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**[6450-01-P]**

**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:** Notice of proposed rulemaking.

**SUMMARY:** This notice proposes to clarify aspects of certain U.S. Department of Energy (DOE) energy efficiency regulations related to electric motors. DOE is considering establishing definitions, specifying testing set-up procedures necessary to test, and extending DOE's existing test procedures for electric motors to certain electric motor types that have not been regulated by DOE. These actions are being proposed to clarify the scope of regulatory coverage for electric motors and to ensure accurate and consistent measurements when determining the energy efficiency of various types of electric motors. This notice seeks comment on this proposal and requests comments, data, and other information to assist DOE in deciding whether to finalize or modify these provisions.

**DATES:** DOE will hold a public meeting on Tuesday, July 16, 2013, from 9 a.m. to 4 p.m., in Washington, DC. The meeting will also be broadcast as a webinar. See section V, "Public Participation," for webinar registration information, participant instructions, and information about the capabilities available to webinar participants.

DOE will accept comments, data, and information regarding this NOPR before and after the public meeting, but no later than **[INSERT DATE 75 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER]**. See section V, "Public Participation." for details.

**ADDRESSES:** The public meeting will be held at the U.S. Department of Energy, Forrestal Building, Room 8E-089, 1000 Independence Avenue, SW., Washington, DC 20585. To attend, please notify Ms. Brenda Edwards at (202) 586–2945. For detailed information regarding attendance and participation at the public meeting, see section V, "Public Participation."

Any comments submitted must identify the NOPR for Test Procedures for Electric Motors, and provide docket number EERE-2012-BT-TP-0043 and/or regulation identifier number (RIN) number 1904-AC89. Comments may be submitted using any of the following methods:

1. Federal eRulemaking Portal: http://www.regulations.gov. Follow the instructions for submitting comments.

2. E-mail: ElectricMotors2012TP0043@ee.doe.gov. Include the docket number EERE-2012-BT-TP-0043 and/or RIN 1904-AC89 in the subject line of the message.

3. Mail: Ms. Brenda Edwards, U.S. Department of Energy, Building Technologies Program, Mailstop EE-2J, 1000 Independence Avenue, SW., Washington, DC, 20585-0121. If possible, please submit all items on a compact disc. It is not necessary to include printed copies.

4. Hand Delivery/Courier: Ms. Brenda Edwards, U.S. Department of Energy, Building Technologies Program, 6th Floor, 950 L'Enfant Plaza, SW., Washington, DC 20024. Telephone: (202) 586-2945. Please submit one signed paper original.

For detailed instructions on submitting comments and additional information on the rulemaking process, see section V, "Public Participation."

Docket: The docket is available for review at www.regulations.gov, including *Federal Register* notices, public meeting attendee lists and transcripts, comments, and other supporting documents/materials.

A link to the docket web page can be found at: http://www1.eere.energy.gov/buildings/appliance_standards/rulemaking.aspx/ruleid/74.

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

**FOR FURTHER INFORMATION CONTACT:**

Mr. James Raba, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Program, EE-2J, 1000 Independence Avenue, SW., Washington, DC 20585-0121. E-mail: medium_electric_motors@ee.doe.gov.

Ms. Ami Grace-Tardy, U.S. Department of Energy, Office of the General Counsel, GC-71, 1000 Independence Avenue, SW., Washington, DC 20585. Telephone: (202) 586-5709. E-mail: Ami.Grace-Tardy@hq.doe.gov.

**SUPPLEMENTARY INFORMATION:**

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## I. Introduction

### A. Authority

Title III of the Energy Policy and Conservation Act, 42 U.S.C. 6291, *et seq.,* ("EPCA" or "the Act") sets forth a variety of provisions designed to improve the energy efficiency of products and commercial equipment. (All references to EPCA refer to the statute as amended through the American Energy Manufacturing Technical Corrections Act (AEMTCA 2012), Pub.

L. 112-210 (December 18, 2012)). Part C of Title III (42 U.S.C. 6311−6317), which was subsequently redesignated as Part A–1 for editorial reasons, 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))

B. Background

In the Energy Policy Act of 1992, Pub. L. 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 in the *Federal Register*, 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. (42 U.S.C. 6311(13), 6313(b)). Consequently, on March 23, 2009, DOE updated the corresponding regulations at 10 CFR part 431 with the new definitions and energy conservation standards. 74 FR 12058. On December 22, 2008, DOE proposed to update the test procedures under 10 CFR part 431 both for electric motors and small electric motors. 73 FR 78220. DOE finalized key provisions related to small electric motor testing in a 2009 final rule at 74 FR 32059 (July 7, 2009), and further updated test procedures for electric motors and small electric motors at 77 FR 26608 (May 4, 2012).

Today's notice of proposed rulemaking (NOPR) focuses on electric motors and proposes to add the aforementioned definitions and additional testing set-up instructions and clarifications to the current test procedures under subpart B of 10 CFR part 431 for a wider variety of electric motor types than currently regulated. Additionally, DOE is proposing to extend the applicability of DOE's existing electric motor test procedure in 10 CFR part 431 to the wider scope of currently unregulated motors. DOE is proposing such amendments because the additional testing set-up instructions and clarifications are designed to help manufacturers of certain types of motors prepare them for testing under the applicable test procedure. The proposed steps are intended to enable a manufacturer to consistently measure the losses and determine the efficiency of a wider variety of motors, and potentially facilitate the application of energy conservation standards to a wider array of motors than what is currently covered under 10 CFR part 431.[1] In addition, DOE is considering prescribing standards for some electric motors addressed in this notice through a parallel energy conservation standards-related activity. See 77 FR 43015 (July 23, 2012). To ensure consistency between the two rulemakings, this test procedure NOPR addresses scope of coverage and test procedure issues raised in response to DOE's current electric motors energy conservation standards rulemaking. See 76 FR 17577

[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))

(March 30, 2011); 77 FR 43015 (July 23, 2012). Finally, to provide regulatory clarity and consistency with existing regulations, today's proposed rule also defines NEMA Design A motors, NEMA Design C motors, International Electrotechnical Commission (IEC) Design H motors and IEC Design N motors, which are covered under subpart B of 10 CFR part 431.

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 MG1–1987[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 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)) Subsequently, as newer versions of the NEMA and IEEE test procedures for electric motors were published and used by industry, DOE updated 10 CFR part 431. For example, see 64 FR 54114 (October 5, 1999) that incorporated by reference into 10 CFR part 431 applicable provisions of NEMA Standards Publication MG1–1993 and IEEE Standard 112–1996, and codified them at 10 CFR 431.16 and appendix B to subpart B of 10

[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.

CFR part 431. DOE also added the equivalent test procedure − Canadian Standards Association (CSA) CAN/CSA C390−93, "Energy Efficiency Test Methods for Three-Phase Induction Motors," because NEMA added this procedure to its Standards Publication, MG1, when it was revised and updated in 1993. See 61 FR 60440, 60446 (November 27, 1996).

On May 4, 2012, DOE incorporated by reference the updated versions of the above test procedures: NEMA MG1−2009, IEEE 112−2004, and CAN/CSA C390−10. 77 FR 26608, 26638 (the "2012 final test procedure.") DOE made these 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 MG1 has been updated to MG1−2011. The text of the sections and paragraphs of NEMA MG1−2009, which is incorporated by reference under 10 CFR part 431.15, is identical to the text of the relevant sections and paragraphs of NEMA MG1−2011. The substance of those NEMA MG1−2009 sections and paragraphs incorporated by reference into subpart B of 10 CFR part 431 were subjected to public notice and comment during the 2012 test procedure rulemaking. DOE addressed its reasons for incorporating the MG1−2009 text into its regulations in its May 2012 final rule. See 77 FR at 26616-26617. For all the above reasons, DOE has preliminarily chosen not to update its regulations with NEMA MG1-2011, but is accepting public comment on this preliminary decision.

## II. Summary of Notice of Proposed Rulemaking

In this NOPR, DOE proposes to:

(1) Define a variety of electric motor configurations (i.e., types) that are currently covered under 10 CFR 431.25 but are not currently defined under 10 CFR 431.12;
(2) Define a variety of electric motor configurations (i.e., types) that are not currently covered under 10 CFR 431.25 and are not currently defined under 10 CFR 431.12; and
(3) Clarify the necessary testing "set-up" procedures to facilitate the testing of the currently not covered motor types under IEEE Standard 112 (Test Method B) or CSA Standard C390–10.

Today's NOPR 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 a request for information regarding definite and special purpose motors (the "March 2011 RFI"). See 76 FR 17577 (March 30, 2011). DOE is considering whether to propose expanding the scope of what its electric motor standards regulate to include all continuous duty, single speed, squirrel-cage, polyphase alternating-current, induction motors, with some narrowly defined exemptions. See 77 FR 43015 (July 23, 2012). Today's NOPR addresses and solicits comment on test procedure issues arising from potentially expanding the scope of DOE's energy efficiency requirements to include certain motor types that are not currently required to meet energy conservation standards. In particular, today's proposal includes definitions for those motor types that DOE may consider regulating and those types that DOE is not considering regulating at this time. DOE is coordinating today's NOPR with a parallel electric motor energy conservation standards rulemaking. To the extent possible, DOE will consider all comments submitted in response to the electric motors test procedure or standards rulemaking in connection with both activities.

In addition to proposing to include new definitions, today's notice proposes to add certain steps to the applicable test procedures contained in appendix B to subpart B of 10 CFR part 431, to accommodate setting those motors up for testing that DOE is considering regulating. Because the proposed amendments are strictly limited to those steps necessary to facilitate testing under the currently incorporated test procedures, DOE does not anticipate that the proposal would affect the actual measurement of losses and the subsequent determination of efficiency for any of the electric motors within the scope of today's proposed rulemaking.

The proposed 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 proposed regulatory text follows the preamble to this notice. DOE seeks comments from interested parties on each of the proposed revisions.

**Table II-1 Summary of Changes Proposed in this NOPR 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:<br>o Air-over electric motor<br>o Component set<br>o Definite-purpose inverter-fed electric motor<br>o Electric motor with moisture resistant windings<br>o Electric motor with sealed windings<br>o IEC Design H motor<br>o IEC Design N motor<br>o Immersible electric motor |

| | |
|---|---|
| | <ul><li>Integral brake electric motor</li><li>Inverter-capable electric motor</li><li>Liquid-cooled electric motor</li><li>NEMA Design A motor</li><li>NEMA Design C motor</li><li>Non-integral brake electrical motor</li><li>Partial electric motor</li><li>Submersible electric motor</li><li>Totally enclosed non-ventilated (TENV) electric motor</li></ul> |
| Appendix B to Subpart B—Uniform Test Method for Measuring Nominal Full Load Efficiency of Electric Motors | • Updates test procedure set-up methods for:<ul><li>Close-coupled pump electric motors and electric motors with single or double shaft extensions of non-standard dimensions or additions</li><li>Electric motors with non-standard endshields or flanges</li><li>Immersible electric motors and electric motors with contact seals</li><li>Integral brake electric motors</li><li>Non-integral brake electric motors</li><li>Partial electric motors</li><li>Vertical electric motors and electric motors with bearings incapable of horizontal operation</li><li>Close-coupled pump electric motors</li></ul> |

DOE developed today's proposal 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.[3]

**Table II-2 Summary of NOPR Commenters**

| Company or Organization | Abbreviation | Affiliation |
|---|---|---|
| Appliance Standards Awareness Project | ASAP | Energy Efficiency Advocate |
| Baldor Electric Co. | Baldor | Manufacturer |
| Copper Development Association | CDA | Trade Association |
| Motor Coalition* | MC | Energy Efficiency Advocates, Trade |

[3] As comments have not yet been submitted for this test procedure rulemaking, all comments cited in this NOPR can be found in the Electric Motors Standards rulemaking docket with the number EERE-2010-BT-STD-0027.

| | | |
|---|---|---|
| | | Associations, Manufacturers |
| National Electrical Manufacturers Association | NEMA | Trade Association |

* 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. Proposed Effective Dates for the Amended Test Procedures

If adopted, the proposed amendments would become effective 30 days after the publication of the final rule. As previously explained, today's proposal would primarily add a new section to DOE's test procedure with the steps that the manufacturers of certain types of special and definite purpose electric motors would need to take before testing a motor. Because these test procedure changes would add only a new section to the existing test procedure for motor types that are not currently regulated (i.e., special and definite purpose motors), manufacturers of motors currently covered by DOE regulations (i.e., general purpose electric motors (subtype I and subtype II), including fire pump electric motors and NEMA Design B motors with a power rating of more than 200 horsepower but not greater than 500 horsepower) can continue to use the current test procedure until 180 days after publication of the final rule. At 180 days after publication of the final rule, both manufacturers of currently regulated motors and manufacturers of special and definite purpose motors for which definitions or testing set-up procedures are proposed in this rule may not make any representations regarding energy use or the cost of energy use for all electric motors addressed in today's rulemaking unless such representations are based on the results of testing, or calculations from a substantiated alternative efficiency determination method (AEDM), that reflect values of efficiency that would be obtained through testing in accordance with the amended test procedures. In addition, 180 days after publication of the final rule, both manufacturers of currently regulated motors and manufacturers of special and definite purpose motors for which definitions or testing set-up procedures are provided would be required to comply with and use the amended test procedures to determine if the covered electric motor types they manufacture comply with the applicable energy conservation standards.[4] See 42 U.S.C. 6314(d).

B. Expanding the Scope of Coverage of Energy Conservation Standards

DOE has the authority to set energy conservation standards for a wider range of electric motors than those classified as general purpose electric motors (e.g., definite or special purpose motors). The EPACT 1992 amendments to EPCA had defined "electric motor" to include a certain type of "general purpose" motor that Congress would eventually classify as a general purpose electric motor (subtype I). (42 U.S.C. 6311(13)(A) (1992)) Those amendments also defined several other types of motors, including definite purpose motors and special purpose motors. (See 42 U.S.C. 6311(13)(C) and (D) (1992)) EPACT 1992 set energy conservation standards for "electric motors" (i.e., general purpose electric motors (subtype I)) and explicitly stated that the standards did not apply to definite purpose or special purpose motors.[5] (42 U.S.C. 6313(b)(1)) (1992)) EISA 2007 struck the narrow EPACT 1992 definition for "electric motor" and replaced it with the heading "Electric motors." As a result of these changes, both definite and special purpose motors fell under the broad heading of "Electric motors" that previously

[4] DOE acknowledges that there are no current energy conservation standards for the majority of the motor types covered in today's proposed rule. If DOE establishes standards for these motor types, manufacturers will be required to use the proposed test procedure to certify compliance with these standards.

[5] 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.

only applied to "general purpose" motors.  While EISA 2007 set specific standards for general purpose electric motors, it did not explicitly apply these new requirements to definite or special purpose motors.  (See generally 42 U.S.C. 6313(b) (2012))

Although DOE believes that EPCA, as amended through EISA 2007, provides sufficient statutory authority for the regulation of special purpose and definite purpose motors as "electric motors," DOE notes it has additional authority provided under section 10 of AEMTCA (to be codified at 42 U.S.C. 6311(2)(B)) to generally regulate "other motors" as covered "industrial equipment." Therefore, even if special and definite purpose motors were not "electric motors," special and definite purpose motors would be considered as "other motors" that EPCA already treats as covered industrial equipment.[6]

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[6] EPCA specifies the types of industrial equipment that can be classified as covered in addition to the equipment enumerated in 42 U.S.C. 6311(1). This equipment includes "other motors" (to be codified at 42 U.S.C. 6311(2)(B)). Industrial equipment must also, without regard to whether such equipment is in fact distributed in commerce for industrial or commercial use, be of a type that: (1) in operation consumes, or is designed to consume, energy in operation; (2) to any significant extent, is distributed in commerce for industrial or commercial use; and (3) is not a covered product as defined in 42 U.S.C. 6291(a)(2) of EPCA, other than a component of a covered product with respect to which there is in effect a determination under 42 U.S.C. 6312(c). (42 U.S.C. 6311 (2)(A)).  Data from the 2002 United States Industrial Electric Motor Systems Market Opportunities Assessment estimated total energy use from industrial motor systems to be 747 billion kWh.  Based on the expansion of industrial activity, it is likely that current annual electric motor energy use is higher than this figure. Electric motors are distributed in commerce for both the industrial and commercial sectors. According to data provided by the Motors Coalition, the number of electric motors manufactured in, or imported into, the United States is over five million electric motors annually, including special and definite purpose motors. Finally, special and definite purpose motors are not currently regulated under Title 10 of the Code of Federal Regulations, part 430 (10 CFR part 430).
To classify equipment as covered commercial or industrial equipment, the Secretary must also determine that classifying the equipment as covered equipment is necessary for the purposes of Part A-1 of EPCA. The purpose of Part A-1 is to improve the efficiency of electric motors, pumps and certain other industrial equipment to conserve the energy resources of the nation. (42 U.S.C. 6312(a)-(b))  In today's proposal, DOE has tentatively determined that the regulation of special and definite purpose motors is necessary to carry out the purposes of part A-1 of EPCA because regulating these motors will promote the conservation of energy supplies. Efficiency standards that may result from coverage would help to capture some portion of the potential for improving the efficiency of special and definite purpose motors.

Consistent with the changes made by EISA 2007, DOE defined the term "electric motor" broadly. See 77 FR 26633 (May 4, 2012). That definition covers "general purpose," "special purpose" and "definite purpose" electric motors (as defined by EPCA). Previously, EPCA did not require either "special purpose" or "definite purpose" motor types to meet energy conservation standards because they were not considered "general purpose" under the EPCA definition of "general purpose motor" − a necessary element to meet the pre-EISA 2007 "electric motor" definition. See 77 FR 26612. Because of the restrictive nature of the prior electric motor definition, along with the restrictive definition of the term "industrial equipment," DOE would have been unable to set standards for such motors. (See 42 U.S.C. 6311(2)(B) (limiting the scope of equipment covered under EPCA)) In view of the changes introduced by EISA 2007 and the absence of current Federal energy conservation standards for special purpose and definite purpose motors, as noted in chapter 2 of DOE's July 2012 electric motors preliminary analysis technical support document (TSD),[7] it is DOE's view that both are categories of "electric motors" covered under EPCA, as currently amended. Accordingly, DOE is considering establishing standards for certain definite purpose and special purpose motors in the context of a separate rulemaking. At this time, DOE is considering setting energy conservation standards for only those motors that exhibit all of the following nine characteristics:

- Is a single-speed, induction motor,
- Is rated for continuous duty (MG1) operation or for duty type S1 (IEC),
- Contains a squirrel-cage (MG1) or cage (IEC) rotor,

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

- Operates on polyphase alternating current 60-hertz sinusoidal line power,
- Is rated 600 volts or less,
- Has a 2-, 4-, 6-, or 8-pole configuration,
- Has a three-digit NEMA frame size (or IEC metric equivalent) or an enclosed 56 NEMA frame size (or IEC metric equivalent),
- Is rated no more than 500 horsepower, but greater than or equal to 1 horsepower (or kilowatt equivalent), and
- Meets all of the performance requirements of one of the following motor types: a NEMA Design A, B, or C motor or an IEC design N or H motor.

Motor types that exhibit all of the characteristics listed above, but that DOE is declining to subject to energy conservation standards at this time because of the inability to test them for efficiency in a repeatable manner, would be identified by DOE through a parallel notice of proposed rulemaking. To prepare this test procedure NOPR, DOE has incorporated feedback received during the August 21, 2012, electric motors standards preliminary analysis public meeting, comments on the March 2011 RFI, and comments on the July 2012 electric motors preliminary analysis ("electric motors preliminary analysis") as well as information gleaned from discussions with testing laboratories, manufacturers, and subject matter experts (SMEs).

To facilitate the potential application of energy conservation standards to motors built in the configurations described above, DOE proposes to first define the motors and then provide additional testing instructions to enable them to be tested using the existing DOE test method for electric motors. The definitions under consideration would address motors currently subject to standards, certain motors DOE is considering requiring to meet standards, and certain other motors that DOE is, at this time, considering not regulating through energy conservation standards. Some clarifying definitions, such as the definitions for NEMA Design A and NEMA Design C motors from NEMA MG1-2009, would be added. However, DOE understands that some motors, such as partial motors and integral brake motors, do not have standard, industry-accepted definitions. For such motor types, DOE conducted its own independent research and consulted with SMEs, manufacturers, and the Motor Coalition so that DOE could create the working definitions that are proposed in section III of this NOPR. For the definitions of "electric motor with moisture resistant windings" and "electric motor with sealed windings," which reference certain subsections of NEMA MG1-2009, DOE intends to incorporate by reference the cited sections of NEMA MG1-2009.

DOE believes that the existing IEEE Standard 112 (Test Method B) and CSA C390-10 test procedures can be used to accurately measure losses and determine the energy efficiency for this additional group (or "expanded scope") of motors 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 the addition of testing step-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 in a horizontal position. 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.[8] 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.

DOE believes that clarifying instructions may be necessary to test some of the expanded-scope motors that DOE is considering and for which DOE is conducting an energy conservation standards rulemaking because some motors may require modifications before they can operate continuously and be tested on a dynamometer in a manner consistent with the current DOE test

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[8] 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 NOPR.

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. Therefore, DOE is proposing to add instructions to facilitate consistent and repeatable procedures for motors such as these. These additions were based on testing and research conducted by the Department along with technical consultations with SMEs, manufacturers, testing laboratories, and various trade associations. Table III-1 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 proposing to address 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 Test Procedure and Standards Rulemakings**

| Motor Type | Currently Subject to Standards? | Under Consideration for Potential Standards? | New Definition Proposed? | Additional Set-Up Instructions Proposed? |
|---|---|---|---|---|
| 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 or Sealed 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 | Yes |
| Integral Brake Electric Motors | No | Yes | Yes | Yes |
| Non-Integral Brake Electric Motors | Yes | 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 |
| Definite-Purpose Inverter-Fed Electric Motors | No | No | Yes | No |

C. Motor Type Definitions

During the course of the 2012 final test procedure rulemaking, some interested parties questioned why DOE defined NEMA Design B motors but not NEMA Design A or Design C motors. DOE explained that it chose to adopt a definition for "NEMA Design B" motor because the application section in MG1 (MG1−1.19.1.2 in both MG1−2009 and MG1−2011) contained a typographical error that required correcting for purposes of DOE's regulations. DOE also noted that it may incorporate a corrected version of the "NEMA Design C" motor definition in a future rulemaking – that definition, which is found in MG1−1.19.1.3, also contains a typographical error. DOE did not intend to add definitions for NEMA Design A and IEC Design N, as the existing definitions found in MG1 are correct as published. 77 FR 26616, 26634 (May 4, 2012). In view of DOE's intention to consider regulating other types of motors, DOE now believes it is necessary to make clear the terms and definitions for them as well. DOE understands that many terms and definitions applicable to motors and used in common industry parlance for voluntary standards and day-to-day business communication are not necessarily defined with sufficient clarity for regulatory purposes. DOE does not, at this time, propose to add amendments related to such types of motors other than to provide more precise definitions for them to sufficiently capture the particular characteristics attributable to each and aid the manufacturing community in determining whether a particular basic model is covered by DOE's regulations for electric motors.

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

NEMA MG1–2009 defines the following three types of polyphase, alternating current, induction motors: NEMA Designs A, B, and C. NEMA MG1–2009 establishes the same pull-up, breakdown, and locked-rotor torque requirements for both NEMA Design A and NEMA Design B motors.[9] 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 (that 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 Underwriters Laboratory requirements.)) In addition, DOE understands that NEMA Design B motors are frequently preferred because the user can

[9] *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.

easily select motor control and protection 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 and Underwriters Laboratory. (NEMA, EERE-2010-BT-STD-0027-0054 at p. 36) A NEMA Design C motor requires a minimum locked-rotor torque per NEMA MG1−2009, Table 12-3, which is higher than either the NEMA Design A or Design B minimum locked-rotor torque required per NEMA MG1−2009, Table 12-2.

In view of the above, DOE is proposing to incorporate a definition for both "NEMA Design A motor" and "NEMA Design C motor" to improve regulatory clarity. DOE notes it has already adopted a definition for "NEMA Design B motor" at 10 CFR 431.12. DOE believes that providing definitions for other motor types will provide consistency in the treatment of all considered motors. The proposed definitions for NEMA Design A and Design C motors are based on the definitions in NEMA MG1–2009, paragraphs 1.19.1.1 and 1.19.1.3, respectively. DOE believes that the NEMA MG1–2009 definition of "NEMA Design A motor" is sufficiently clear and concise and is proposing to add it with minor clarifying elements. DOE is proposing to incorporate the definition of "NEMA Design C motor" from NEMA MG1−2009, paragraph 1.19.1.3 with some minor corrections because the NEMA MG1−2009 definition appears to contain typographical errors[10] with regard to the tables referenced in the definition. As detailed in the proposed regulations below, a NEMA Design A motor is defined as a squirrel-cage motor designed to withstand full-voltage starting and developing locked-rotor torque, pull-up torque,

[10] In NEMA MG1-2009, the definition for NEMA Design C refers the reader to paragraph 12.34.1 for locked-rotor current limits for 60 hertz motors. The appropriate paragraph appears to be 12.35.1.

breakdown torque, and locked-rotor current as specified in NEMA MG1–2009; and with a slip at rated load of less than 5 percent for motors with fewer than 10 poles.  A NEMA Design C motor is defined as a squirrel-cage motor designed to withstand full-voltage starting and developing locked-rotor torque for high-torque applications, pull-up torque, breakdown torque, and locked-rotor current as specified in NEMA MG1-2009; and with a slip at rated load of less than 5 percent.

As previously mentioned, DOE is proposing these definitions to retain consistency with other already incorporated regulatory definitions. General purpose electric motors that meet the definition of NEMA Design A and Design C motor and are rated between 1 and 200 horsepower are currently subject to energy conservation standards. DOE is not aware of any difficulties in testing either of these motor design types using the current procedures. Therefore, DOE is not proposing any test procedure amendments for these motor types at this time. DOE requests comment on its proposal to incorporate definitions for NEMA Design A and NEMA Design C motors based on the NEMA MG1−2009 definitions of these motor designs.

2. International Electrotechnical Commission Designs N and H Motors

Similar to NEMA, the European International Electrotechnical Commission (IEC) produces industry standards that contain performance requirements for electric motors. Analogous to NEMA Designs B and C, the IEC has design types 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 is proposing to include a definition for IEC Design N and IEC Design H motor types to ensure that these functionally similar motors are 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" incorporates 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 1 600 kW," with torque characteristics and locked-rotor characteristics detailed in subsequent tables of the standard.[11] A similar approach for IEC Design H motors is taken in IEC 60034, but with references to different sections and slightly different wording. DOE is proposing to include all references to tables for torque characteristics and locked-rotor characteristics as part of these definitions to improve their comprehensiveness. As detailed in the proposed regulations below, today's proposed rule defines 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, and conforming to IEC specifications for torque characteristics, locked rotor apparent power, and starting. An "IEC Design H motor" is defined as an induction motor designed for use with three-phase power with the following

[11] 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.

characteristics: a cage rotor, intended for direct-on-line starting, with 4, 6, or 8 poles, rated from 0.4 kW to 160 kW, and conforming to IEC specifications for starting torque, locked rotor apparent power, and starting.

Electric motors that meet these performance 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 specified horsepower ranges. Because these IEC definitions stipulate a set of performance parameters that do not inhibit an electric motor's ability to be tested, DOE is not proposing any additional test procedure amendments at this time. However, DOE requests comment on the proposed definitions.

3. Electric Motors with Sealed and Moisture Resistant 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,[12] DOE set forth a possible definition for the term "encapsulated electric motor." The definition presented was based upon a NEMA definition for the term "Machine with Sealed Windings" and was intended to cover motors containing special windings that could withstand exposure to contaminants and moisture. As highlighted in NEMA and Baldor's comments, NEMA MG1-2009 does not specify a single term that encompasses a motor with encapsulated windings. Instead, NEMA MG1-2009 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 MG1 since the 1967 edition. Because of potential confusion, NEMA asked DOE to clarify which type of motor, or possibly both, DOE was considering covering. (Baldor, Pub. Mtg. Tr., EERE-2010-BT-STD-0027-0060 at p 52; NEMA, EERE-2010-BT-STD-0027-0054 at p. 33)

After reviewing the two pertinent definitions, the comments from Baldor and NEMA, and DOE's own research on these types of motors, DOE believes that motors that meet both definitions should be covered by any proposed definition and be included within its expanded scope of coverage. 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 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 is preliminarily using to characterize the electric motors that are within the

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

scope of DOE’s regulatory authority.  Therefore, DOE is proposing two definitions based on the NEMA MG1−2009 definitions of a “Machine with Moisture Resistant Windings” and a “Machine with Sealed Windings.”  DOE’s proposed definitions are based on modified versions of the NEMA MG1−2009 definitions in order to eliminate potential confusion and ambiguities. The proposed definitions emphasize 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 proposed regulations below, today’s proposed rule defines “electric motor with moisture resistant” as an electric motor engineered to pass the conformance test for moisture resistance as specified in NEMA MG1-2009.  An “electric motor with sealed windings” is defined as an electric motor engineered to pass the conformance test for water resistance as specified in NEMA MG1-2009.

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. While DOE received comment advocating the regulation of motors with special windings, it did not receive any comments suggesting or raising any necessary test procedure changes that would need to be made as a result of the stator winding encapsulation. (NEMA, EERE-2010-BT-STD-0027-0054 at p. 14)  Subsequently, DOE conducted its own research and consulted with testing laboratories and various industry experts regarding any effects that specially insulated windings may have on testing or efficiency.

As a result of these discussions, DOE does not believe that the presence of specially insulated stator windings in an electric motor would interfere with DOE-prescribed test procedures. Also, because temperature measurements are taken by measuring the stator winding resistance, DOE does not believe that the insulation on the stator windings themselves would 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, at this time, DOE is not proposing any test procedure amendments for electric motors with moisture resistant windings or electric motors with sealed windings.

DOE believes that the effects that specially insulated windings may have on an electric motor's efficiency are likely to be minimal. Although DOE recognizes there could be a change in the thermal characteristics of the motor, DOE believes that the additional treatment given to these specially insulated windings could, in some cases, improve heat dissipation. Again, however, DOE does not believe that the efficiency changes, whether positive or negative, will be significant. DOE requests any data, information, or comments regarding the effects of specially insulated stator windings on electric motor efficiency.

DOE also seeks comment on its proposed definition for motors with moisture resistant windings and motors with sealed windings and its preliminary decision not to propose additional testing instructions for these motors types.

4. Inverter-Capable Electric Motors

DOE currently regulates single speed motors with a 2-, 4-, 6-, or 8-pole configuration. 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 MG1−2009.[13]

Currently, being suitable for use on an inverter alone would not exempt a motor from having to satisfy any applicable energy conservation requirements because it does not preclude a motor from meeting the nine design characteristics of electric motors that will define regulatory coverage. In today's NOPR, DOE is maintaining this approach. However, today's NOPR seeks to further clarify this position by proposing a definition for the term "inverter-capable electric motor."

In its comments about the electric motors preliminary analysis, NEMA provided suggestions on how to define inverter capable-electric motors. NEMA agreed with DOE that these motors are capable of both operating with or without an inverter. However, NEMA stressed that these electric motors are primarily engineered to be used without an inverter and, in its view, this fact should be evident by the definition DOE ultimately adopts. NEMA also provided a suggested definition for the term "inverter-capable electric motor." (NEMA, EERE-2010-BT-STD-0027-0054 at pp. 34-35) This definition, similar in substance and meaning to the definition that DOE presented in the electric motors preliminary analysis but including a few minor word changes, is consistent with DOE's understanding. As detailed in the proposed regulations below, today's proposed rule defines an "inverter-capable electric motor" as an electric motor

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

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 does not believe any test procedure amendments are needed. Under DOE's proposed approach, an inverter-capable electric motor would be tested without the use of an inverter and rely on the procedures used when testing a general purpose electric motor. DOE requests comments on its proposed definition and its tentative decision not to specify any test procedure instructions for this motor type beyond that which is already contained in the current procedure.

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 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, DOE is analyzing TENV motors in the energy conservation standards rulemaking. (Motor Coalition, EERE-2010-BT-STD-0027-0035 at p. 19) As part of this effort, DOE proposes 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 MG1−2009. DOE tentatively concludes that this definition is accurate and sufficiently clear and concise and is proposing that the definition be adopted with minor alterations. As detailed in the proposed regulations below, today's proposed rule defines 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 modifications to the test procedure may be necessary to test TENV motors. Prior to the electric motors preliminary analysis, 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 because of testing difficulties.

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) 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 knows of no technical reason why a TENV motor could not be tested using either IEEE Standard 112 (Test Method B) or the CSA−C390 procedure without modification. In view of NEMA's most recent comments suggesting that IEEE Standard 112 (Test Method B) is 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 is not proposing any test procedure amendments for TENV electric motors.

DOE requests comments on its proposed definition and preliminary decision not to propose any test procedure amendments for TENV electric motors.

D. Electric Motor Types Requiring Definitions and Test Procedure Instructions

DOE is proposing to add definitions for a number of electric motor types that are already commonly understood, but not necessarily clearly defined, by the industry. DOE is also proposing clarifying language for testing each of these motor types.

1. Immersible Electric Motors and Electric Motors with Contact Seals

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 MG1-2009, 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 interprets "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.

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.

As a result, as detailed in the proposed regulations below, today's proposed rule defines 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.

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.[14] 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

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[14] *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.

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 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. Given the break-in period considerations discussed above, 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.[15] Upon receipt of the motor, DOE's testing laboratory followed IEEE Standard 112 (Test Method B) and tested the motor 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 confirmed the significant impact that contact seals can have on demonstrated efficiency.  In the case of the five-horsepower, two-pole, TENV motor, the motor performed significantly better 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

[15] 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, thus being able to test the motor properly per IEEE 112 Test Method B.

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-2 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% |

Although DOE's testing confirmed that the impacts from contact seals can be significant and may reduce over time, DOE is proposing test procedure instructions that differ from the recommendations offered by interested parties. DOE believes testing with the contact seals may better represent an immersible motor's installed efficiency. DOE does not have specific data showing how the impacts from contact seals decay over time and DOE believes this decay may vary by basic model of immersible motor. In absence of such data showing near equivalent performance of immersible motors that are tested without contact seals to those that have contact seals that have been broken in, DOE is proposing that these motors be tested with the contact seals in place. In addition, DOE is proposing an allowance of a maximum run-in period of 10 hours prior to performing IEEE Standard 112 (Test Method B). This run-in period is intended to allow the contact seals a sufficient amount of time to break-in such that test conditions are equal or very similar to normal operating conditions that will be experienced by a user. DOE's proposed 10-hour maximum is a preliminary estimate obtained through discussions with electric motors testing experts. DOE may consider a longer run-in period or potentially removing the seals prior to testing in the final rule if data are obtained from manufacturers that substantiate the claim that an immersible motor's contact seals will wear-in, early on during the motor's lifetime (i.e., 200 hours), and to the point that the motor's efficiency is not affected. DOE is soliciting comments on its 200 hour assumption in its early motor lifetime estimate.

Finally, with regard to immersible motors built in a TEBC configuration, DOE is proposing instructions that would require the testing laboratory to power the smaller blower motor from an alternate power source than the one used for the electric motor being tested for efficiency. This approach will allow the testing laboratory to isolate the performance of the motor under test while continuing to provide the necessary cooling from the blower motor.

DOE requests comments concerning its proposed definition for "immersible electric motor," especially with respect to differentiating this motor type from "liquid-cooled" and "submersible" motors. Additionally, DOE invites comment on its proposal to permit manufacturers to run their motors for a period of time prior to performing IEEE Standard 112 (Test Method B) to break-in any contact seals. In particular, DOE requests comment and any data on the appropriateness of the proposed 10-hour time limit allowable for the run-in period. Finally, DOE requests comment on the appropriateness of allowing manufacturers to use an alternative power source to run the blower motor while testing an immersible motor built in a TEBC frame.

2. Integral and Non-Integral 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.

There are two general types of brake motors − integral and non-integral brake motors. An electric motor falls into one of these two categories depending on how its brake component is connected to the motor. If the brake component is integrated with other components of the electric motor and not readily detachable, it is usually considered[16] an integral brake motor. Conversely, if the brake component is connected externally and is more readily detachable, it is considered a non-integral brake motor.

In its August 15, 2012 "Joint Petition to Adopt Joint Stakeholder Proposal As it Relates to the Rulemaking on Energy Conservation Standards for Electric Motors" (the Petition), the Motor Coalition proposed a definition for the term "integral brake electric motor." That definition stated that an integral brake electric motor is "an electric motor containing a brake

[16] DOE's proposed definitions for integral and non-integral brake motors do not require a certain manner of attachment of the brake rather, the placement of the brake is the relevant distinctive factor.

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) Subsequent to the submission of the petition, DOE spoke with some of the Motor Coalition's manufacturers and its own SMEs. Based on these conversations, DOE believes 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 believes that there may be uncertainty regarding certain aspects of the definition, particularly, what constitutes "extensive disassembly of the motor or motor parts." Therefore, DOE is proposing a new definition that would remove this ambiguity. As detailed in the proposed regulations below, today's proposed rule defines 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. However, as with the definition of an "integral brake motor," DOE reconsidered the definition it presented in its electric motors preliminary analysis TSD for "non-integral brake electric motor." Similarly, DOE concluded that the previous definition was ambiguous, particularly with regards to detaching the brake component. Therefore, in today's notice, DOE is proposing a new definition for "non-integral brake electric motor" that parallels its proposed definition for “integral brake electric motor.” DOE believes that the new definition is clearer because it relies solely on the placement of the brake and not what level of effort is needed to remove it. Additionally, DOE believes that the structure of its two definitions encompasses all brake motors by requiring them to meet one definition or the other. As detailed in the proposed regulations below, DOE’s proposed definition for a “non-integral brake electric motor” is an electric motor containing a brake mechanism outside of the endshield, but not between the motor fan and endshield.

DOE believes that a definition for both integral and non-integral brake electric motors is necessary to distinguish between the two motor types because DOE may consider requiring different setup procedures for the two motor types and holding them to different efficiency levels.

In the electric motors preliminary analysis, DOE stated that it had preliminarily planned to include integral brake motors in the scope of expanded energy conservation. The Motor Coalition suggested that DOE continue to exclude these motors from coverage because of potential complications with testing. The group explained that there are no test standards for this motor type and that removing the brake components from the motor would affect the motor’s performance and possibly leave the motor inoperable because of the integrated nature of the removed brake components. The Motor Coalition added that the efficiency losses from brake componentry would not be uniform across the industry. (Motor Coalition, EERE-2010-BT-STD-0027-0035 at p. 13)

When considering test procedures for both brake motor types, DOE considered all the recommendations from the Motor Coalition and the results of its own testing. DOE conducted its own testing to gather information on the feasibility of testing integral and non-integral brake motors. During its investigation of integral brake motors, DOE procured and tested two motors: one five-horsepower, four-pole, TEFC motor and one one-horsepower, four-pole, TEFC motor. For each of the motors, DOE performed three tests. Each motor was initially tested following IEEE Standard 112 (Test Method B) as the motor was received (i.e., no modifications to the brake components). Then, the test laboratory removed the brake components and retested the motor, again following IEEE Standard 112 (Test Method B). Finally, a third test was conducted after the test laboratory reattached the brake components. The results of this testing are shown in Table III-3.

**Table III-3 Results of Integral Brake Motor Testing**

| Motor Type | Nameplate Efficiency | Test 1 | Test 2 | Test 3 |
|---|---|---|---|---|
| Integral Brake Motor 1 | 87.5% | 86.4% | 87.2% | 86.0% |
| Integral Brake Motor 2 | 82.5% | 77.4% | 80.3% | 78.0% |

For the two integral brake motors, there was no consistent amount of losses observed and attributable to the brake component. However, the decrease in motor losses that resulted when the brake was removed reached as high as 16 percent. While DOE anticipated that brake losses would vary based on motor horsepower and brake type, it appears that such losses are difficult to quantify in certain integral brake motor configurations. Additionally, while DOE found that the testing laboratory was able to reconnect the braking mechanisms after removal and to make the motor operable again after reconnecting the braking mechanism, there was a slight change in the performance of the two motors tested.

DOE also sought to investigate the feasibility of testing non-integral brake motors. DOE procured two non-integral brake motors, one five-horsepower, four-pole, TEFC motor and one 15-horsepower, four-pole, TEFC motor. When testing the motors, DOE's testing laboratory performed two tests on each motor. Initially, the motors were to be tested as they were received, following IEEE Standard 112 (Test Method B); however DOE's test facility faced a few complications. When attempting to test the five-horsepower motor, the test laboratory experienced complications when trying to conduct the no-load test. Because of the low voltage levels required for the no-load test, the braking mechanism would engage, stopping the test. Therefore, the testing laboratory spliced the electrical connections of the braking mechanism and connected the brake to an external power source. For the 15-horsepower motor, the brake had its own power connection and the test laboratory elected to connect the brake to an external power source (i.e., separate from what was supplied to the motor itself). For both motors, the test laboratory performed a second test in which the brake component was completely removed and the motor was tested according to IEEE Standard 112 (Test Method B) again. Finally, for the five-horsepower motor, the test laboratory performed a third test with the brake mechanism reattached.[17] The results of DOE's non-integral brake motor testing are shown below.

[17] This motor was originally thought to be an integral brake motor, which is why it was tested a third time.

**Table III-4 Results of Non-Integral Brake Motor Testing**

| Motor Type | Nameplate Efficiency | Test 1 | Test 2 | Test 3 |
|---|---|---|---|---|
| Non-Integral Brake Motor 1 | 87.5% | 87.3%[18] | 87.7% | 87.1% |
| Non-Integral Brake Motor 2 | 89.5% | 90.0%[19] | 90.0% | - |

DOE obtained much useful information from both rounds of non-integral brake motor testing. For the five-horsepower motor ("non-integral brake motor 1"), DOE obtained additional test data that supports the notion that removing and reattaching a brake mechanism to a motor could affect its performance. In this case, when the brake was reattached, the demonstrated efficiency of the motor decreased, albeit a minimal amount that could simply be due to testing variation. For the 15-horsepower motor ("non-integral brake motor 2") DOE obtained the same tested efficiency when the brake was powered externally and when it was removed. In this instance, this shows that there was a negligible impact on friction and windage losses due to the brake mechanism. DOE understands that this could have occurred for several reasons. It could be because the significant impacts on losses from brakes come from the power consumed to keep the brake disengaged. It could also be that the design of this particular brake mechanism was an anomaly and most brake mechanisms would have a larger impact on friction and windage. Finally, it could be because the motor tested was a 15-horsepower motor and the friction and windage losses due to the brake may have been small relative to other losses in the motor.

[18] For this test, the brake would engage during the no-load test, thus the testing laboratory connected the brake to a separate power source for that test.
[19] For this test, the laboratory connected the brake to an external power source for the duration of the test.

In light of the test results of the 15 horsepower, non-integral brake motor, DOE sought to investigate testing brake motors with the brake powered separately. Therefore, DOE conducted a final set of tests for the other three motors. During this testing the brake component was attached, but powered by a source separate from the motor. This testing showed that powering the brake component separately resulted in demonstrated efficiencies equivalent to testing a motor with the brake component completely removed. Results are shown in the Table below.

**Table III-5 Comparison of Removing Brake and Powering Brake Separately**

| Motor Tested | Tested Efficiency with Brake Removed | Tested Efficiency with Brake Powered Separately |
|---|---|---|
| Integral Brake Motor 1 | 87.2% | 87.6% |
| Integral Brake Motor 2 | 80.3% | 80.4% |
| Non-Integral Brake Motor 1 | 87.7% | 87.7% |

As a result of its testing of integral and non-integral brake electric motors, DOE is proposing the same test instructions for both motors types in today's notice. DOE proposes 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 believes that this is the best approach because it allows the test laboratory to isolate the losses due to the motor, which includes the friction and windage produced by the rotating brake mechanism. DOE believes 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 believes 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 believes that this process would not be unduly burdensome.

DOE requests comments on its proposed definitions. Additionally, DOE requests comments on its proposed instructions for testing integral and non-integral brake electric motors.

3. Partial Electric Motors

Most general purpose electric motors have two endshields,[20] 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, thus 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.[21] 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.

[20] 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.
[21] DOE notes that integral brake motors are not considered integral or partial motors.

DOE is aware that there are many different industry terms used to describe a partial electric motor and now that it is considering covering special and definite purpose electric motors in light of the EISA 2007 changes to EPCA, DOE is proposing to define the term "partial electric motor" to ensure clarity. Additionally, because DOE considers integral gearmotors to be a subset of partial electric motors, this definition would also apply to integral gearmotors. Also, DOE does not wish to create confusion regarding the difference between a "component set" of an electric motor (discussed below in section III.G.2) and a "partial electric motor." Therefore, as detailed in the proposed regulations below, today's proposed rule defines "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 "operable motor" means an electric motor engineered for performing 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 purposes. DOE received comments concerning potential testing difficulties for partial motors. The CDA indicated that a new test procedure may be required for partial motors and that DOE should consider developing a new test procedure for these and other motors. (CDA, No. 18 at p. 2) DOE has also received feedback suggesting that manufacturers could show compliance by testing a similar model that could more easily be attached to a dynamometer. (ASAP and NEMA, EERE-2010-BT-STD-0027-0012 at p. 9) In comments on the electric motors preliminary analysis, NEMA recommended that DOE require endshields to be installed prior to testing a partial motor. NEMA stated this would be an appropriate approach as long as the operating and cooling characteristics of a particular motor with endshields installed for testing is similar to how the partial motor would operate when connected to the driven equipment.[22] (NEMA, EERE-2010-BT-STD-0027-0054 at p 16)

DOE discussed NEMA's proposal 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 have considered machining the "dummy" endplates themselves, and supplying the properly sized deep-groove, ball bearings for the testing. Various testing laboratories have indicated 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.

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[22] Driven equipment is machinery that is run or "driven" by an electric motor.

**Table III-6 Results of Partial Electric Motor Testing**

| Motor Type | Nameplate Efficiency | Test 1 | Test 2 |
|---|---|---|---|
| Partial Electric Motor | 81.0% | 83.5% | 82.9% |

As stated by testing laboratories, DOE found a variation in efficiency because of the endplate used during testing. In this case, DOE understands 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 replace the manufacturer's endshield with one of the same material. Additionally, DOE knows of no testing laboratory (other than a motor manufacturer), with such capability. DOE understands that the variance in the magnetic properties of steel likely produced small eddy currents in the endshield which increased heat and, therefore, losses within the motor.[23] Consequently, DOE believes that it is necessary to try and maintain a consistency in frame material, in order to prevent such variances in future testing.

At this time, because of the possible variance that DOE found through its testing, DOE is proposing that an endplate be provided by the manufacturer of the motor and test with that endplate in place. If bearings are also needed, the test laboratory should 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 common bearing type capable of horizontal

[23] Eddy currents are circulating currents induced in conductors (e.g., steel) by changing magnetic fields. They typically manifest themselves as heat, which can increase losses within an electric motor.

operation. DOE requests comments on its proposed testing instructions for partial electric motors. In particular, DOE requests any data regarding the variation in tested efficiency likely to result from varying an endplate and its material.

E. <u>Electric Motor Types Requiring Only Test Procedure Instructions</u>

DOE is proposing to add additional instructions to the DOE test procedure that would affect a number of motor types for which DOE is analyzing new energy conservation standards. DOE is not proposing any definitions for these terms because DOE believes the terms are self-explanatory or already readily understood in the industry.

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 MG1-2009. 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 MG1−2009, paragraphs 1.63.1, 1.63.2, and 1.63.3 designate Type C face-mounting, Type D flange-mounting, and Type P flange-mounting motors, respectively. These definitions provide reference figures in NEMA MG1-2009, section I, part 4 titled "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 MG1−2009, 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 special and definite purpose electric motors such as those motors with non-standard endshields. This change to the scope of energy conservation standards for electric motors means 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 believes that an actual definition for such motors is unnecessary.

In evaluating the possibility of requiring these motor types to meet potential energy conservation standards, DOE is assessing whether these motors can be tested using non-standard flanges or endshields. DOE has 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 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) 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)

DOE understands that it may not be possible to attach motors with non-standard endshields to a testing laboratory's dynamometer. If such situation arises and a test laboratory is unable to reconfigure the motor without removal of the endplate such that attachment to a dynamometer is possible, DOE proposes that the custom endshield be replaced with one that has standard (i.e., in compliance with NEMA MG1) dimensions and mounting configurations. As with partial electric motors, such a replacement must be obtained through the manufacturer and be constructed of the same material as the original endplate.

DOE requests comment on its preliminary decision not to propose a definition for these motor types. DOE also requests comments on its proposed instructions for testing motors with non-standard endshields or flanges.

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

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 MG1-2009 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 special application. In 2011, DOE proposed to clarify its treatment of these types of motors and included a table with allowable shaft variations. 76 FR 648, 671-72 (January 5, 2011) This 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.

The guidance was intended to identify variations in shaft dimensions for a motor that would be covered as a general purpose electric motor under EPCA. However, in view of the EISA 2007 and AEMTCA 2012 amendments, DOE has preliminarily decided to expand the scope of regulatory coverage beyond the initial scope set by EPCA prior to these two amendments. As such, DOE believes that a motor's shaft alone, no matter what its dimensions or type, is an insufficient reason to exclude a motor from having to satisfy 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 is assessing 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 sought to investigate 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 in this case, was not needed. 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, at this time, DOE agrees with the above NEMA comment and is proposing to include instructions for special couplings or adapters. In 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 understands that a motor's shaft configuration has minimal, if any, impact on overall motor efficiency, and believes that this approach is technologically feasible and will not result in any distortion of a motor's inherent efficiency when tested.

DOE seeks comment on its tentative approach declining to propose a definition for motors with non-standard shaft dimensions or additions. DOE also requests comment on its proposed instructions for testing such motors.

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.E.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.

At this time, DOE is not proposing a definition for any terms related to vertical electric motors. DOE believes definitions are 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 without need for DOE clarification. Although defining a vertically mounted electric motor does not appear necessary, DOE believes 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)) NEMA, ASAP, and the Motor Coalition submitted comments agreeing with the EISA 2007 provision and noted that vertical motors cannot be tested on a standard dynamometer because most dynamometers are designed to operate in conjunction with horizontally oriented electric motors. (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 subject matter experts. In view of the statutory requirement and current dynamometer testing configuration limits, DOE is proposing to test motors, which are otherwise engineered to operate vertically, in a horizontal position when determining efficiency.

Another consideration is the shaft of a vertical motor and whether it is solid or hollow. If a vertical motor has a solid shaft, then no further adjustments are needed after considering orientation, unless the motor contains a special shaft. (See section III.E.2) If a vertical motor has 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) then additional instructions would be needed prior to testing for efficiency.

After publishing the preliminary analysis, DOE did not receive any public comments suggesting that the testing of a vertical, hollow-shaft motor in a horizontal position would be technologically infeasible or unduly burdensome, especially when compared to the testing of a vertical solid-shaft motor. DOE understands that vertical hollow-shaft motors may not have a shaft extension at the drive end of the motor, which would be necessary for attaching or coupling the motor to a dynamometer for testing.

DOE conducted testing 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 believes that, as long as the attached solid-shaft maintains sufficient clearance through the drive end of the motor to enable the motor to be attached to the dynamometer this is a feasible approach to testing vertical hollow-shaft motors. Aside from the addition of a shaft extension, DOE does 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 MG1 paragraph 12.58.1 "Determination of Motor Efficiency and Losses."[24] (NEMA, EERE-2010-BT-STD-0027-0019 at p. 4)

DOE consulted testing laboratories about whether IEEE Standard 112 (Test Method E) would be an appropriate procedure to use when testing vertical motors. DOE understands that the primary difference between IEEE Standard 112 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 measurement method to directly 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 equipment that cannot be attached to a dynamometer. Although Test Method E

[24] "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) [Footnote: 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) [Footnote: 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

may reduce some testing burden for vertical motors, DOE is concerned that Test Method E could produce results that are inconsistent and inaccurate relative to testing comparable motors under Test Method B. Therefore, DOE is declining to propose the use of Test Method E for vertical motors. However, DOE requests additional comments and test data that demonstrate any differences in the results of testing under Test Method E and Test Method B for the same basic model of vertical motor.

DOE requests comments on its preliminary decision not to propose any definitions for vertical motors. It also requests comments on its proposed instructions when addressing various construction differences between vertical and horizontal motors, in particular, test methods for vertical motors with hollow shafts.

4. Electric Motor Bearings

Electric motors usually employ antifriction bearings that are housed within the endshields to support the motor's shaft and provide a low-friction means for shaft rotation. Antifriction 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).

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.

DOE also understands that 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.[25] 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 understands that reorienting the motor, as would be necessary for testing, could cause physical damage to the motor. For motors equipped with such bearings, DOE is proposing to add testing instructions that would require the testing laboratory to replace the thrust bearing with a "standard bearing," which shall be interpreted 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

[25] 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.

motor is oriented horizontally, DOE is proposing that the motor should be tested as is, without replacing the bearings. DOE believes that this is the most appropriate approach because it will provide the truest representation of the energy use that will be experienced by the user.

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.[26] 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 which employs standard bearings.[27] (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, 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

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

[27] 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.

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.[28] As a result of this collective research, DOE has tentatively determined that sleeve bearings do not significantly degrade efficiency when compared to spherical, radial ball bearings. More importantly, DOE does not believe that it is any 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 believes 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 is not certain that sleeve bearings could be readily swapped with standard ball bearings without significant, costly motor alterations. Therefore, because it may be impracticable to swap them out with other bearings, DOE is proposing that motors with sleeve bearings be tested as-is and with the sleeve bearings installed.

DOE requests comment regarding its proposed approach to testing motors with thrust bearings only capable of vertical operation. DOE also requests comment on its proposed

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

approach to testing motors with all types of bearings that are capable of horizontal operation, in particular, its proposed approach to testing motors with sleeve bearings.

F. <u>General Clarification for Certain Electric Motor Types</u>

For some electric motor types, DOE is neither proposing additions to the DOE test procedure nor proposing to define the motor types. However, DOE believes that some general clarification is needed for the following electric motor types to ensure that the regulations have sufficient clarity in detailing whether a particular motor is covered by DOE's regulations.

1. 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 considering whether to set standards for electric motors with non-standard bases, feet, or mounting configurations.

Part 4 of section I in NEMA MG1−2009 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.

DOE believes that a definition is not needed for this particular type of electric motor because whether a motor has a mounting base, feet, or configuration that is built within compliance of the standard dimensions laid out in NEMA MG1−2009 or IEC Standard 60072−1 is unambiguous. Also, DOE believes that additional instructions for these types of electric motors are 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 believes testing a "similar model" to show compliance would likely create difficulties in ensuring the accuracy and equivalence of claimed efficiency ratings. Additionally, DOE believes that testing motors with non-standard bases or mounting feet would not present an undue burden or insurmountable obstacle to testing. DOE understands that 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 believes non-standard mounting feet 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 understands that an electric motor's mounting base, feet, or configuration will 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 seeks comment about its tentative decision declining to propose a definition for "electric motors with non-standard base, feet, or mounting configurations." DOE also requests comment on any potential testing difficulties that may arise from testing these motor types and its preliminary decision not to issue any specific instructions related to testing such electric motors. Finally, DOE requests comment on its understanding that a motor's mounting base, feet, or configuration will not impact its demonstrated efficiency.

G. Electric Motor Types DOE Proposes Not to Regulate at this Time

1. 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 air flow over the surface of the motor frame. This air flow 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.[29] On the other hand, air-over electric motors do not have a factory-attached fan and, therefore, require a separate and external means of forcing air over the frame of the motor. Without an external means of cooling, an air-over electric motor could overheat during continuous operation and potentially degrade the

[29] 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.

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 extremely 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 is 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. This is a capability that most testing laboratories, at this time, 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 has no plans to require energy conservation standards for air-over electric motors, making further test procedure changes unnecessary.

Although DOE does not plan to apply energy conservation standards to air-over electric motors, it is proposing to define them for clarity. DOE's proposed "air-over electric motor" definition is based on the NEMA MG1−2009 definition of a "totally enclosed air-over machine," with some modification to that definition to include air-over electric motors with open frames. DOE believes 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. DOE requests comment on the broad definition for air-over electric motor. As detailed in the proposed regulations below, today's proposed rule defines "air-over electric motor" as an electric motor designed to be cooled by a ventilating means external to, and not supplied with, the motor.

DOE believes 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 -- are insurmountable at this time. Therefore, DOE also requests comment on its tentative decision not to require air-over electric motors to meet energy conservation standards at this time given the difficulties in developing a consistent, repeatable test method for these motors.

2. 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. A component set of an electric motor is comprised of any combination of these motor parts that does not form an operable motor.[30] 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

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[30] A combination of wound stator, rotor, shaft, and stator housing that is missing only one or both endshields or bearings is not considered a component set because this particular combination of assembled components creates an operable motor. A set of motor parts missing one or both endshields or bearing components is considered a "partial electric motor" and is discussed earlier in this NOPR.

with the intention of having the motor parts mounted inside a piece of 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 is 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. DOE is aware that there is no definition for either of these motor types in NEMA MG1−2009 or any other standard. Therefore, DOE is proposing a definition for "component set" in view of comments from SMEs, NEMA, and other industry experts. Defining "component set" is necessary to differentiate it from a "partial electric motor," addressed previously in this NOPR. DOE requests comment on its definition of "component set." As detailed in the proposed regulations below, today's proposed rule defines "component set" as a combination of motor parts that require the addition of more than two endshields to create an operable motor. Under the definition, these parts may consist of any combination of a stator frame, wound stator, rotor, shaft, or endshields and the term "operable motor" means an electric motor engineered for performing in accordance with nameplate ratings.

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 is declining at this time to require them to satisfy any energy conservations standards.

DOE requests comment on its proposed definition for “component set.” DOE also requests comment on its tentative decision to not require component sets to meet any particular energy conservation standards.

3. Liquid-Cooled Electric Motor

While most electric motors are cooled by air 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 does not intend to subject them to energy conservation standards at this time.

NEMA and ASAP commented in response to the October 15, 2010, energy conservation standards framework document, 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 does not plan to subject these motors to energy conservation standards, but instead is proposing to define "liquid-cooled electric motor" to clarify its view of what motors fall within this term. DOE's proposed definition is based on the definition of a "totally enclosed water-cooled machine" found in paragraph 1.26.5 of NEMA MG1−2009. Further, DOE is proposing to remove "totally enclosed" from the definition to prevent any unintentional limitations of the definition due to frame construction. DOE also plans 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 is proposing to modify the term "water conductors" to "liquid-filled conductors" to make it clear that the conductors are not made of liquid. (NEMA, EERE-2010-BT-STD-0027-0054 at p. 35) As detailed in the proposed regulations below, today's proposed rule defines "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.

DOE seeks comment on its proposed definition for "liquid-cooled electric motor" as well as its tentative decision not to cover these motors because of potential testing difficulties identified above, along with the testing variables that are introduced by an additional coolant system and pump apparatus. Nevertheless, DOE is open to comment about any test procedure standards or additional test procedure instructions that would take into account all such variables and allow this motor-type to be tested in a consistent, manageable, and repeatable manner.

4. Submersible Electric Motor

As previously addressed, most motors are not engineered for operation 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 preliminary analysis. (NEMA, EERE-2010-BT-STD-0027-0054 at p. 37) Consequently, as detailed in the proposed regulations below, today's proposed rule defines "submersible electric motor" as an electric motor designed for continuous operation only while submerged in liquid.

DOE does not plan to require submersible electric motors to meet energy conservation standards at this time. DOE believes that testing submersible electric motors would be extremely difficult because the motor must be submerged in a liquid to properly operate. After having discussions with manufacturers and testing laboratories, DOE is not aware of any industry test procedures or potential modifications to the procedures under 10 CFR 431.16 that could test a motor that relies on submersion in liquid for continuous-duty operation. Additionally DOE is not aware of any testing facilities that are capable of testing a submerged motor. Consequently, DOE has tentatively decided not to propose specific preparatory instructions for testing submersible electric motors. DOE is interested in 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.

DOE seeks comment about its proposed definition for "submersible electric motor." Additionally, DOE seeks comment on its tentative decision not to cover these motors because of potential testing difficulties and the number of testing concerns, such as the availability of standard testing procedures and testing facilities. Nevertheless, DOE is open to comment about any test procedure standards or additional test procedure instructions that would facilitate the testing of submersible electric motors in a consistent, manageable, and repeatable manner.

5. Definite-Purpose Inverter-Fed Electric Motors

DOE considers 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 are otherwise capable of general, continuous-duty operation without an inverter. This section addresses the former type of electric motors. Inverter-capable electric motors are addressed in section II.C.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.

NEMA agreed with DOE's preliminary approach to define such motors and not require them to meet energy conservation standards, but suggested a more specific definition of "inverter-only motor," based on NEMA MG1 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 is proposing to adopt it, with minor modifications. At this time, DOE is not proposing to require that a motor be marked as a "definite-purpose, inverter-fed electric motor," but may consider such a requirement in the future. DOE believes the new definition is more precise than what it previously considered and understands that it is a term currently recognized and used in common industry parlance. As detailed in the proposed regulations below, today's proposed rule defines "definite-purpose, inverter-fed 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.

Regarding testing a definite-purpose inverter-fed 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, but inverter-fed motors are incapable of meeting this requirement without the inverter. (See NEMA, at EERE-2010-BT-STD-0027-0054 at p. 35 and NEMA MG1-2009, part 31 at paragraph 31.4.3.1, which elaborates that an "inverter-fed motor" cannot perform across-the-line starting unless the motor is attached to the inverter.) Otherwise, DOE is not aware of an industry accepted test procedure that specifies at which speed or torque characteristics an inverter-fed motor should be tested. Furthermore, DOE does not believe it would be possible for it to develop a standardized test procedure for definite-purpose, inverter-fed electric motors on its own. 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 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. Therefore, even if DOE intended to regulate such motors, testing them could be extremely challenging using the currently accepted industry test procedures.

DOE requests comment on its proposed definition for “definite-purpose, inverter-fed electric motors” and its preliminary decision to exclude such motors from any expanded energy conservation standards for electric motors.

## IV. Procedural Issues and Regulatory Review

### A. Review Under Executive Order 12866

The Office of Management and Budget has determined that test procedure rulemakings do not constitute “significant regulatory actions” under section 3(f) of Executive Order 12866, Regulatory Planning and Review, 58 FR 51735 (October 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 (IRFA) for any rule that by law must be proposed for public comment, unless the agency certifies that the rule, if promulgated, will not have a significant economic impact on a substantial number of small entities. As required by Executive Order 13272, “Proper Consideration of Small Entities in Agency Rulemaking,” 67 FR 53461 (August 16, 2002), DOE published procedures and policies on February 19, 2003, to ensure that the potential impacts of its rules on small entities are properly considered during the DOE rulemaking process. 68 FR 7990. DOE has made its procedures and policies available on the Office of the General Counsel’s website: www.gc.doe.gov.

As described in the preamble, today's proposal 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 proposals are consistent with current industry practices and, once adopted and compliance is required, should be used for making representations of energy-efficiency of those covered electric motors and for certifying compliance to Federal energy conservation standards. DOE certified to the Office of Advocacy of the Small Business Administration (SBA) that the proposed test procedures for electric motors would not have a significant economic impact on a substantial number of small entities. The factual basis for this certification is as 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 its proposal 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 would 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.

If DOE ultimately adopts the additional definitions in this rulemaking extending the existing test procedures to motors that are not currently subject to Federal energy conservation standards, manufacturers would only need to use the testing set-up instructions, testing procedures, and rating procedures if a manufacturer elected to make voluntary representations of energy-efficiency of his or her basic models once compliance with the final test procedure was required. To better understand how the proposal would impact small manufacturers of electric motors, DOE reviewed current industry practice regarding the representations of energy efficiency currently made for motors not currently subject to energy conservation standards and how the proposal may impact current industry practice. Specifically, DOE's test procedures would require that those manufacturers of motors not currently subject to standards who choose to make public representations of efficiency to comply with the proposed methods. DOE's rule would not require manufacturers who do not currently make voluntary representations to then begin making public representations of efficiency.

DOE researched the catalogs and websites of the 13 identified small manufacturers and found that only four of the small manufacturers clearly list efficiency ratings for their equipment in public disclosures. The remaining manufacturers either build custom products, which would not be subject to the proposal, or do not list energy efficiency in their motor specifications, in part because it is not required. For the manufacturers that currently do not make any public representations of energy efficiency of their motors, DOE does not believe the proposal would impact the current behavior of those manufacturers that do not elect to make voluntary representations. DOE does not anticipate any burden accruing to these manufacturers unless the agency was to consider 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 that are contained within DOE's proposals. DOE does not have any reason to believe that the test set-up clarifications proposed for adoption would have any significant impact on the current practice of these four manufacturers.

In view of the foregoing, DOE certifies that today's proposal would 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).

## 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. The collection-of-information requirement for electric motors 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 that expires February 13, 2014. 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 proposed rule, DOE proposes test procedure amendments that it expects will be used to develop and implement future energy conservation standards 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 proposed rule would amend the existing test procedures without affecting the amount, quality or distribution of energy usage, and, therefore, would not result in any environmental impacts. Thus, this rulemaking is covered by Categorical Exclusion A5 under 10 CFR part 1021, subpart D, which applies to any rulemaking that interprets or amends an existing rule without changing the environmental effect of that rule. Accordingly, neither an environmental assessment nor an environmental impact statement is required.

## E. Review Under Executive Order 13132

Executive Order 13132, "Federalism," 64 FR 43255 (August 4, 1999) imposes certain requirements on agencies formulating and implementing policies or regulations that preempt State law or that have Federalism implications. The Executive Order requires agencies to examine the constitutional and statutory authority supporting any action that would limit the policymaking discretion of the States and to carefully assess the necessity for such actions. The Executive Order also requires agencies to have an accountable process to ensure meaningful and timely input by State and local officials in the development of regulatory policies that have Federalism implications. On March 14, 2000, DOE published a statement of policy describing the intergovernmental consultation process it will follow in the development of such regulations. 65 FR 13735. DOE has examined this proposed rule and has determined that it would not have a substantial direct effect on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government. EPCA governs and prescribes Federal preemption of State regulations as to energy conservation for the products that are the subject of today's proposed rule. States can petition

DOE for exemption from such preemption to the extent, and based on criteria, set forth in EPCA. (42 U.S.C. 6297(d)) No further action is required by Executive Order 13132.

F. Review Under Executive Order 12988

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

G. Review Under the Unfunded Mandates Reform Act of 1995

Title II of the Unfunded Mandates Reform Act of 1995 (UMRA) requires each Federal agency to assess the effects of Federal regulatory actions on State, local, and Tribal governments and the private sector. Pub. L. No. 104-4, sec. 201 (codified at 2 U.S.C. 1531). For a proposed regulatory action likely to result in a rule that may cause the expenditure by State, local, and Tribal governments, in the aggregate, or by the private sector of $100 million or more in any one year (adjusted annually for inflation), section 202 of UMRA requires a Federal agency to publish a written statement that estimates the resulting costs, benefits, and other effects on the national economy. (2 U.S.C. 1532(a), (b)) The UMRA also requires a Federal agency to develop an effective process to permit timely input by elected officers of State, local, and Tribal governments on a proposed "significant intergovernmental mandate," and requires an agency plan for giving notice and opportunity for timely input to potentially affected small governments before establishing any requirements that might significantly or uniquely affect small governments. On March 18, 1997, DOE published a statement of policy on its process for intergovernmental consultation under UMRA. 62 FR 12820; also available at www.gc.doe.gov. DOE examined today's proposed rule according to UMRA and its statement of policy and determined that today's proposal contains neither an intergovernmental mandate, nor a mandate that may result in the expenditure of $100 million or more in any year, so these requirements do not apply.

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

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

### I. Review Under Executive Order 12630

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

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

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

### K. Review Under Executive Order 13211

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

Today’s proposal to amend the test procedure for measuring the energy efficiency of electric motors is not a significant regulatory action under Executive Order 12866. Moreover, it would not, if adopted, 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 rule proposed in this notice incorporates portions of the following commercial standard as specified: National Electrical Manufacturers Association (NEMA) Standards Publication MG1-2009 Section I (Part 4), Section II and Section II (Part 12). Although other portions of NEMA MG1-2009 are already incorporated by reference into DOE regulations, portions of Section I (Part 4) and Section II (Part 12) have yet to be incorporated. DOE has evaluated these provisions and is unable to conclude whether they fully comply with the requirements of section 32(b) of the Federal Energy Administration Act (i.e., that they were developed in a manner that fully provides for public participation, comment, and review). DOE will consult with the Attorney General and the Chairman of the FTC about the impact of this test procedure on competition.

## V. Public Participation

### a. Attendance at Public Meeting

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

Any foreign national wishing to participate in the meeting should advise DOE as soon as possible by contacting Ms. Edwards to initiate the necessary procedures. Please also note that those wishing to bring laptop computers into the Forrestal Building will be required to obtain a property pass. Visitors should avoid bringing laptop computers, or allow an extra 45 minutes for security screening. Persons can also participate in the public meeting via webinar. For more information, refer to the Public Participation section near the end of this notice.

In addition, you can attend the public meeting via webinar. Webinar registration information, participant instructions, and information about the capabilities available to webinar participants will be published on DOE's website http://www1.eere.energy.gov/buildings/appliance_standards/rulemaking.aspx/ruleid/74. Participants are responsible for ensuring their systems are compatible with the webinar software.

b. Procedure for Submitting Prepared General Statements For Distribution

Any person who has plans to present a prepared general statement may request that copies of his or her statement be made available at the public meeting. Such persons may submit requests, along with an advance electronic copy of their statement in PDF (preferred), Microsoft Word or Excel, WordPerfect, or text (ASCII) file format, to the appropriate address shown in the ADDRESSES section at the beginning of this notice. The request and advance copy of statements must be received at least one week before the public meeting and may be emailed, hand-delivered, or sent by mail. DOE prefers to receive requests and advance copies via email. Please include a telephone number to enable DOE staff to make a follow-up contact, if needed.

c. Conduct of Public Meeting

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

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

At the end of all prepared statements on a topic, DOE will permit participants to clarify their statements briefly and comment on statements made by others. Participants should be prepared to answer questions by DOE and by other participants concerning these issues. DOE representatives may also ask questions of participants concerning other matters relevant to this rulemaking. The official conducting the public meeting will accept additional comments or questions from those attending, as time permits. The presiding official will announce any further procedural rules or modification of the above procedures that may be needed for the proper conduct of the public meeting.

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

d. Submission of Comments

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

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

However, your contact information will be publicly viewable if you include it in the comment or in any documents attached to your comment. Any information that you do not want to be publicly viewable should not be included in your comment, nor in any document attached to your comment. Persons viewing comments will see only first and last names, organization names, correspondence containing comments, and any documents submitted with the comments.

Do not submit to regulations.gov information for which disclosure is restricted by statute, such as trade secrets and commercial or financial information (hereinafter referred to as Confidential Business Information (CBI)). Comments submitted through regulations.gov cannot be claimed as CBI. Comments received through the website will waive any CBI claims for the information submitted. For information on submitting CBI, see the Confidential Business Information section.

DOE processes submissions made through regulations.gov before posting. Normally, comments will be posted within a few days of being submitted. However, if large volumes of comments are being processed simultaneously, your comment may not be viewable for up to several weeks. Please keep the comment tracking number that regulations.gov provides after you have successfully uploaded your comment.

Submitting comments via email, hand delivery, or mail. Comments and documents submitted via email, hand delivery, or mail also will be posted to regulations.gov. If you do not want your personal contact information to be publicly viewable, do not include it in your comment or any accompanying documents. Instead, provide your contact information on a cover letter. Include your first and last names, email address, telephone number, and optional mailing address. The cover letter will not be publicly viewable as long as it does not include any comments

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

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

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

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

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

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

e. Issues on Which DOE Seeks Comment

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

1. DOE requests comment on the decision to incorporate definitions for NEMA Design

A and NEMA Design C motors based on the NEMA MG1−2009 definitions of these motor designs.

2. DOE requests comment on the proposed definitions for IEC Design N and H motors.

3. DOE seeks comment on its proposed definition for electric motors with moisture resistant windings and electric motors with sealed windings and its preliminary decision to not propose additional testing instructions for these motors types.

4. DOE requests comments on its proposed definition for inverter-capable electric motors and its decision not to provide any test procedure instructions for this motor type.

5. DOE requests comments on its proposed definition and preliminary decision not to propose any clarifying testing instructions for TENV electric motors.

6. DOE requests comments on its proposed definition of integral brake electric motor and its preliminary decision to include them in the scope of these test procedures.

7. DOE requests comments on its preliminary decision to test integral brake electric motors and non-integral brake electric motors without disassembly but, rather, with their brake components powered externally.

8. DOE requests comments concerning its proposed definition for immersible electric motor, especially with regards to differentiating this motor type from liquid-cooled electric and submersible electric motors.

9. DOE invites comment on its proposed test procedure instructions for immersible electric motors, in particular, the proposal to allow for a maximum run-in period of 10 hours prior to testing according to IEEE Standard 112 Test Method B.

10. DOE requests comment on its preliminary decision not to propose a definition for electric motors with non-standard endshields or bases

11. DOE invites comment on its proposed instructions for testing electric motors with non-standard endshields or flanges.

12. DOE seeks comment on the decision to not propose a definition for electric motors with non-standard shaft dimensions or additions.

13. DOE requests comment on it proposed instructions for testing motors with non-standard shaft dimensions or additions.

14. DOE seeks comment regarding its decision not to propose a definition for electric motors with non-standard base, feet, or mounting configurations.

15. DOE requests comment on its instructions for testing electric motors with non-standard base, feet, or mounting configurations.

16. DOE seeks comment on any other testing difficulties that may arise from testing electric motors with non-standard base, feet, or mounting configurations.

17. DOE requests comment regarding its proposed approach to testing electric motors with bearings capable of horizontal orientation. DOE also requests comment on its

propose approach to testing electric motors with bearings not capable of horizontal orientation.

18. DOE requests comments on its preliminary decision not to propose any definitions for vertical motors.

19. DOE seeks comments on its proposed instructions for dealing with the various construction differences found between vertical and horizontal motors.

20. DOE requests comment on its decision not to propose additional test procedure clarifications for motors with sleeve bearings or a definition for these motor types.

21. DOE requests comment regarding the effect of sleeve bearings on a motor's tested efficiency.

22. DOE requests comment on its proposed definition for air-over electric motor, and the decision to include both open and enclosed frame motors under the same definition .

23. DOE requests comment on the decision to not require air-over electric motors to meet energy conservation standards at this time.

24. DOE requests comment on its proposed definition of component set of an electric motor.

25. DOE is open to comment on its tentative decision to not require component sets of electric motors to meet any particular energy conservation standards.

26. DOE seeks feedback on its proposed definition for liquid-cooled electric motors.

27. DOE seeks comment on its tentative decision not to cover liquid-cooled electric motors, primarily because of the testing difficulties encountered when testing them, namely the number of testing variables that are introduced by the additional coolant system and pump apparatus.

28. DOE is open to comment regarding any test procedure standards or additional test procedure guidance language that would take into account all variables involved in testing liquid-cooled motors and allows this motor type to be tested in a consistent, manageable, and repeatable manner.

29. DOE requests comment on its proposed definition of submersible electric motor.

30. DOE requests comment on whether it is correct that there are no test facilities capable of conducting performance tests on submersible electric motors.

31. DOE requests comment on its proposed definition for definite-purpose, inverter-fed electric motors.

32. DOE seeks comment on its preliminary decision to continue to not require definite-purpose, inverter-fed electric motors to meet any expanded energy conservation standards for electric motors.

## VI. Approval of the Office of the Secretary

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

**List of Subjects in 10 CFR Part 431**

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

Issued in Washington, DC, on June 19, 2013.

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

For the reasons stated in the preamble, DOE proposes to amend 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. Section 431.12 is amended 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,” “component set,” “definite-purpose, inverter-fed electric motor,” “electric motor with moisture resistant windings,” “electric motor with sealed windings,” “IEC Design H motor,” “IEC Design N motor,” “immersible electric motor,” “integral brake electric motor,” “inverter-capable electric motor,” “liquid-cooled electric motor,” “NEMA Design A motor,” “NEMA Design C motor,” “non-integral brake electric motor,” “partial 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 designed to be cooled by a ventilating means external to, and not supplied with, the motor.

*	*	*	*	*

Component set means a combination of motor parts that require the addition of more than two endshields 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, inverter-fed electric motor means 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.

*	*	*	*	*

Electric motor with moisture resistant windings means an electric motor that is engineered for passing the conformance test for moisture resistance described in NEMA MG1–2009, paragraph 12.63, (incorporated by reference, see § 431.15) as demonstrated on a representative sample or prototype.

Electric motor with sealed windings means an electric motor that is engineered for passing the conformance test for water resistance described in NEMA MG1-2009, paragraph 12.62, (incorporated by reference, see § 431.15) as demonstrated on a representative sample or prototype.

* * * * *

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 intended for direct-on-line starting (as demonstrated by the motor's ability to operate without an inverter)

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

(5) Is rated from 0.4 kW to 160 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 intended for direct-on-line starting (as demonstrated by the motor's ability to operate without an inverter);

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

(5) Is rated from 0.4 kW to 1600 kW; 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 withstanding complete immersion in liquid for a continuous period of no less than 30 minutes.

Integral brake electric motor means an electric motor containing a brake mechanism either inside of the motor endshield or between the motor fan and endshield.

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.

Liquid-cooled electric motor means a motor that is cooled by circulating liquid with the liquid or liquid-filled conductors coming into direct contact with the machine parts.

* * * * *

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 (incorporated by reference, see § 431.15);

(2) Has pull-up torque as shown in NEMA MG1–2009, paragraph 12.40;

(3) Has breakdown torque as shown in NEMA MG1–2009, paragraph 12.39;

(4) Has a locked-rotor current higher than 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 (incorporated by reference, see § 431.15);

(2) Has pull-up torque as shown in NEMA MG1−2009, paragraph 12.40;

(3) Has breakdown torque up to the values shown in NEMA MG1−2009, paragraph 12.39;

(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.

Non-integral brake electric motor means an electric motor containing a brake mechanism outside of the endshield, but not between the motor fan and endshield.

* * * * *

Partial electric 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 an electric motor engineered for performing in accordance with the applicable nameplate ratings.

* * * * *

Submersible electric motor means an electric motor designed for continuous operation only while submerged in liquid.

* * * * *

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. 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: Any representation made after [date 180 days after publication of the final rule will be inserted here] related to special and definite purpose motor types for which definitions are provided at §431.12, or for which specific testing procedures are provided in this appendix, must be based upon results generated under this test procedure. Upon the compliance date(s) of any energy conservation standard(s) for special and definite purpose motor types, use of the applicable provisions of this test procedure to demonstrate compliance with the energy conservation standard will also be required.

Any representation, including demonstrations of compliance, related to general purpose electric motors (subtype I or II) made after [date 180 days after publication of the final rule will be inserted here] must be based upon results generated under this test procedure.

*     *     *     *     *

4. <u>Procedures for the Testing of Certain Electric Motor Types.</u>

Prior to testing according to IEEE Standard 112 (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 prepared 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, open, single-row, deep groove, radial ball bearing.

<u>4.1 Close-Coupled Pump Electric Motors and Electric Motors with Single or Double Shaft Extensions of Non-Standard Dimensions or Additions:</u>

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 additions must be tested using a special coupling adapter.

4.2 Electric Motors with Non-Standard Endshields or Flanges:

If it is not possible to connect the electric motor to a dynamometer without removing the endplate, the testing laboratory shall replace the non-standard endshield or flange with an endshield or flange meeting NEMA or IEC specifications. The NEMA specifications are found in NEMA MG-1 (2009) in Section I, Part 4, paragraphs 4.1, 4.2.1, 4.2.2, 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, and 4-5, and Table 4-2 (incorporated by reference, see § 431.15). The IEC specifications are found in IEC 60072-1 (1991) (incorporated by reference, see § 431.15). If this is necessary, the replacement endshield or flange shall be obtained through the manufacturer, either by request or purchased as a replacement part; any such replacement endshield or flange must be constructed of the same material as the original endplate.

4.3 Immersible Electric Motors and Electric Motors with Contact Seals:

Immersible electric motors shall be tested with all contact seals installed as the motor is received. A manufacturer or test laboratory may run the electric motor being tested for a period of no more than 10 hours in order to break in the contact seals prior to testing. For immersible motors built in a totally enclosed blower cooled construction, the smaller, cooling motor shall be powered by a source separate from the source powering the electric motor under test.

4.4 Integral Brake Electric Motors:

Integral brake electric motors shall be tested with the integral brake component powered by a source separate from the source powering the electric motor under test. 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).

4.5 Non-Integral Brake Electric Motors:

Non-integral brake electric motors shall be tested with the non-integral brake component powered by a source separate from the source powering the electric motor under test. 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).

4.6 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 shall be obtained through the manufacturer, either by request or purchased as a replacement part.

4.7 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 configuration. If the unit under test cannot be reoriented horizontally due to its bearing construction, the electric motor's bearings 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.