consistent with 42 U.S.C. 6314(d), any representations of energy efficiency or energy consumption of motors for which energy conservation standards are currently provided at 10 CFR 431.25 must be based on any final amended procedures in appendix B to subpart B of part 431 starting 180 days after the publication of any final amended test procedures. Until that time, manufacturers of motors for which energy conservation standards are currently provided at 10 CFR 431.25 may make such representations based either on the final amended test procedures or on the previous test procedures, set forth at 10 CFR part 431, subpart B, appendix B as contained in the 10 CFR parts 200 to 499 edition revised as of January 1, 2013.

For any other electric motor type that is not currently covered by the energy conservation standards at 10 CFR 431.25 but may become covered by standards under the standards rulemaking for which a proposed rule is currently open for comment (see 78 FR 73589 (Dec. 6, 2013), manufacturers of this equipment would need to use Appendix B 180 days after the effective date of the final rule adopting energy conservation standards for these motors. DOE would publish a notice upon publication of a final rule in that standards rulemaking announcing the specific date and amending the Note regarding compliance with test procedures that the today's final rule codifies in Appendix B.

NEMA also suggested that the test procedures should be applicable only to those general purpose, definite purpose and special purpose electric motors for which energy conservation standards apply. (NEMA, No. 10 at p. 10) DOE disagrees. For the motor types defined in 10 CFR part 431, and to the extent to which any representations of energy efficiency are made, manufacturers must follow the given test procedures even if they are currently exempt from energy conservation standards. This approach follows from DOE's intention to standardize the way the motors are tested and energy efficiency is reported.

NEMA asserted that the proposed ''note'' limits the use of Appendix B to Subpart B for purposes related to representation of efficiency and demonstration of compliance and would not apply to the test procedures for the enforcement process. (NEMA, No. 10 at p. 11) Again, DOE disagrees. The note lays out the test procedures that a manufacturer would use to determine that any applicable energy conservation requirements are met. Those procedures would be followed by DOE as part of any enforcement action against a given manufacturer.

NEMA suggested that any provisional requirements included in the final rule should be within the appropriate requirements in 10 CFR 431.16 or 10 CFR 431.17. (NEMA, No. 10 at pp. 10–13). DOE takes note of NEMA's suggestions and has ensured that today's final rule meets the requirements in 10 CFR 431.16 or 10 CFR 431.17.

NEMA suggested replacing the term ''open bearing'' with ''grease lubricated double shielded bearing'' in the proposed definition of standard bearing in paragraph 4 of Appendix B to Subpart B because, in its view, bearings require lubrication during operation and not all endshields have the ability to contain lubricating material. (NEMA, No. 10 at p. 38) DOE notes NEMA's concern that some endshields may not be able to contain grease or lubricating material and thus would require grease-lubricated bearings instead of open bearings. Therefore, DOE has amended the definition to allow the use of grease-lubricated double shielded bearing.

As for other concerns raised by NEMA suggesting that the test procedures be structured to limit their application to special and definit purpose electric motors, DOE notes that the procedures are to apply to electric motors as a whole. There is no need to insert limiting language that would narrow the application of the procedure. DOE further notes that it chose the proposed (and now final) definitional structure because the now-proposed standards rulemaking develops a coverage structure based on a motor satisfying both the broad ''electric motors'' definition and the nine referenced criteria. With the release of this standards proposal, many, if not all, of NEMA's comments on electric motor definitions are resolved. Any further comments that interested parties may have on this structure can be submitted for consideration as part of the ongoing energy conservation standards rulemaking.

IV. Procedural Issues and Regulatory Review

A. Review Under Executive Order 12866

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

B. Review Under the Regulatory Flexibility Act

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

[31] DOE acknowledged that, at the time, there are were no current energy conservation standards for the majority of the motor types covered in the NOPR. DOE stated that if it establishes standards for these motor types, manufacturers will be required to use the proposed test procedure to certify compliance with these standards.

[32] In this and subsequent citations, the document number refers to the number of the comment in the Docket for the DOE rulemaking on test procedures for electric motors, Docket No. EERE–2012–BT–TP–0043; and the page references refer to the place in the document where the statement preceding appears.

Counsel's Web site: *http://energy.gov/gc/office-general-counsel*.

As described in the preamble, today's final rule presents additional test procedure set-up clarifications for motors currently subject to Federal energy conservation standards, new test procedure set-up and test procedures for motors not currently subject to Federal energy conservation standards, and additional clarifications of definitions for certain key terms to aid manufacturers in better understanding DOE's regulations. All of the additions are consistent with current industry practices and, once compliance is required, should be used for making representations of energy-efficiency of those covered electric motors and for certifying compliance with any applicable Federal energy conservation standards. DOE certified to the Office of Advocacy of the Small Business Administration (SBA) that the additional test procedures and definitions for electric motors would not have a significant economic impact on a substantial number of small entities. The factual basis for this certification follows.

To estimate the number of small businesses impacted by the rule, DOE considered the size standards for a small business listed by the North American Industry Classification System (NAICS) code and description under 13 CFR 121.201. To be considered a small business, a manufacturer of electric motors and its affiliates may employ a maximum of 1,000 employees. DOE estimates that there are approximately 30 domestic motor manufacturers that manufacture electric motors covered by EPCA, and no more than 13 of these manufacturers are small businesses employing a maximum of 1,000 employees. The number of motor manufacturers, including the number of manufacturers qualifying as small businesses, was estimated based on interviews with motor manufacturers and publicly available data.

To determine the anticipated economic impact of the testing requirements on small manufacturers, DOE compared this final rule to current industry practices regarding testing procedures and representations for energy efficiency along with those steps DOE has taken in the design of the rule to minimize the testing burden on manufacturers. For motors that are currently subject to Federal standards, today's procedures are largely clarifications and will not change the underlying DOE test procedure and methodologies currently being employed by industry to rate and certify to the Department compliance with Federal standards.

For motors that are not currently subject to Federal standards, manufacturers of such unregulated electric motors would only need to use the testing set-up instructions, testing procedures, and rating procedures provided in today's rule 180 days after the effective date of any relevant energy conservation standards final rule if a manufacturer elected to make voluntary representations of energy-efficiency of its basic models. To better understand how this rule will impact small manufacturers of electric motors, DOE reviewed current industry practice regarding the representations of energy efficiency made for motors not subject to energy conservation standards and how the rulemaking will impact current industry practice. Specifically, DOE's test procedures require that those manufacturers of regulated motors not currently subject to standards who choose to make public representations of efficiency to follow the methods prescribed in this rule. DOE's rule does not require manufacturers who do not currently make voluntary representations to then begin making public representations of efficiency.

DOE researched the catalogs and Web sites of the 13 identified small manufacturers and found that only four of these manufacturers clearly list efficiency ratings for their equipment in public disclosures. The remaining manufacturers either build custom equipment, which are not subject to the changes made in this rule, or do not list energy efficiency in their motor specifications, in part because it is not required. For the manufacturers that currently do not voluntarily make any public representations of energy efficiency for their motors, DOE does not believe this rule will impact their current practice. DOE does not anticipate any burden accruing to these manufacturers unless the agency considered and set energy conservation standards for those additional electric motor types. Of the four manufacturers that currently elect to make voluntary representations of the electric motor efficiency, DOE believes those manufacturers will be minimally impacted because they are already basing those representations on commonly used industry standards, which are the same testing procedures incorporated by this rule. DOE does not have any reason to believe that the test set-up clarifications adopted in today's rule would have any significant impact on the current practice of these four manufacturers.

In view of the foregoing, DOE certifies that today's final rule will not impose significant economic impacts on a substantial number of small entities. Accordingly, DOE has not prepared a regulatory flexibility analysis for this rulemaking. DOE has provided its certification and supporting statement of factual basis to the Chief Counsel for Advocacy of the Small Business Administration for review under 5 U.S.C. 605(b).

In response to the regulatory flexibility analysis in the NOPR, Bluffton stated that while it agrees that the test procedure being proposed would not have a significant impact on small electric motor manufacturers, if energy conservation standards are applied to newly-defined electric motor types and special and definite purpose electric motors, as extended to 56-frame motors, there would be a major impact to small electric motor manufacturers. Bringing these electric motors types into compliance using the proposed test procedure could put a small electric motor manufacturer's existence in jeopardy. (Bluffton, No. 11 at pp. 1–2)

DOE acknowledges that expanding the scope of the existing energy conservation standards to include additional electric motor types, such as special and definite purpose electric motors and 56-frame motors, could disproportionally impact small electric motor manufacturers that specialize in producing these types of motors. DOE further notes that in the final test procedure rule that manufacturers of electric motors whose energy efficiency is not currently regulated will not need to use the test procedure until energy conservation standards are set for those electric motor types. Bluffton also commented that since a number of suppliers would also be considered small businesses, they could also be adversely affected by an expanded scope for standards since they could potentially lose customers of their products. Bluffton also stated that expanding the scope of standards could also prove to be a significant impact on the many small businesses that are customers of small electric motor manufacturers because their customers would have to redesign and re-tool their units to accommodate potentially larger new designs. (Bluffton, No. 11 at pp. 1–2) For purposes of the Regulatory Flexibilty Act, DOE notes that it is required to focus its analysis on the direct impact of the current rule on those small businesses that manufacture electric motors as part of the regulatory flexibility analysis. DOE will address the impacts of any proposed standards on small manufacturers of electric motors in the Review Under the Regulatory Flexibility Act of the related electric motor standards' rulemaking.

C. Review Under the Paperwork Reduction Act of 1995

Manufacturers of electric motors must certify to DOE that their products comply with any applicable energy conservation standards. In certifying compliance, manufacturers must test their products according to the DOE test procedures for electric motors, including any amendments adopted for those test procedures. DOE has established regulations for the certification and recordkeeping requirements for all covered consumer products and commercial equipment, including electric motors. (76 FR 12422 (March 7, 2011). The collection-of-information requirement for certification and recordkeeping is subject to review and approval by OMB under the Paperwork Reduction Act (PRA). This requirement has been approved by OMB under OMB control number 1910–1400. Public reporting burden for the certification is estimated to average 20 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

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

E. Review Under Executive Order 13132

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

F. Review Under Executive Order 12988

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

G. Review Under the Unfunded Mandates Reform Act of 1995

Title II of the Unfunded Mandates Reform Act of 1995 (UMRA) requires each Federal agency to assess the effects of Federal regulatory actions on State, local, and Tribal governments and the private sector. Public Law104–4, sec. 201 (codified at 2 U.S.C. 1531). For a regulatory action resulting in a rule that may cause the expenditure by State, local, and Tribal governments, in the aggregate, or by the private sector of $100 million or more in any one year (adjusted annually for inflation), section 202 of UMRA requires a Federal agency to publish a written statement that estimates the resulting costs, benefits, and other effects on the national economy. (2 U.S.C. 1532(a), (b)) The UMRA also requires a Federal agency to develop an effective process to permit timely input by elected officers of State, local, and Tribal governments on a proposed ''significant intergovernmental mandate,'' and requires an agency plan for giving notice and opportunity for timely input to potentially affected small governments before establishing any requirements that might significantly or uniquely affect small governments. On March 18, 1997, DOE published a statement of policy on its process for intergovernmental consultation under UMRA. 62 FR 12820; also available at *http://energy.gov/gc/office-general-counsel*. DOE examined today's final rule according to UMRA and its statement of policy and determined that the rule contains neither an intergovernmental mandate, nor a mandate that may result in the expenditure of $100 million or more in any year, so these requirements do not apply.

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

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

I. Review Under Executive Order 12630

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

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

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

K. Review Under Executive Order 13211

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

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

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

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

The modifications DOE addressed in this action incorporate testing methods followed by industry when evaluating the energy efficiency of electric motors. DOE's rule establishes the necessary testing set-up to facilitate consistency and repeatability when conducting a test in accordance with one of the prescribed test procedures incorporated into DOE's regulations. These methods, as described earlier in the preamble discussion above, would be used in instances where an electric motor manufacturer makes representations of energy efficiency regarding its motors. DOE has consulted with both the Attorney General and the Chairman of the FTC about the impact on competition of using the methods contained in these standards and has received no comments objecting to their use.

M. Congressional Notification

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

N. Approval of the Office of the Secretary

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

List of Subjects in 10 CFR Part 431

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

Issued in Washington, DC, on December 6, 2013.

Kathleen B. Hogan,

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

For the reasons stated in the preamble, DOE amends part 431 of chapter II of title 10, Code of Federal Regulations as set forth below:

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

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

Authority: 42 U.S.C. 6291–6317.

■ 2. Amend § 431.12 by:

■ a. Removing the reserved terms ''Fire pump motor'' and ''NEMA design B general purpose electric motor;'' and

■ b. Adding in alphabetical order, definitions for: ''air-over electric motor,'' ''brake electric motor,'' ''component set,'' ''definite purpose electric motor,'' ''electric motor with encapsulated windings,'' ''electric motor with moisture resistant windings,'' ''electric motor with sealed windings,'' ''IEC Design H motor,'' ''IEC Design N motor,'' ''immersible electric motor,'' ''inverter-capable electric motor,'' ''inverter-only electric motor,'' ''liquid-cooled electric motor,'' ''NEMA Design A motor,'' ''NEMA Design C motor,'' ''partial electric motor,'' ''special purpose electric motor,'' ''submersible electric motor,'' ''totally enclosed non-ventilated (TENV) electric motor.''

The additions read as follows:

§ 431.12 Definitions.

* * * * *

Air-over electric motor means an electric motor rated to operate in and be cooled by the airstream of a fan or blower that is not supplied with the motor and whose primary purpose is providing airflow to an application other than the motor driving it.

* * * * *

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

* * * * *

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

* * * * *

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

(1) To standard ratings with standard operating characteristics or standard mechanical construction for use under service conditions other than usual, such as those specified in NEMA MG1–2009, paragraph 14.3, ''Unusual Service Conditions,'' (incorporated by reference, see § 431.15); or

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

* * * * *

Electric motor with encapsulated windings means an electric motor capable of passing the conformance test for water resistance described in NEMA MG 1–2009, paragraph 12.62 (incorporated by reference, see § 431.15).

* * * * *

Electric motor with moisture resistant windings means an electric motor that is capable of passing the conformance test for moisture resistance generally described in NEMA MG 1–2009, paragraph 12.63 (incorporated by reference, see § 431.15).

* * * * *

Electric motor with sealed windings means an electric motor capable of passing the conformance test for water resistance described in NEMA MG 1–2009, paragraph 12.62 (incorporated by reference, see § 431.15).

* * * * *

IEC Design H motor means an electric motor that

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

(2) Contains a cage rotor;

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

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

(5) Is rated from 0.4 kW to 1600 kW at a frequency of 60 Hz; and

(6) Conforms to sections 8.1, 8.2, and 8.3 of the IEC 60034–12 edition 2.1 (incorporated by reference, see § 431.15) requirements for starting torque, locked rotor apparent power, and starting.

* * * * *

IEC Design N motor means an electric motor that:

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

(2) Contains a cage rotor;

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

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

(5) Is rated from 0.4 kW to 1600 kW at a frequency of 60 Hz; and

(6) Conforms to sections 6.1, 6.2, and 6.3 of the IEC 60034–12 edition 2.1 (incorporated by reference, see § 431.15) requirements for torque characteristics, locked rotor apparent power, and starting.

* * * * *

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

* * * * *

Inverter-capable electric motor means an electric motor designed to be directly connected to polyphase, sinusoidal line power, but that is also capable of continuous operation on an inverter drive over a limited speed range and associated load.

* * * * *

Inverter-only electric motor means an electric motor that is capable of rated operation solely with an inverter, and is not intended for operation when directly connected to polyphase, sinusoidal line power.

* * * * *

Liquid-cooled electric motor means a motor that is cooled by liquid circulated using a designated cooling apparatus such that the liquid or liquid-filled conductors come into direct contact with the parts of the motor.

* * * * *

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

(1) Is Designed to withstand full-voltage starting and developing locked-rotor torque as shown in NEMA MG1–2009, paragraph 12.38.1 (incorporated by reference, see § 431.15);

(2) Has pull-up torque not less than the values shown in NEMA MG1–2009, paragraph 12.40.1;

(3) Has breakdown torque not less than the values shown in NEMA MG1–2009, paragraph 12.39.1;

(4) Has a locked-rotor current not to exceed the values shown in NEMA MG1–2009, paragraph 12.35.1 for 60 hertz and NEMA MG1–2009, paragraph 12.35.2 for 50 hertz; and

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

* * * * *

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

(1) Is Designed to withstand full-voltage starting and developing locked-rotor torque for high-torque applications up to the values shown in NEMA MG1–2009, paragraph 12.38.2 (incorporated by reference, see § 431.15);

(2) Has pull-up torque not less than the values shown in NEMA MG1–2009, paragraph 12.40.2;

(3) Has breakdown torque not less than the values shown in NEMA MG1–2009, paragraph 12.39.2;

(4) Has a locked-rotor current not to exceed the values shown in NEMA MG1–2009, paragraphs 12.35.1 for 60 hertz and 12.35.2 for 50 hertz; and

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

* * * * *

Partial electric motor means an assembly of motor components necessitating the addition of no more than two endshields, including bearings, to create an an electric motor capable of operation in accordance with the applicable nameplate ratings.

* * * * *

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

* * * * *

Submersible electric motor means an electric motor that:

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

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

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

* * * * *

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

■ 3. Amend § 431.15 by adding paragraph (e)(1)(iii)(D) to read as follows:

§ 431.15 Materials incorporated by reference.

* * * * *

(e) * * *

(1) * * *

(iii) * * *

(D) Paragraphs 12.62 and 12.63, IBR approved for § 431.12.

* * * * *

■ 4. Appendix B to Subpart B of Part 431 is amended by adding an introductory note and section 4 to read as follows:

Appendix B to Subpart B of Part 431—Uniform Test Method for Measuring Nominal Full-Load Efficiency of Electric Motors

Note: After June 11, 2014, any representations made with respect to the energy use or efficiency of electric motors for which energy conservation standards are currently provided at 10 CFR 431.25 must be made in accordance with the results of testing pursuant to this appendix.

For manufacturers conducting tests of motors for which energy conservation standards are provided at 10 CFR 431.25, after January 13, 2014 and prior to June 11, 2014, manufacturers must conduct such test in accordance with either this appendix or appendix B as it appeared at 10 CFR Part 431, subpart B, appendix B, in the 10 CFR Parts 200 to 499 edition revised as of January 1, 2013. Any representations made with respect to the energy use or efficiency of such electric motors must be in accordance with whichever version is selected. Given that after June 11, 2014 representations with respect to the energy use or efficiency of electric motors must be made in accordance with tests conducted pursuant to this appendix, manufacturers may wish to begin using this test procedure as soon as possible.

For any other electric motor type that is not currently covered by the energy conservation standards at 10 CFR 431.25, manufacturers of this equipment will need to use Appendix B 180 days after the effective date of the final rule adopting energy conservation standards for these motors.

* * * * *

4. Procedures for the Testing of Certain Electric Motor Types.

Prior to testing according to IEEE Std 112–2004 (Test Method B) or CSA C390–10 (incorporated by reference, see § 431.15), each basic model of the electric motor types listed below must be set up in accordance with the instructions of this section to ensure consistent test results. These steps are designed to enable a motor to be attached to a dynamometer and run continuously for testing purposes. For the purposes of this appendix, a ''standard bearing'' is a 6000 series, either open or grease-lubricated double-shielded, single-row, deep groove, radial ball bearing.

4.1 Brake Electric Motors:

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

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

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

4.3 Electric Motors with Non-Standard Endshields or Flanges:

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

4.4 Electric Motors with Non-Standard Bases, Feet or Mounting Configurations

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

4.5 Electric Motors with a Separately-powered Blower:

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

4.6 Immersible Electric Motors

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

4.7 Partial Electric Motors:

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

4.8 Vertical Electric Motors and Electric Motors with Bearings Incapable of Horizontal Operation:

Vertical electric motors and electric motors with thrust bearings shall be tested in a horizontal or vertical configuration in accordance with IEEE 112 (Test Method B), depending on the testing facility's capabilities and construction of the motor, except if the motor is a vertical solid shaft normal thrust general purpose electric motor (subtype II), in which case it shall be tested in a horizontal configuration in accordance with IEEE 112 (Test Method B). Preference shall be given to testing a motor in its native orientation. If the unit under test cannot be reoriented horizontally due to its bearing construction, the electric motor's bearing(s) shall be removed and replaced with standard bearings. If the unit under test contains oil-lubricated bearings, its bearings shall be removed and replaced with standard bearings. Finally, if the unit under test contains a hollow shaft, a solid shaft shall be inserted, bolted to the non-drive end of the motor and welded on the drive end. Enough clearance shall be maintained such that attachment to a dynamometer is possible.

■ 5. Amend § 431.383 by adding paragraph (e)(4) to read as follows:

§ 431.383 Enforcement process for electric motors.

* * * * *

(e) * * *

(4)(i) *Non-standard endshields or flanges.* For purposes of DOE-initiated testing of electric motors with non-standard endshields or flanges, the Department will have the discretion to determine whether the lab should test a general purpose electric motor of equivalent electrical design and enclosure rather than replacing the nonstandard flange or endshield.

(ii) *Partial electric motors.* For purposes of DOE-initiated testing, the Department has the discretion to determine whether the lab should test a general purpose electric motor of equivalent electrical design and enclosure rather than machining and attaching an endshield.

* * * * *

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