DEPARTMENT OF ENERGY

10 CFR Parts 429 and 431

[EERE–2020–BT–TP–0011]

RIN 1904–AE62

Energy Conservation Program: Test Procedure for Electric Motors

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

ACTION: Final rule.

SUMMARY: This final rule amends the existing scope of the U.S. Department of Energy (''DOE'') test procedures for electric motors consistent with related updates to the relevant industry testing standard (*i.e.,* for air-over electric motors, electric motors greater than 500 horsepower, electric motors considered small, inverter-only electric motors, and synchronous electric motors); adds test procedures, an appropriate metric, and supporting definitions for additional electric motors covered under the amended scope; and updates references to industry standards to reference current versions. Furthermore, DOE is adopting certain industry provisions related to the prescribed test conditions to further ensure the comparability of test results. DOE is also amending provisions pertaining to certification testing and the determination of represented values for electric motors other than dedicated-purpose pool pump motors, and re-locating such provisions consistent with the location of the certification requirements for other covered products and equipment. Finally, DOE is adding provisions pertaining to certification testing and the determination of represented values for dedicated-purpose pool pump motors.

DATES: The effective date of this rule is November 18, 2022. The final rule changes will be mandatory for product testing starting April 17, 2023. The incorporation by reference of certain publications listed in the rule is approved by the Director of the Federal Register on November 18, 2022. The incorporation by reference of certain other publications listed in the rule was approved by the Director as of June 4, 2012 and February 3, 2021.

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

A link to the docket web page can be found at *www.regulations.gov/docket?D=EERE-2020-BT-TP-0011.* The docket web page contains instructions on how to access all documents, including public comments, in the docket.

For further information on how to review the docket contact the Appliance and Equipment Standards Program staff at (202) 287–1445 or by email: *ApplianceStandardsQuestions@ee.doe.gov.*

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SUPPLEMENTARY INFORMATION: DOE maintains standards previously approved for incorporation by reference and incorporates by reference the following industry standards into part 431:

CSA C390:10 (reaffirmed 2019), ''Test methods, marking requirements, and energy efficiency levels for three-phase induction motors,'' including Updates No. 1 through 3, Revised January 2020 (''CSA C390–10'').

CSA C747–09 (reaffirmed 2019), ''Energy Efficiency Test Methods for Small Motors,'' including Update No. 1 (August 2016), dated October 2009 (''CSA C747–09'').

Copies of CSA C390–10 and CSA C747–09 can be obtained from Canadian Standards Association (''CSA''), Sales Department, 5060 Spectrum Way, Suite 100, Mississauga, Ontario, L4W 5N6, Canada, 1–800–463–6727, or by visiting *www.shopcsa.ca/onlinestore/welcome.asp.*

IEC 60034–12:2016, Edition 3.0 2016–11, ''Rotating Electrical Machines, Part 12: Starting Performance of Single-Speed Three-Phase Cage Induction Motors,'' Published November 23, 2016 (''IEC 60034–12:2016'').

IEC 60072–1, ''Dimensions and Output Series for Rotating Electrical Machines—Part 1: Frame numbers 56 to 400 and flange numbers 55 to 1080,'' Sixth Edition, 1991–02, clauses 2, 3, 4.1, 6.1, 7, and 10, and Tables 1, 2 and 4. (''IEC 60072–1'')

IEC 60079–7:2015, Edition 5.0 2015–06, ''Explosive atmospheres—Part 7: Equipment protection by increased safety 'e,' '' Published June 26, 2015 (''IEC 60079–7:2015'').

IEC 61800–9–2:2017, ''Adjustable speed electrical power drive systems—Part 9–2: Ecodesign for power drive systems, motor starters, power electronics and their driven applications—Energy efficiency indicators for power drive systems and motor starters,'' Edition 1.0, March 2017 (''IEC 61800–9–2:2017'').

Copies of IEC 60034–12:2016, IEC 60079–7:2015 and IEC 61800–9–2:2017 may be purchased from International Electrotechnical Commission (''IEC''), 3 rue de Varembé, 1st floor, P.O. Box 131, CH–1211 Geneva 20–Switzerland, +41 22 919 02 11, or by visiting *https://webstore.iec.ch/home.*

IEEE 114–2010, ''Test Procedure for Single-Phase Induction Motors,'' December 23, 2010 (''IEEE 114–2010'').

Copies of IEEE 114–2010 can be obtained from: Institute of Electrical and Electronics Engineers (''IEEE''), 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855–1331, (732) 981–0060, or by visiting *www.ieee.org.*

ANSI/NEMA MG 1–2016 (Revision 1, 2018), ''Motors and Generators,'' ANSI approved June 15, 2021 (''NEMA MG 1–2016'').

Copies of NEMA MG 1–2016 may be purchased from National Electrical Manufacturers Association (''NEMA''), 1300 North 17th Street, Suite 900, Arlington, Virginia 22209, +1 703 841 3200, or by visiting */www.nema.org.*

National Fire Protection Association (''NFPA'') 20, 2022 Edition, ''Standard for the Installation of Stationary Pumps for Fire Protection,'' Approved by ANSI on April 8, 2021 (''NFPA 20–2022'').

Copies of NFPA 20–2022 may be purchased from National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169, +1 800 344 3555, or by visiting *www.nfpa.org.*

See section IV.N of this document for a further discussion of these standards.

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I. Authority and Background

Electric motors are included in the list of ''covered equipment'' for which the U.S. Department of Energy (''DOE'') is authorized to establish and amend energy conservation standards and test procedures. (42 U.S.C. 6311(1)(A)) DOE's energy conservation standards and test procedures for electric motors are currently prescribed at 10 CFR 431.25 and appendix B to subpart B of 10 CFR part 431 (''appendix B''), respectively. The following sections discuss DOE's authority to establish test procedures for electric motors and relevant background information regarding DOE's consideration of test procedures for this equipment.

A. Authority

The Energy Policy and Conservation Act, as amended (''EPCA''),[1] authorizes DOE to regulate the energy efficiency of a number of consumer products and certain industrial equipment. (42 U.S.C. 6291–6317) Title III, Part C [2] of EPCA, added by the National Energy Conservation Policy Act, Pub. L. 95–619, Title IV, section 441(a), established the Energy Conservation Program for Certain Industrial Equipment, which sets forth a variety of provisions designed to improve energy efficiency. These equipment include electric motors, the subject of this document. (42 U.S.C. 6311(1)(A))

The energy conservation program under EPCA consists essentially of four parts: (1) testing, (2) labeling, (3) Federal energy conservation standards, and (4) certification and enforcement procedures. Relevant provisions of EPCA include definitions (42 U.S.C. 6311), test procedures (42 U.S.C. 6314), labeling provisions (42 U.S.C. 6315), energy conservation standards (42 U.S.C. 6313), and the authority to require information and reports from manufacturers (42 U.S.C. 6316; 42 U.S.C. 6296).

The Federal testing requirements consist of test procedures that manufacturers of covered equipment must use as the basis for: (1) certifying to DOE that their equipment complies with the applicable energy conservation standards adopted pursuant to EPCA (42 U.S.C. 6316(a); 42 U.S.C. 6295(s)), and (2) making other representations about the efficiency of that equipment (42 U.S.C. 6314(d)). Similarly, DOE must use these test procedures to determine whether the equipment complies with relevant standards promulgated under EPCA. (42 U.S.C. 6316(a); 42 U.S.C. 6295(s))

Federal energy efficiency requirements for covered equipment established under EPCA generally supersede State laws and regulations concerning energy conservation testing, labeling, and standards. (42 U.S.C. 6316(a) and 42 U.S.C. 6316(b); 42 U.S.C. 6297) DOE may, however, grant waivers of Federal preemption for particular State laws or regulations, in accordance with the procedures and other provisions of EPCA. (42 U.S.C. 6316(b)(2)(D))

Under 42 U.S.C. 6314, EPCA sets forth the criteria and procedures DOE must follow when prescribing or amending test procedures for covered equipment. EPCA requires that any test procedures prescribed or amended under this section must be reasonably designed to produce test results which reflect energy efficiency, energy use or estimated annual operating cost of a given type of covered equipment during a representative average use cycle (as determined by the Secretary) and requires that test procedures not be unduly burdensome to conduct. (42 U.S.C. 6314(a)(2))

EPCA, pursuant to amendments made by the Energy Policy Act of 1992, Pub. L. 102–486 (Oct. 24, 1992) (''EPACT 1992''), specifies that the test procedures for electric motors subject to the standards prescribed in 42 U.S.C. 6313 shall be those specified in National Electrical Manufacturers Association (''NEMA'') Standards Publication MG1–1987 and the Institute of Electrical and Electronics Engineers (''IEEE'') Standard 112 Test Method B, as in effect on October 24, 1992. (42 U.S.C. 6314(a)(5)(A)). If these industry test procedures are amended, DOE must

[1] All references to EPCA in this document refer to the statute as amended through the Energy Act of 2020, Pub. L. 116–260 (Dec. 27, 2020), which reflect the last statutory amendments that impact Parts A and A–1 of EPCA.

[2] For editorial reasons, upon codification in the U.S. Code, Part C was redesignated Part A–1.

amend its own test procedures to conform to such amended test procedure requirements, unless DOE determines by rule, published in the **Federal Register** and supported by clear and convincing evidence, that to do so would not meet the statutory requirements related to the test procedure representativeness and burden. (42 U.S.C. 6314(a)(5)(B))

EPCA also requires that, at least once every 7 years, DOE evaluate test procedures for each type of covered equipment, including electric motors, to determine whether amended test procedures would more accurately or fully comply with the requirements for the test procedures to not be unduly burdensome to conduct and be reasonably designed to produce test results that reflect energy efficiency, energy use, and estimated operating costs during a representative average use cycle. (42 U.S.C. 6314(a)(1))

In addition, if the Secretary determines that a test procedure amendment is warranted, the Secretary must publish proposed test procedures in the **Federal Register**, and afford interested persons an opportunity (of not less than 45 days' duration) to present oral and written data, views, and arguments on the proposed test procedures. (42 U.S.C. 6314(b)). If DOE determines that test procedure revisions are not appropriate, DOE must publish its determination not to amend the test procedures.

DOE is publishing this final rule in satisfaction of its statutory obligations specified in EPCA.

B. Background

On December 17, 2021, DOE published a notice of proposed rulemaking (''NOPR'') for the electric motors test procedure. 86 FR 71710 (''December 2021 NOPR''). In the December 2021 NOPR, DOE proposed to revise the current scope of the test procedures to add additional electric motors and implement related updates needed for supporting definitions and metric requirements as a result of this expanded scope; incorporate by reference the most recent versions of the referenced industry standards; incorporate by reference additional industry standards used to test additional electric motors that DOE had proposed to include within its scope; clarify the current test procedure's scope and test instructions by adding definitions for specific terms; revise the current vertical motor testing instructions to reduce manufacturer test burden; clarify that the current test procedure permits removal of contact seals for immersible electric motors only; revise the provisions pertaining to certification testing and determination of represented values; and add provisions pertaining to certification testing and determination of represented values for dedicated purpose pool pump (''DPPP'') motors. *Id* The NOPR provided an opportunity for submitting written comments, data, and information on the proposal by February 15, 2022.

On February 4, 2022, DOE published a notice granting an extension of the public comment period to allow public comments to be submitted until February 28, 2022. 87 FR 6436.

DOE received comments in response to the December 2021 NOPR from the interested parties listed in Table II.1.

TABLE II.1—LIST OF COMMENTERS WITH WRITTEN SUBMISSIONS IN RESPONSE TO THE DECEMBER 2021 NOPR

Commenter(s)	Reference in this final rule	Docket No.	Commenter type
ABB Motors and Mechanical Inc	ABB	18	Manufacturer.
Air Movement and Control Association International	AMCA	21	Industry Motor Trade Association.
American Gear Manufacturers Association	AGMA	14	Industry Gear Manufacturer Trade Association.
Appliance Standards Awareness Project, American Council for an Energy-Efficient Economy, Natural Resources Defense Council, New York State Energy Research and Development Authority.	Joint Advocates	27	Efficiency Organizations.
Association of Home Appliance Manufacturers; Air-Conditioning, Heating, and Refrigeration Institute.	AHAM and AHRI	36	Industry OEM Trade Association.
The Australian Industry Group[i]	AI Group	25	Industry Motor Trade Association.
ebm-papst Inc	ebm-papst	23	Manufacturer.
European Committee of Manufacturers of Electrical Machines and Power Electronics.	CEMEP	19	Industry Electrical Machines and Power Electronics Trade Association.
Franklin Electric Co, Inc	Franklin Electric	22	Manufacturer.
Grundfos Americas Corporation	Grundfos	29	OEM/Pump manufacturer.
Hydraulics Institute	HI	30	Industry Pump Trade Association.
International Electrotechnical Commission	IEC	20	Industry Standards Organization.
Johnson Controls	JCI	34	Manufacturer.
Lennox International	Lennox	24	Manufacturer.
National Electrical Manufacturers Association	NEMA	26	Industry Trade Association.
North Carolina Advanced Energy Corporation	Advanced Energy	33	Independent Testing Laboratory.
Northwest Energy Efficiency Alliance (NEEA), Northwest Power and Conservation Council (NWPCC).	NEEA/NWPCC	37	Non-profit organization/interstate compact agency.
Pacific Gas and Electric Company (PG&E), San Diego Gas and Electric (SDG&E), and Southern California Edison (SCE).	CA IOUs	32.1 and 32.2	Utilities.
Regal Rexnord	Regal	28	Manufacturer.
Sumitomo Machinery Corporation of America	Sumitomo	17	Manufacturer.
Trane Technologies	Trane	31	OEM.
Water Systems Council	WSC	35	Industry Trade Association.

[i] The AI group submitted multiple comments to the docket. One comment was an email cover letter, while the other two were preliminary and final submission of their comments. In their cover letter, the AI group attested that there were no changes between the final and preliminary submissions. Therefore, in this final rule, DOE's reference to AI group's comment submission is the final submission.

To the extent that DOE received comments relating to the energy conservation standards for electric motors subject to DOE's proposal to expand the test procedure's scope, those comments fall outside of the focus of this rulemaking, which addresses only the test procedure itself. Comments related to any potential standards that DOE may consider for electric motors will be discussed in the separate energy conservation standards rulemaking docket (EERE–2020–BT–STD–0007).[3]

Regarding the general rulemaking timeline, ABB requested that DOE issue a Supplemental NOPR and schedule a meeting to discuss the test procedure before a final rule is issued. (ABB, No. 18 at p. 3) NEMA requested a Supplemental NOPR be added to this rulemaking asserting that significant changes to the scope and test methods are needed to ensure the test procedure is reasonable, accurate, and repeatable. (NEMA, No. 26 at p. 6) CA IOUs suggested that DOE consider forming an ASRAC Working Group to engage on cross-segment electric motor topics. (CA IOUs, No. 32.1 at p. 50)

As discussed in this final rule, DOE is amending the scope of the test procedure and adopting corresponding test procedure provisions consistent with the most current applicable industry test standard. The test procedure adopted in this final rule is generally consistent with the test procedure proposed in the December 2021 NOPR. Therefore, DOE has determined that additional actions such as an SNOPR or ASRAC Working Group are not appropriate and is proceeding with this final rule. Additionally, as stated, EPCA requires DOE to evaluate the test procedures at least once every seven years to determine whether amendments to the test procedure are needed to more fully meet the statutory requirement that the test procedure be representative of an average use cycle without being unduly burdensome. (42 U.S.C. 6314(a)(1)) Accordingly, DOE is proceeding with a final rule as discussed in the following sections.

II. Synopsis of the Final Rule

In this final rule, DOE amends the test procedure as follows:

(1) Update the existing definitions for IEC Design N and H motors to reflect industry standard updates; amend the existing scope to reflect updates in industry nomenclature, specifically for new industry motor design designations IEC Design NE, HE, NEY and HEY, and include corresponding definitions;

(2) Amend the definition of ''basic model'' to rely on the term ''equipment class'' and add a definition for ''equipment class'' to make the electric motor provisions consistent with the provisions for other DOE-regulated products and equipment;

(3) Add test procedures, a full-load efficiency metric, and supporting definitions for air-over electric motors; electric motors greater than 500 horsepower (''hp''); electric motors considered small (*i.e.,* SNEMs); inverter-only electric motors, and synchronous electric motors;

(4) Incorporate by reference the most recent versions of NEMA MG 1 (*i.e.,* NEMA MG 1–2016 (Revision 1, 2018) ANSI-approved 2021) and CSA C390–10 (*i.e.,* reaffirmed 2019), as well as other referenced industry standards *i.e.,* IEC 60034–12:2016, Edition 3.0 2016–11, ''Rotating Electrical Machines, Part 12: Starting Performance of Single-Speed Three-Phase Cage Induction Motors,''; IEC 60079–7:2015, Edition 5.0 2015–06, ''Explosive atmospheres—Part 7: Equipment protection by increased safety 'e,' '', which is referenced within IEC 60034–12:2016 and is necessary for the test procedure; and NFPA 20 ''Standard for the Installation of Stationary Pumps for Fire Protection'' 2022 Edition (''NFPA 20–2022'');

(5) Incorporate by reference additional industry test standards and test instructions to support testing of the additional motors included in the amended test procedure scope: CSA C747–09 (reaffirmed 2019) (''CSA C747–09''), IEEE 114–2010, and IEC 61800–9–2:2017;

(6) Provide additional detail in the test instructions for electric motors by adding definitions for the terms ''rated frequency'' and ''rated voltage;''

(7) Update the testing instructions for vertical electric motors to reduce manufacturer test burden;

(8) Add a definition of ''independent'' as it relates to nationally recognized certification and accreditation programs;

(9) Permit manufacturers to certify an electric motor's energy efficiency using one of three options: (i) testing the electric motor at an accredited laboratory and then certifying on its own behalf or having a third-party submit the manufacturer's certification report; (ii) testing the electric motor at a testing laboratory other than an accredited laboratory and then having a nationally recognized certification program certify the efficiency of the electric motor; or (iii) using an alternative efficiency determination method (''AEDM'') and then having a third-party nationally recognized certification program certify the efficiency of the electric motor. Using these provisions would be required for certification starting on the compliance date for any new or amended standards for electric motors published after January 1, 2022;

(10) Revise the provisions pertaining to the determination of represented values applied starting on the compliance date of the next final rule adopting new or amended energy conservation standards for electric motors;

(11) Revise the AEDM provisions for electric motors and apply them to all electric motors covered in the scope of the test procedure;

(12) Revise the procedures for recognition and withdrawal of recognition of accreditation bodies and certification programs as applied to electric motors and apply these provisions to all electric motors covered in the scope of the test procedure;

(13) Move provisions pertaining to certification testing, AEDM, and determination of represented values from 10 CFR part 431 to 10 CFR part 429; and

(14) Add provisions pertaining to certification testing and determination of represented values for DPPP motors.

The adopted amendments are summarized in Table II–1 compared to the test procedure provision prior to the amendment, as well as the reason for the adopted change.

TABLE II–1—SUMMARY OF CHANGES IN THE AMENDED TEST PROCEDURE

Current DOE test procedure	Amended test procedure	Attribution
Applies to Design N and H motors defined at 10 CFR 431.12.	Reflects updates in industry nomenclature, specifically, new motor design designations IEC Design HE, HY, HEY, NE, NY and NEY, and includes corresponding definitions.	Update to industry testing standard IEC 60034–12.

[3] The parenthetical reference provides a reference for information located in the docket of DOE's rulemaking to develop test procedures for electric motors. (Docket No. EERE–2020–BT–TP–0011, which is maintained at *www.regulations.gov*). The references are arranged as follows: (commenter name, comment docket ID number, page of that document).

TABLE II–1—SUMMARY OF CHANGES IN THE AMENDED TEST PROCEDURE—Continued

Current DOE test procedure	Amended test procedure	Attribution
Exempts air-over electric motors	Includes test methods, full-load efficiency metric, and supporting definitions for air-over electric motors.	Update to industry testing standard NEMA MG 1 2016 with revisions through 2021 which include a test method for air-over electric motors.
Includes electric motors with a horsepower equal to or less than 500 hp.	Includes test methods and full-load efficiency metric for electric motors with a horsepower greater than 500 and equal to or less than 750 hp.	Statute allowance to extend applicability of the test procedure to these electric motors.
Includes electric motors with a horsepower equal to or greater than 1 hp.	Includes test methods and full-load efficiency metric for electric motors considered small (*i.e.,* small non-small-electric-motor electric motors, or SNEMs).	Statute allowance to extend applicability of the test procedure to these electric motors.
Exempts inverter-only electric motors.	Includes test methods, full-load efficiency metric, and supporting definitions for inverter-only electric motors.	New industry testing standard (IEC 61800–9–2:2017).
Includes electric motors that are induction motors only.	Includes test methods, full-load efficiency metric, and supporting definitions for certain synchronous electric motors.	New developments in motor technologies and new industry testing standard (IEC 61800–9–2:2017).
Incorporates by reference NEMA MG 1–2009, CSA 390–10, IEC 60034–12 Edition 2.1 2007–09, and NFPA 20–2010.	Incorporates by reference the most recent versions of NEMA MG 1 (*i.e.,* NEMA MG 1–2016), CSA 390 (*i.e.,* CSA C390–10), as well as other referenced industry standards (*i.e.,* IEC 60034–12 Edition 3.0 2016 and NFPA 20–2022). In addition, incorporates by reference IEC 60079–7:2015, which is referenced within IEC 60034–12:2016 and is necessary for the test procedure. Incorporates by reference additional industry test standards and testing instructions to support testing of the additional motors included in scope: CSA C747–09, IEEE 114–2010, and IEC 61800–9–2:2017.	Updates to industry testing standards NEMA MG 1, CSA 390, IEC 60034–12 and NFPA 20–209. Incorporates industry standards for additional motors included in scope.
Specifies testing at rated frequency, and rated voltage but does not define these terms.	Provides additional detail in the test instructions for electric motors by adding definitions for the terms "rated frequency," and "rated voltage".	Harmonizes with definitions from NEMA MG 1 and improves the repeatability of the test procedure.
Specifies one method of connecting the dynamometer to vertical electric motors.	Updates the vertical electric motor testing requirements to allow alternative methods for connecting to the dynamometer.	Reduce manufacturer testing burden.
Includes a description of "independent" at 10 CFR 431.19(b)(2), 431.19(c)(2), 431.20(b)(2) and 431.20(c)(2).	Adds a definition for "independent" as it relates to nationally recognized certification and accreditation programs and replace the descriptions of "independent" at 10 CFR 431.19(b)(2), 431.19(c)(2), 431.20(b)(2) and 431.20(c)(2) by this definition.	Required by 42 U.S.C. 6316(c).
Allows a manufacturer to both test in its own accredited laboratories and directly submit the certification of compliance to DOE for its own electric motors.	Continues to allow a manufacturer to both test in its own accredited laboratories and directly submit the certification of compliance to DOE for its own electric motors. Also now permits certification of compliance using one of three options: (1) a manufacturer can have the electric motor tested using an accredited laboratory and then certify on its own behalf or have a third-party submit the manufacturer's certification report; (2) a manufacturer can test the electric motor at a testing laboratory other than an accredited laboratory and then have a nationally recognized certification program certify the efficiency of the electric motor; or (3) a manufacturer can use an alternative efficiency determination method and then have a third-party nationally recognized certification program certify the efficiency of the electric motor. DOE adopts to require these provisions on or after the compliance date for any new or amended standards for electric motors published after January 1, 2021.	Required by 42 U.S.C. 6316(c).
Includes provisions pertaining to the determination of the represented value at 10 CFR 431.17.	Revises the provisions pertaining to the determination of the represented values (*i.e.,* nominal full-load efficiency and average full-load efficiency) and requires use of these provisions for all electric motors subject to energy conservation standards at 10 CFR 431, subpart B, on or after the compliance date of the final rule adopting new or amended energy conservation standards for electric motors. Moves the provisions to 10 CFR 429.64. Applies these provisions to all electric motors included in the scope of the test procedure.	Align the determination of the average and nominal full-load efficiency with the definitions at 10 CFR 431.12. Harmonizes sampling requirements with other covered equipment and covered products at 10 CFR 429.70.
Includes AEDM provisions at 10 CFR 431.17.	Revises the AEDM provisions and applies these provisions to all electric motors included in the scope of the test procedure.	Harmonizes the AEDM requirements with other covered equipment and covered products at 10 CFR 429.70.
Includes provisions pertaining to nationally recognized accreditation bodies and certification programs at 10 CFR 431.19, 431.20, and 431.21.	Revises the procedures for recognition and withdrawal of recognition of accreditation bodies and certification programs as applied to electric motors. Applies these provisions to all electric motors included in the scope of the test procedure.	Transfer provisions related to certification at 10 CFR part 429.

TABLE II–1—SUMMARY OF CHANGES IN THE AMENDED TEST PROCEDURE—Continued

Current DOE test procedure	Amended test procedure	Attribution
Includes a definition of basic model that relies on the term "rating".	Amends the definition of "basic model" to rely on the term "equipment class." Adds a definition for "equipment class".	Align the definition of basic model with other DOE-regulated products and equipment and eliminate the ambiguity of the term "rating."
Does not include any certification, sampling plans, or AEDM provisions for DPPP Motors.	Adds certification, sampling plans, and AEDM provisions for DPPP Motors.	Aligns DPPP motor provisions with the provisions for electric motors subject to the requirements in subpart B of 10 CFR part 431.

DOE has determined that the amendments described in section III of this final rule would not alter the measured efficiency of those electric motors that are currently within the scope of the test procedure and that are currently required to comply with energy conservation standards.

The effective date for the amended test procedures adopted in this final rule is 30 days after publication of this document in the **Federal Register**. Representations of energy use or energy efficiency must be based on testing in accordance with the amended test procedures beginning 180 days after the publication of this final rule. DOE notes that manufacturers of electric motors that have been added to the scope of the test procedure per this final rule are not required to use the test procedure for Federal certification or labeling purposes until such time as energy conservation standards are established for such electric motors. But, if manufacturers, distributors, retailers, and private labelers choose to make any representations respecting the energy consumption or cost of energy consumed by such motors, then such voluntary representations must be made in accordance with the test procedure and sampling requirements, and such representation must also fairly disclose the results of such testing. In addition, manufacturers of electric motors subject to energy conservation standards at 10 CFR part 431, subpart B, will be required to follow the newly adopted certification provisions at 10 CFR 429.64(d) through (f) beginning on the compliance date of the final rule adopting new or amended energy conservation standards for electric motors.

Similarly, DOE notes that manufacturers of dedicated-purpose pool pump motors falling within the scope of the test procedure at 10 CFR 431.484 are not required to use the test procedure for Federal certification or labeling purposes until such time as energy conservation standards are established for those motors. But, if manufacturers, distributors, retailers, and private labelers choose to make any representations respecting the energy consumption or cost of energy consumed by such motors, then such voluntary representations must be made in accordance with the test procedure and sampling requirements, and such representation must also fairly disclose the results of such testing. In addition, manufacturers of dedicated-purpose pool pump motors subject to any energy conservation standards at 10 CFR part 431, subpart Z, will be required to follow the newly adopted certification provisions at 10 CFR 429.65 starting on the compliance date of the final rule adopting new energy conservation standards for these motors.

III. Discussion

A. Scope of Applicability

The term "electric motor" is defined as "a machine that converts electrical power into rotational mechanical power." 10 CFR 431.12. Manufacturers are required to test those electric motors subject to energy conservation standards according to the test procedure in appendix B.[4] (*See generally* 42 U.S.C. 6314(a)(5)(A); see also the introductory paragraph to 10 CFR part 431, subpart B, appendix B) Currently, energy conservation standards apply to certain categories of electric motors provided that they meet the criteria specified at 10 CFR 431.25(g). These categories of electric motors are NEMA Design A motors,[5] NEMA Design B motors,[6] NEMA Design C motors,[7] IEC Design N motors,[8] IEC Design H motors,[9] and fire

[4] The amendments do not address *small electric motors,* which are covered separately under 10 CFR part 431, subpart X. A *small electric motor* is "a NEMA general purpose alternating current single-speed induction motor, built in a two-digit frame number series in accordance with NEMA Standards Publication MG1–1987, including IEC metric equivalent motors." 10 CFR 431.442.

[5] "NEMA Design A" motor means a squirrel-cage motor that: (1) Is designed to withstand full-voltage starting and developing locked-rotor torque as shown in NEMA MG 1–2009, Paragraph 12.38.1 (incorporated by reference, see § 431.15); (2) Has pull-up torque not less than the values shown in NEMA MG 1–2009, Paragraph 12.40.1; (3) Has breakdown torque not less than the values shown in NEMA MG 1–2009, Paragraph 12.39.1; (4) Has a locked-rotor current higher than the values shown in NEMA MG 1–2009, Paragraph 12.35.1 for 60 hertz and NEMA MG 1–2009, 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. 10 CFR 430.12.

[6] "NEMA Design B motor" means a squirrel-cage motor that is: (1) Designed to withstand full-voltage starting; (2) Develops locked-rotor, breakdown, and pull-up torques adequate for general application as specified in Paragraphs 12.38, 12.39 and 12.40 of NEMA MG1–2009 (incorporated by reference, see § 431.15); (3) Draws locked-rotor current not to exceed the values shown in Paragraph 12.35.1 for 60 hertz and 12.35.2 for 50 hertz of NEMA MG1–2009; and (4) Has a slip at rated load of less than 5 percent for motors with fewer than 10 poles. *Id.*

[7] "NEMA Design C" motor means a squirrel-cage motor that: (1) Is Designed to withstand full-voltage starting and developing locked-rotor torque for high-torque applications up to the values shown in NEMA MG1–2009, Paragraph 12.38.2 (incorporated by reference, see § 431.15); (2) Has pull-up torque not less than the values shown in NEMA MG1–2009, Paragraph 12.40.2; (3) Has breakdown torque not less than the values shown in NEMA MG1–2009, Paragraph 12.39.2; (4) Has a locked-rotor current not to exceed the values shown in NEMA MG1–2009, Paragraphs 12.35.1 for 60 hertz and 12.35.2 for 50 hertz; and (5) Has a slip at rated load of less than 5 percent. *Id.*

[8] IEC Design N motor means an electric motor that: (1) Is an induction motor designed for use with three-phase power; (2) Contains a cage rotor; (3) Is capable of direct-on-line starting; (4) Has 2, 4, 6, or 8 poles; (5) Is rated from 0.4 kW to 1600 kW at a frequency of 60 Hz; and (6) Conforms to Sections 6.1, 6.2, and 6.3 of the IEC 60034–12 edition 2.1 (incorporated by reference, see § 431.15) requirements for torque characteristics, locked rotor apparent power, and starting. *Id.*

[9] IEC Design H motor means an electric motor that (1) Is an induction motor designed for use with three-phase power; (2) Contains a cage rotor; (3) Is capable of direct-on-line starting (4) Has 4, 6, or 8 poles; (5) Is rated from 0.4 kW to 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. *Id.*

pump electric motors.[10] See 10 CFR 431.25(h)–(j). The current energy conservation standards apply to electric motors within the identified categories only if they:

(1) Are single-speed, induction motors;

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

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

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

(5) Are rated 600 volts or less;

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

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

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

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

10 CFR 431.25(g).

In the test procedure final rule published on December 13, 2013 (''December 2013 Final Rule''), DOE identified certain categories of motors that meet the definition of ''electric motor'' but for which DOE determined the referenced industry test procedures do not provide a standardized test method for determining the energy efficiency. 78 FR 75962, 75975, 75987–75989. Motors that fall into this grouping are not currently regulated by DOE and consist of the following categories:

- Air-over electric motors;
- Component sets of an electric motor;
- Liquid-cooled electric motors;
- Submersible electric motors; and
- Inverter-only electric motors.

10 CFR 431.25(l).

In this final rule, DOE is clarifying that certain equipment that are designated with IEC Design letters NE, HE, NY, NEY, HY, and HEY are within the scope of the current electric motors test procedure. Furthermore, DOE is establishing test procedure requirements for certain categories of electric motors not currently subject to energy conservation standards. These categories are (1) air-over electric motors; (2) certain electric motors greater than 500 hp; (3) electric motors considered small (*i.e.,* small not-small-electric-motor electric motors or ''SNEMs''); and (4) inverter-only electric motors. Finally, DOE is also including within the scope of the test procedure synchronous electric motors. DOE is covering these motors under its ''electric motors'' authority. (42 U.S.C. 6311(1)(A))

DOE notes that manufacturers of electric motors for which DOE is including within the scope of the test procedure, but that are not currently subject to an energy conservation standard, are not required to use the test procedure for Federal certification or labeling purposes until such time as amended or new energy conservation standards are established for such electric motors. However, any voluntary representations by manufacturers, distributors, retailers, or private labelers about the energy consumption or cost of energy for these motors must be based on the use of the test procedure beginning 180 days following publication of this final rule, and such representation must also fairly disclose the results of such testing. DOE's rule does not require manufacturers who do not currently make voluntary representations to then begin making public representations of efficiency. (42 U.S.C. 6314(d)(1)) Manufacturers not currently making representations of efficiency would be required to test such motors in accordance with the test procedure only when compliance is required with a labeling or energy conservation standard requirement if such a requirement should be established. (42 U.S.C. 6315(b); 42 U.S.C. 6316(a); 42 U.S.C. 6295(s))

In the December 2021 NOPR, DOE proposed an amended scope for the electric motors test procedure that is generally consistent with the amendments established in this final rule and also proposed to include submersible electric motors. 86 FR 71710, 71716. In general, NEEA/NWPCC supported DOE's proposed changes to expand the scope of the electric motors test procedure to include additional motor sizes and topologies. They stated that the current test procedure is limited to one category of motor, excluding many commonly used general purpose motors, and most advanced motor technologies. NEEA/NWPCC recommended the electric motors test procedure apply to as broad a range of motor technologies, designs, and categories as possible to enable consumers to make fair comparisons and informed decisions. NEEA/NWPCC commented that these motors are installed in the same applications as regulated motors, yet are not subject to the same test procedure and standard. (NEEA/NWPCC, No. 37 at p. 2) DOE also received a number of specific comments on each category of electric motor included in the scope of the test procedure, which are discussed in the following sections.

1. Motor Used as a Component of a Covered Product or Equipment

In the December 2021 NOPR, DOE proposed not to exclude motors used as a component of a covered product or covered equipment from the test procedure scope. This includes any proposed expanded scope electric motors. Specifically, DOE noted that the current electric motors test procedure applies to definite purpose and special purpose electric motors, and DOE is not aware of any technical issues with testing such motors using the current DOE test procedure. 86 FR 71710, 71728. In response, DOE received a number of comments, many of whom objected to DOE's approach.

AHAM and AHRI filed joint comments opposing DOE's proposed expansion of the test procedure's scope of coverage to include special-and definite-purpose electric motors, specifically air-over electric motors, inverter-only electric motors, synchronous motors, and SNEMs. They explained that Original Equipment Manufacturer (''OEM'') products have been built around special/definite purpose motors or that these motors are specially built to be installed inside OEM products. AHAM and AHRI stated that those finished products are already regulated by DOE and many manufacturers turn to more efficient designs that include components such as more efficient motors to meet more stringent energy conservation standards. (AHAM and AHRI, No. 36 at pp. 1–3) AHAM and AHRI added that special purpose and definite purpose motors are distinct and different from general purpose motors and noted that despite the reworking of the ''electric motor'' definition in the Energy Independence and Security Act of 2007, special purpose and definite purpose motors are still defined separately. *Id.*

AHAM and AHRI commented that efficient electric motors destined for finished products are already a major part of the energy equation when OEMs consider which design options to apply to meet new standards and added that DOE's proposed test procedure, which would rate motor efficiency at full-load, fails to adequately capture representative load conditions for finished products and equipment that

[10] ''Fire pump electric motor'' means an electric motor, including any IEC-equivalent motor, that meets the requirements of Section 9.5 of NFPA 20. *Id.*

are largely optimized for, and regulated on, part-load performance. AHAM and AHRI commented that regulating special and definite purpose motors, particularly with the proposed third-party nationally recognized certification program requirements, will add cost, reduce market choices, and do little, if anything, to realize further energy savings over time. AHRI and AHAM asserted that in the near-term, the proposed rules will counter intuitively create a recipe for setbacks in energy savings. They stated that the timing of these proposed changes will also exacerbate supply chain disruption, further delaying products reaching U.S. consumers and inflating the cost of finished goods. *Id.*

AHAM and AHRI provided information on the market size represented by their respective member companies, stating that it represents a significant segment of the economy. AHRI and AHAM commented that regulation of a single component product can have ramifications to other components throughout the product. AHAM and AHRI stated that durable products work as a system to achieve their purpose for the consumer and as such, requested DOE carefully consider the perspective of the end-purchasers and users of the categories of small electric motors (''SEMs'') that would be governed by the proposed regulation. (AHAM and AHRI, No. 36 at pp. 1–3)

Further, AHAM and AHRI commented that small electric motors that are components of covered equipment are, and should continue to be, appropriately afforded an exemption from energy conservation standards and test method, and SNEMs should be given similar treatment. AHAM and AHRI stated that DOE's proposal to not exclude motors that are components of regulated products was contrary to DOE's previously published public opinion (regarding SEMs) and the intent of Congress as expressed in the EPCA Amendments of 1992. (AHAM and AHRI, No. 36 at pp. 3–5) AHAM and AHRI further commented that in the April 2020 Small Electric Motors Proposed Determination (*see* 85 FR 24146, 24152 (April 30, 2020)), DOE acknowledged, ''the term 'small electric motor' has a specific meaning under EPCA,'' codified in 42 U.S.C. 6311(13)(G) and 10 CFR 431.442. AHAM and AHRI commented that DOE's preliminary findings, outlined in the 2011 RFI for Increased Scope of Coverage for Electric Motors (*see* 76 FR 17577, 17578 (March 30, 2011)), noted explicitly that many of the motors contemplated for coverage by DOE's proposed test procedure require separate analysis from general purpose motors. AHAM and AHRI commented that the notable exceptions from scope outlined in the final rule published May 29, 2014, Energy Conservation Standards for Commercial and Industrial Electric Motors Final Rule (79 FR 30934 (''May 2014 Final Rule''), are fractional horsepower motors. They agreed with DOE's previous determination related to small electric motors (81 FR 41378, 41394–41395) in which the agency recognized that Congress intentionally excluded these motors from coverage by DOE regulation when such motors are used as components of products and equipment that are already subject to DOE regulation. (AHAM and AHRI, No. 36 at pp. 3–5)

AHAM and AHRI commented that regulating SNEMs directly conflicts with Congress's vision that components of EPCA-covered products and equipment remain unregulated. AHAM and AHRI commented that given DOE's claimed similarities between small electric motors and the SNEMs category, DOE nevertheless proposes to deny to SNEMs a key exemption that Congress expressly provided for small electric motors. AHAM and AHRI stated that when Congress amended EPCA through the Energy Policy Act of 1992 and defined ''small electric motors,'' it expressly required that energy conservation standards ''shall not apply to any small electric motor which is a component of a covered product under section 6292(a) of this title or covered equipment under section 6311 of this title.'' 42 U.S.C. 6317(b)(3) (emphasis added). AHAM and AHRI commented that DOE provides no rationale or explanation for the disparate treatment of small electric motors and SNEMs when it comes to their use as components. (AHAM and AHRI, No. 36 at pp. 3–5)

Similarly, Lennox stated that the exemption for SEMs that are components of larger regulated equipment (42 U.S.C. 6317(b)(3)) should also apply to SNEMs, particularly with respect to the heating, ventilation, air-conditioning, and refrigeration (''HVACR'') context. (Lennox, No. 24 at pp. 5–6)

AI Group stated that SNEMs often go into regulated equipment and that double regulation should be avoided. (AI Group, No. 25 at p. 3) NEMA argued that the creation of the SNEM category violated the intent of 42 U.S.C. 6317(b)(3)'s prohibition against applying the SEM standards to an SEM that is used as a component in another regulated product. (NEMA, No. 26 at p. 5) NEMA also stated that much of the SNEM expanded scope includes definite and special-purpose motors that have been designed for specific applications. (NEMA, No. 26 at p. 5) Trane commented that SNEMs are designed for end-product performance requirements and that applying efficiency standards to the motor specifically would add burden without providing energy savings, and on that basis opposed including them in the scope of the test procedure. (Trane, No. 31 at p. 3)

In addition, JCI generally opposed the proposed scope expansion to mandate new test procedures to include special and definite purpose motors—which specifically includes air-over, inverter, synchronous as well as SNEMs—because these motors are already being regulated at the system level and are, in its view, clearly exempted under 42 U.S.C. 6317(b)(3). (JCI, No. 34 at p. 1) JCI commented that component level regulations will not result in significant savings or performance benefits to consumers, and that consumers do not inquire about component level efficiency and only are concerned with system-level efficiency. In its view, this double regulation stifles design and limits improvements because of the higher constraints without benefit. It stated that the motor is typically not the least efficient component with air conditioners, heat pumps, or furnaces and double regulation only serves to add unnecessary cost. (JCI, No. 34 at p. 1)

In contrast, the Joint Advocates and the CA IOUs supported including motors falling within the scope of the test procedure that are installed into other DOE covered products. (Joint Advocates, No. 27 at p. 5; CA IOUs, No. 32.1 at p. 45) The CA IOUs cautioned, however, that DOE consider the manufacturer burdens associated with regulation, and to not push manufacturers towards offering less diverse product lines. (CA IOUs, No. 32.1 at pp. 45–46)

In their joint comments, NEEA/NWPCC recommended that DOE include all electric motors that directly compete against each other in this test procedure so that they can be fairly compared against other motor designs. NEEA/NWPCC noted that some of these motor categories and designs are known for having low efficiencies but are commonly chosen by consumers and OEMs because they are cheaper than other motors. They added that because of the incomplete coverage of the current test procedure and standard, unregulated inefficient motor categories have a competitive advantage compared to more efficient motors and—in spite of their cheaper initial costs—result in increased operating costs for consumers. (NEEA/NWPCC, No. 37 at p. 3)

DOE is not addressing any potential standards in this rulemaking; standards for electric motors are addressed in a separate rulemaking procedure (see docket number EERE–2020–BT–STD–0007). Rather, this rulemaking addresses only the scope of the test procedure.

As discussed in the final rule published on May 4, 2012 (the ''May 2012 Final Rule''), EPCA, as amended through EISA 2007, provides DOE with the authority to regulate the expanded scope of motors addressed in this rule. 77 FR 26608, 26612–26613. Before the enactment of EISA 2007, EPCA defined the term ''electric motor'' as any motor that is a general purpose T-frame, single-speed, foot-mounting, polyphase squirrel-cage induction motor of the NEMA, 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. (*See* 42 U.S.C. 6311(13)(A) (2006)) Section 313(a)(2) of EISA 2007 removed that definition and the prior limits that narrowly defined what types of motors would be considered as electric motors. In its place, EISA 2007 inserted a new ''Electric motors'' heading, and created two new subtypes of electric motors: General purpose electric motor (subtype I) and general purpose electric motor (subtype II). (42 U.S.C. 6311(13)(A)–(B) (2011)) In addition, section 313(b)(2) of EISA 2007 established energy conservation standards for four types of electric motors: general purpose electric motors (subtype I) (*i.e.,* subtype I motors) with a power rating of 1 to 200 horsepower; fire pump motors; general purpose electric motor (subtype II) (*i.e.,* subtype II motors) with a power rating of 1 to 200 horsepower; and NEMA Design B, general purpose electric motors with a power rating of more than 200 horsepower, but less than or equal to 500 horsepower. (42 U.S.C. 6313(b)(2)) The term ''electric motor'' was left undefined.

As described in the May 2012 Final Rule, a regulatory definition for ''electric motor'' was necessary, and therefore DOE adopted the broader definition of ''electric motor'' currently found in 10 CFR 431.12. Specifically, DOE noted that the absence of a definition may cause confusion about which electric motors are required to comply with mandatory test procedures and energy conservation standards. 77 FR 26608, 26613. Further, in the May 2012 Final Rule, DOE noted that this broader approach would allow DOE to fill the definitional gap created by the EISA 2007 amendments while providing DOE with the flexibility to set energy conservation standards for other types of electric motors without having to continuously update the definition of ''electric motors'' each time DOE sets energy conservation standards for a new subset of electric motors. *Id.*

Congress specifically defined what equipment comprises an SEM—specifically, ''a NEMA general purpose alternating current single-speed induction motor, built in a two-digit frame number series in accordance with NEMA Standards Publication MG1–1987.'' (42 U.S.C. 6311(13)(G)) (DOE clarified, at industry's urging, that the definition also includes motors that are IEC metric equivalents to the specified NEMA motors prescribed by the statute. See 74 FR 32059, 32061–32062; 10 CFR 431.442)) In conjunction with this definition, Congress also exempted any SEM that is a component of a covered product or a covered equipment from the standards that DOE was required to establish under 42 U.S.C. 6317(b). Congress did not, however, similarly restrict electric motors.

SNEMs, which are electric motors, are not SEMs because they do not satisfy the more specific statutory SEM definition—or even the arguably broader clarifying definition that DOE adopted to accommodate electric motors that were IEC metric equivalents of the NEMA motors falling under the SEM definition of that term and therefore not subject to the exclusion explicitly established for SEMs. Accordingly, DOE is declining to adopt the suggestions offered by commenters to exclude SNEMs installed as components in other DOE regulated products and equipment from the test procedure being promulgated in this final rule.

DOE is not establishing energy conservation standards for SNEMs in this final rule. Were DOE to consider energy conservation standards for SNEMs, DOE would evaluate the efficiency of SNEMs on the market for their various applications, as well as opportunities for improved efficiency while still being able to serve those applications.

DOE is also including in the scope of the test procedure special purpose and definite purpose motors.

DOE notes that manufacturers of electric motors for which DOE is including within the scope of the test procedure, but that are not currently subject to an energy conservation standard, would not be required to use the test procedure for Federal certification or labeling purposes until such time as amended or new energy conservation standards are established for such electric motors.

Further discussion on each of the expanded scope categories are provided in the following sections. Discussion on maintaining the full-load metric in this test procedure is provided in section III.E. of this document.

2. ''E'' and ''Y'' Designations of IEC Design N and H Motors

Currently regulated electric motors include those motors designated as IEC Design N and IEC Design H motors. In the December 2021 NOPR, DOE discussed that IEC 60034–12:2016 includes industry nomenclature updates to IEC Design N and IEC Design H motors, whose designations are augmented with the designations IEC Design NE, HE, NY, NEY, HY, and HEY. 86 FR 71710, 71716–71717. DOE stated that all six additional categories are described as electric motors that are variants of IEC Design N and IEC Design H electric motors that DOE currently regulates, with the only differences being the premium efficiency attribute (indicated by the letter ''E''), and starting configuration [11] (''star-delta'' starter [12] indicated by the letter ''Y''). *Id.* Accordingly, DOE proposed to revise 10 CFR 431.25 to reflect the inclusion of IEC Design NE, NEY, and NY motors as IEC Design N motors and to make a similar set of revisions to reflect the inclusion of IEC Design HE, HEY, and HY motors as IEC Design H motors. DOE clarified that to the extent IEC Design N and IEC Design H motors are subject to the DOE regulations for electric motors, such coverage already includes IEC Design NE, NY, NEY, HE, HY and HEY motors. *Id.*

In response, CEMEP, NEMA and Grundfos supported DOE's proposed clarification regarding the additional IEC designations. (CEMEP, No. 19 at p. 1; NEMA, No. 26 at p. 6; Grundfos, No. 29 at p. 1) For the reasons discussed in the previous paragraph, DOE is adopting its proposal to reflect the inclusion of IEC Design NE, NEY, and NY motors as IEC Design N motors and to make a similar set of revisions to reflect the

[11] For induction motors, the starting configuration refers to the manner in which the three-phase input terminals are connected to each other, and the star configuration results in a lower line-to-line voltage than the delta configuration. *See* Sections 2.62 and 2.64 of NEMA MG 1–2016 (with 2018 Supplements) and 2021 updates for further detail.

[12] A ''star-delta starter'' refers to a reduced voltage starter system arranged by connecting the supply with the primary motor winding initially in star (''wye'' or ''Y'') configuration, then reconnected in a delta configuration for running operation. In the star configuration, all three supply lines are connected at a single point and the circuit diagram resembles the letter Y. In the delta configuration each supply line is connected at one end with the next supply line and the circuit diagram resembles the Greek letter delta (Δ).

inclusion of IEC Design HE, HEY, and HY motors as IEC Design H motors. In this final rule, DOE is revising 10 CFR 431.25(g)–(i) to reflect the inclusion of IEC Design N and H variants as it relates to current energy conservation standards.

DOE received comments regarding the definitions proposed for the IEC Design designations, which are addressed separately in section III.B.1. of this document.

3. Air-Over Electric Motors

DOE defines an ''air-over electric motor'' as an electric motor rated to operate in and be cooled by the airstream of a fan or blower that is not supplied with the motor and whose primary purpose is providing airflow to an application other than the motor driving it. 10 CFR 431.12. These motors are currently exempt from the energy conservation standards. 10 CFR 431.25(l)(4). In the December 2021 NOPR, DOE reviewed NEMA MG 1–2016, Part 34: Air-Over Motor Efficiency Test Method, as well as Section 8.2.1 of IEEE 114–2010 and Section 5 of CSA C747–09, and initially determined that sufficient information was available to propose a test method for air-over electric motors, and therefore proposed to include air-over electric motors in the scope of the test procedure. 86 FR 71710, 71718. Further, DOE also proposed an amended definition for air-over electric motors (86 FR 71710, 71730–71731), which is discussed further in section III.B.4 of this rulemaking. Accordingly, DOE requested comment on its proposal to add air-over electric motors in scope. *Id.*

In response to the expanded scope proposal, a number of stakeholders supported the inclusion of air-over electric motors. (AMCA, No. 21 at p. 2; ebm-papst, No. 23 at pp. 2, 6; CA IOUs, No. 32.1 at p. 10) NEMA agreed with the proposal in concept, but disagreed with several testing provisions, which are discussed further in section III.D.1 of this document. (NEMA, No. 26 at p. 6) Lennox opposed the inclusion of air-over motors, citing that component-level regulation should be avoided when system-level regulation is possible. Lennox stated that the cost of component-level regulation outweighs the benefit when DOE could more effectively use system-level regulation (HVAC in this case). (Lennox, No. 24 at p. 1–2) Regal opposed including air-over motors to the scope of test procedure, explaining that it already tests the motors according to DOE requirements for the equipment into which these motors would be installed, and that regulating these motors separately would increase costs while yielding no benefit. (Regal, No. 28 at p. 1) AI Group referenced a 2019 Australian testing standard for three-phase cage induction motors that includes testing requirements for totally enclosed air-over motors. (AI Group, No. 25 at p. 3)

DOE is covering air-over electric motors under its ''electric motors'' authority. (42 U.S.C. 6311(1)(A)) As discussed in section III.A of this document, the statute does not limit DOE's authority to regulate an electric motor with respect to whether they are stand-alone equipment items or as components of a covered product or covered equipment. See 42 U.S.C. 6313(b)(1) (providing that standards for electric motors be applied to electric motors manufactured ''alone or as a component of another piece of equipment'') DOE's previous determination in the December 2013 Final Rule to exclude air-over electric motors from scope was due to insufficient information available to DOE at the time to support establishment of a test method. 78 FR 75962, 75974–75975. Since that time, NEMA published a test standard for air-over motors in Section IV, ''Performance Standards Applying to All Machines,'' Part 34 ''Air-Over Motor Efficiency Test Method'' of NEMA MG 1–2016 (''NEMA Air-over Motor Efficiency Test Method''). The air-over method was originally published as part of the 2017 NEMA MG–1 Supplements and is also included in the latest version of NEMA MG 1–2016. Therefore, DOE does not consider including air-over electric motors within its test procedure scope significantly burdensome because the NEMA test method (which is an industry-accepted method) has existed since 2017. Further, based on a general market review, DOE notes that several manufacturers have already been representing the performance of their air-over electric motors in marketing materials. Based on the additional information and the development of an industry standard appropriate for air-over electric motors, DOE is including air-over electric motors within scope of the test procedure. DOE believes that including such a test procedure within its regulations will provide consistent and comparable efficiency ratings for consumers and provide manufacturers with a level playing field.

DOE notes that air-over electric motors are not currently subject to energy conservation standards in 10 CFR 431.25(l)(1). Manufacturers would not be required to use the test procedure for certification, until such time as a standard is established. If a manufacturer voluntarily chooses to make representations about the energy consumption or cost of energy for these motors such representations must be based on the use of that test procedure beginning 180 days following publication of a final rule. DOE's amendments do not require manufacturers who do not currently make voluntary representations to then begin making public representations of efficiency. (42 U.S.C. 6314(d)(1)) Manufacturers would be required to test such motors in accordance with the DOE test procedure at such time as compliance is required with a labeling or energy conservation standard requirement should such a requirement be established. (42 U.S.C. 6315(b); 42 U.S.C. 6316(a); 42 U.S.C. 6295(s))

In addition, DOE notes that the industry test procedure incorporated by reference (see section III.D.1) are only applicable to air-over motors that are induction motors and capable of operating without an inverter. As such, they are not applicable to air-over electric motors that are synchronous electric motors and to air-over electric motors that are inverter-only. Accordingly, DOE clarifies that it did not propose and is not adopting to include air-over electric motors that are synchronous electric motors and air-over electric motors that are inverter-only in the scope of the test procedure. DOE adopts to add a clarification in the scope section of the test procedure in appendix B to subpart B to specify which air-over electric motors are included in the test procedure.

DOE also received a number of comments on the air-over electric motor definition and test method, which are discussed in section III.B.4 and section III.D.1 of this document, respectively.

4. AC Induction Electric Motors Greater Than 500 Horsepower

DOE currently specifies that its test procedures and energy conservation standards for electric motors do not apply to motors that produce greater than 500 horsepower (373 kW). 10 CFR 431.25(g)(8); appendix B, Note.

In the December 2021 NOPR, DOE proposed to expand the scope of the test procedure to include induction electric motors with a horsepower rating greater than 500 hp and up to 750 hp, that otherwise meet the criteria provided in 10 CFR 431.25(g) and are not currently listed at 10 CFR 431.25(l)(2)–(4). 86 FR 71710, 71719.

In response, CEMEP supported expanding the test procedure's scope to include motors between 500 and 750 hp that otherwise meet the conditions of 10 CFR 431.25(g). (CEMEP, No. 19 at p. 2) NEMA supported adding motors between 500 and 750 hp to the energy conservation standards but noted there are currently no NEMA Design A, B, or C performance requirements for this horsepower range, and that these requirements would need to be developed. (NEMA, No. 26 at p. 7) The CA IOUs supported DOE's inclusion of 500+ hp motors to the test procedure. (CA IOUs, No. 32.1 at p. 46) The Joint Advocates supported expanding the scope beyond 500 hp and suggested the upper limit should be 1000 hp and identified models that they asserted would be included in scope even with a limit of 600V input voltage. (Joint Advocates, No. 27 at p. 3) Grundfos questioned how many motors were sold in this range and what energy savings could be captured by including 500 to 750 hp motors into the scope of the test procedure. (Grundfos, No. 29 at p. 2) Advanced Energy stated that motors of this size are outside of its lab test capabilities, but as a nationally recognized certification program for electric and small electric motor efficiency, its certification scheme allows it to certify motors of this size by witnessing testing in manufacturer's accredited labs. Accordingly, they commented that they offer certification services for covered motor products above 250 hp. (Advanced Energy, No. 33 at p. 3)

As discussed in the December 2021 NOPR, DOE's review of catalog offerings identified large induction motors rated up to 750 hp currently being sold in the market, and the majority of the models identified listed full-load efficiencies even though DOE currently does not regulate electric motors greater than 500 hp. 86 FR 71710, 71719. Based on discussions with a subject matter expert, DOE understands that most of these large motors rely on the alternative efficiency determination method (''AEDM'') permitted under 10 CFR 431.17 to determine full-load efficiencies for regulated electric motors at and under 500 hp.[13] *Id.* Accordingly, DOE understands that there are motors sold in the range between 500 and 750 hp. DOE was unable to identify any motors for sale greater than 750 hp with input voltages up to 600 volts. Accordingly, DOE will not be expanding the horsepower limit of the test procedure beyond 750 hp. While there may be motors available at input voltages greater than 600 volts, in this final rule, DOE is maintaining the approach from the December 2021 NOPR proposal to limit the voltage to 600 volts, consistent with other in-scope electric motors defined by 10 CFR 431.25(g).

DOE notes that the proposed expanded scope would have required that an electric motor meet all of the performance requirements of one of the following motor types: A NEMA Design A, B, or C motor or an IEC Design N or H motor. 10 CFR 431.25(g)(9) While DOE agrees with NEMA's comment that there are no NEMA Design A, B, or C performance requirements for motors greater than 500 hp, there are performance requirements for IEC Design N or H motors for the same range. As such, the IEC Design N or H performance requirements would be applicable for this horsepower range instead of the NEMA Design A, B, or C performance requirements.

Accordingly, consistent with the proposed scope expansion and related discussion from the December 2021 NOPR and the reasons set forth in the preceding paragraphs, DOE is expanding the scope of the test procedure to include induction electric motors with a horsepower rating greater than 500 hp and up to 750 hp that otherwise meet the criteria provided in 10 CFR 431.25(g) and are not currently listed at 10 CFR 431.25(l)(2)–(4).

5. SNEMs

An SEM is a NEMA general purpose AC single-speed induction motor, built in a two-digit frame number series in accordance with NEMA Standards Publication MG1–1987, including IEC metric equivalent motors. *See* 42 U.S.C. 6311(G); see also 10 CFR 431.442 (clarifying that the statutory definition for ''small electric motor'' includes IEC metric equivalent motors). Table III–1 and Table III–2 provide a general description of currently regulated small electric motors and electric motors.

TABLE III–1—GENERAL DESCRIPTION OF SINGLE-PHASE INDUCTION MOTORS CURRENTLY SUBJECT TO ENERGY CONSERVATION STANDARDS AND TEST PROCEDURES

Motor enclosure construction	NEMA frame size	
	2-Digit NEMA frame size	3-Digit NEMA frame size or above
Open	NEMA general purpose capacitor-start induction run, capacitor-start capacitor run motors between 0.25 and 3 hp.	None.
Enclosed	None	None.

Note: this table provides a high-level description. Full description of motors currently subject to energy conservation standards and test procedures available at 10 CFR part 431 subpart B and subpart X.

TABLE III—2 GENERAL DESCRIPTION OF POLYPHASE PHASE INDUCTION MOTORS CURRENTLY SUBJECT TO ENERGY CONSERVATION STANDARDS AND TEST PROCEDURES

Motor enclosure construction	NEMA frame size	
	2-Digit NEMA frame size	3-Digit NEMA frame size or above
Open	NEMA general purpose motor between 0.25 and 3 hp	Between 1–500 hp.
Enclosed	NEMA 56-frame size only between 1–500 hp	Between 1–500 hp.

Note: this table provides a high-level description. Full description of motors currently subject to energy conservation standards and test procedures in available at 10 CFR part 431 subpart B and subpart X.

[13] An AEDM may be used to determine the average full-load efficiency of one or more of a manufacturer's basic models if the average full-load efficiency of at least five of its other basic models is determined through testing. 10 CFR 431.17(a)(1). An AEDM applied to a basic model must be: (i) derived from a mathematical model that represents the mechanical and electrical characteristics of that basic model, and (ii) based on engineering or statistical analysis, computer simulation or modeling, or other analytic evaluation of performance data. 10 CFR 431.17(a)(2).

This section addresses electric motors that do not fall within the SEM definition as described above but that are generally considered ''small'' by industry (*i.e.,* ''small, non-small-electric-motor electric motor,'' or ''SNEM''). In this section, DOE specifically discusses SNEMs that are induction motors. Some of these motors are marketed as general purpose by manufacturers, although they do not meet the definition of small electric motor at 10 CFR 431.442.[14] Non-induction motor topologies (specifically certain synchronous electric motors) are discussed in section III.A.7 of this document.

In the December 2021 NOPR, DOE proposed to include test procedures for additional electric motors not covered under the current electric motors test procedure and that do not meet the definition of small electric motors in 10 CFR part 431, subpart X, but are nonetheless considered ''small,'' *i.e.,* SNEMs. 86 FR 71710, 71719–71725. DOE proposed to distinguish SNEMs from SEMs by specifying combinations of frame size, rated motor horsepower, enclosure construction, and additional performance criteria that are not currently included in the existing electric motors and small electric motors regulations at 10 CFR part 431 subpart B and subpart X (*See* Table III–1 and Table III–2 for electric motors and small electric motors that are currently regulated). *Id.*

Accordingly, DOE proposed the following definition for this expanded scope in the December 2021 NOPR:

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

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

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

(c) Is capable of operating on polyphase or single-phase alternating current 60-hertz (Hz) sinusoidal line power (with or without an inverter);

(d) Is rated for 600 volts or less;

(e) Is a single-speed induction motor;

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

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

86 FR 71710, 71780.

DOE received a number of comments on how the criteria for SNEMs was defined. Some commenters supported including SNEMs in the scope of the test procedure as proposed. Commenters noted that these motors are very similar in application, construction, and performance to existing covered equipment, and therefore should be covered. (Advanced Energy, No. 33 at p. 3; NEEA/NWPCC, No. 37 at p. 3) Further, NEEA/NWPCC encouraged DOE to include all motors that directly compete against each other in the test procedure so that they can be fairly compared against other motor designs. (NEEA/NWPCC, No. 37 at p. 3) Other commenters, however, criticized DOE's approach. ABB stated that the criteria for establishing if a product is in the proposed scope as an SNEM are not adequately defined, and recommended that DOE list the criteria that an SNEM must satisfy, citing the nine criteria DOE has already listed for electric motors in 10 CFR 431.25. (ABB, No. 18 at p. 1) NEMA added that the proposed SNEM definition needs to be clearer since it does not allow manufacturers to clearly identify what motors in their inventory would fall within the SNEM category. NEMA requested that DOE provide specific examples of SNEMs and better identify whether an electric motors is an SNEM. (NEMA, No. 26 at p. 7) HI offered a similar view, noting that the proposed SNEM scope is too broad and that the proposed definition's overly-broad nature prevented HI from identifying areas of concern. (HI, No. 30 at p. 2)

DOE proposed to distinguish SNEMs by specifying combinations of frame sizes, rated motor horsepower, enclosure construction, and additional performance criteria that are not currently included in the existing electric motors and small electric motors regulations at 10 CFR part 431 subpart B and subpart X (*See* Table III–1 and Table III–2, and proposed definition for SNEM earlier in this section). DOE proposed seven specific criteria to identify whether an electric motor is a SNEM, an approach similar to how DOE identifies those electric motors that are subject to the standards at 10 CFR 431.25. If an electric motor meets the seven proposed criteria, then it is an SNEM. ABB recommended listing criteria to identify the appropriate scope (ABB, No. 18 at p. 1), which DOE notes is consistent with the approach DOE proposed in the December 2021 NOPR and is consistent with how specifications are provided for motors currently in scope in 10 CFR 431.25(g). Further, other commenters did not identify any specific areas of confusion. In the December 2021 NOPR, DOE provided a detailed description on how the SNEM scope was determined based on the current SEM and electric motor scope. 86 FR 71710, 71719–71725. In all, it is DOE's understanding that the proposed specifications are sufficient to specify the SNEM scope. DOE is, however, clarifying some of the proposed criteria related to frame size, speed, and power supply in response to other comments.

For example, the Joint Advocates suggested that multi-speed SNEMs should be included in the scope as well, and that including only single-speed SNEMs is inconsistent with the proposed broader test procedure scope that includes variable-speed motors. They raised the concern of a loophole with inefficient multi-speed SNEMs replacing more efficient single-speed SNEMs. (Joint Advocates, No. 27 at pp. 3–4) The CA IOUs recommended including multi-speed SNEMs to the test procedure's scope, citing as support the scenario where a consumer seeks to replace a failed variable-speed electrically commutated motor (''ECM'') in a residential furnace fan with a lower first cost, less efficient, multi-speed permanent split capacitor (''PSC'') motor. They also stated that multi-speed PSC and shaded-pole motors are in widespread use. (CA IOUs, No. 32.1 at p. 42)

After careful consideration of these comments, DOE has decided at this time to retain its single-speed limitation for SNEMs. As explained, DOE is taking this step to ensure coverage of those motors that are generally considered small by industry that have similarities to motors that DOE currently regulates as SEMs at 10 CFR part 431 subpart X—the scope of which only includes single-speed induction motors. *See* 10 CFR 431.442.

Commenters also had some concerns with the inclusion of the clause ''with or without an inverter'' within the SNEM definition. Specifically, Grundfos stated that the proposed SNEM definition is confusing and that DOE should clarify the intent with the ''single speed'' and ''with or without an inverter'' requirements to remove any ambiguity on the intention. (Grundfos, No. 29 at p. 2) HI stated that for clarity, the clause ''with or without an inverter'' should be removed from the criteria. (HI, No. 30 at p. 2) DOE re-evaluated the proposed text relevant to inverters. DOE's intention with the proposal was

[14] Based on DOE review of catalogs from four major manufacturers, out of 3262 SNEMs in scope identified, 1300 were marketed either general (1128) or definite purpose (172).

to ensure that in-scope electric motors that satisfy the SNEM definition would be either: (1) single-speed and capable of operating without an inverter; or (2) inverter-only electric motors operating with an inverter and capable of varying speed.[15] Therefore, to clarify this intent, DOE is revising the language used to describe SNEMs to state this more directly. First, to add clarity, DOE is replacing the proposed criteria ''Is capable of operating on polyphase or single-phase alternating current 60-hertz (Hz) sinusoidal line power (with or without an inverter)'' with ''Operates on polyphase or single-phase alternating current 60-hertz (Hz) sinusoidal line power; or is used with an inverter that operates on polyphase or single-phase alternating current 60-hertz (Hz) sinusoidal line power.'' Second, to clarify its intent, DOE is replacing the proposed criterion ''Is a single-speed induction motor'' with a revised one that accounts for inverter-only electric motors as follows: ''Is a single-speed induction motor capable of operating without an inverter or is an inverter-only electric motor.''

Separately, HI had concerns regarding how the frame sizes should be identified within the SNEM definition. HI commented that DOE should explicitly list the NEMA and IEC equivalents frame sizes that are covered. (HI, No. 30 at p. 2) Further, HI noted that the proposed phase ''any frame size'' in the SNEM definition is not defined, and could imply a motor of any dimensions, or a motor of any defined NEMA or IEC frame size is covered. They suggested that this ambiguity needs to be remedied. *Id.* DOE clarifies in this final rule that the proposed ''any frame size'' is intended to designate ''any NEMA or IEC-equivalent'' frame size. As such, in this final rule, DOE is modifying the term ''any frame size'' to ''any two-, or three- digit NEMA frame size (or IEC-equivalent).'' DOE notes that there are no four-digit frames sizes that qualify as SNEMs.

Finally, DOE also received comments regarding the proposed term ''small non-small-electric-motor electric motor,'' or ''SNEM''. NEEA/NWPCC recommended that DOE reconsider the use of the term ''small non-small-electric-motor electric motor'' because it is a confusing term for these motors. NEEA/NWPCC suggested ''Other Small HP Motors (OSHM)'' or ''Other Small Electric Motors (OSEM)'' as two possible options. (NEEA/NWPCC, No. 37 at p. 3) Grundfos stated that the DOE should identify a more suitable, and less confusing name for this class of motors. (Grundfos, No. 29 at p. 2) DOE did not receive any other recommendations regarding an alternate to the proposed ''SNEM'' term. DOE notes that the term explicitly states that it is a ''non-small-electric-motor.'' This specifies that SEMs, as defined in 10 CFR 431.442, are not part of this scope. Accordingly, DOE is maintaining the term ''SNEM'' in this final rule.

Accordingly, DOE is finalizing the scope to cover SNEMs, which DOE is defining as:

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

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

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

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

(d) Is rated for 600 volts or less;

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

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

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

6. AC Induction Inverter-Only Electric Motors

The current electric motor test procedures apply to AC induction motors except for those AC induction motors that are ''inverter-only electric motors.''[16] These motors are an exempted category of electric motors listed at 10 CFR 431.25(l)(5).[17] As it noted in its May 2014 Final Rule, DOE exempted these electric motors from its standards at 10 CFR 431.25 in the absence of a reliable and repeatable method to test their efficiency. 79 FR 30934, 30945. In the December 2021 NOPR, DOE noted that in the interim since its 2014 rule was published, the industry has developed several methods to test inverter-only motors. As a result of this development, DOE proposed to include within the electric motor test procedure's scope those AC induction inverter-only electric motors that meet both the criteria listed at 10 CFR 431.25(g) and the proposed SNEM scope. 86 FR 71710, 71725–71726. Further, as discussed in section III.A.4 of this section, DOE also separately proposed to include within the test procedure's scope those induction electric motors with a horsepower rating greater than 500 hp and up to 750 hp that otherwise meet the criteria provided in 10 CFR 431.25(g) and are not currently listed as exempt at 10 CFR 431.25(l)(2)–(4). 86 FR 71710, 71719.

In response, several stakeholders objected to the inclusion of inverter-only electric motors and suggested that DOE continue to exempt them from coverage under the test procedure. (NEMA, No. 26 at p. 7; CEMEP, No. 19 at p. 2; Lennox, No. 24 at p. 6; AI Group, No. 25 at p. 4; Regal, No. 28 at p. 1; Trane, No. 31 at pp. 3, 5–6) Further, CEMEP suggested that DOE address inverter-only electric motors in a separate (presumably dedicated) rulemaking. (CEMEP, No. 19 at p. 2) ABB supported NEMA's request that inverter-only motors be excluded from the test procedure because inverter-only motors are different from currently covered electric motors that are operated from inverters (presumably inverter-capable) to operate continuous loads like pumps and fans. On the other hand, ABB noted that inverter-only motors are rated by the amount of torque they produce and are generally not used for continuous fixed loads; instead, they operate at widely varying loads or directions in applications such as sawmill carriage drives, machine tools and other high-performance machinery. ABB also commented that

[15] See discussion of the term ''inverter-only electric motor'' in section III.B.3 of this document.

[16] NEMA MG–1 2016, Paragraph 30.2.1.5 defines the term ''control'' for motors receiving AC power, as ''devices that are also called inverters and converters. These are ''electronic devices that convert an input AC or DC power into a controlled output AC voltage or current..''.'' Converters can also be found in motors that receive DC power and include electronic devices that convert an AC or DC power input into a controlled output DC voltage or current. *See* section III.B.3 of this final rule.

[17] DOE defines an ''inverter-only electric motor'' as an electric motor that is capable of rated operation solely with an inverter, and is not intended for operation when directly connected to polyphase, sinusoidal line power.'' 10 CFR 431.12 DOE notes that more generally, the requirement to operate with an inverter also means that that inverter-only motors are not intended for operation when directly connected to single-phase, sinusoidal line power or to DC power. *See* section III.B.3 of this final rule.

inverter-only motors may have a special voltage/frequency combination that allows them to operate at very high speeds with up to 400 Hz input, and these motors are normally cooled by separately powered fans and may have their laminations exposed with no external frame. Finally, regarding inverters, ABB stated that inverters may vary from micro designs to very large drives with widely varying topography, and some newer drive topographies may result in a more efficient drive but at the expense of producing additional harmonics, heating, and reduced efficiency from the motor. (ABB, No. 18 at pp. 2–3) AI Group stated that inverter-only motors are rarely general-purpose motors and have non-continuous duty applications with high cycling and high-performance demands. In its view, these special characteristics and the low volume of sales for inverter-only motors favor excluding them from the scope of the test procedure. (AI Group, No. 25 at p. 4)

Similarly, NEMA, along with a number of individual electric motor manufacturers, also supported excluding inverter-only motors from the test procedure's scope. It explained that the motor and drive combination required to operate is a ''motor-drive system''—not an electric motor—and should not fall within the scope of an electric motor test procedure. It further stated that inverter-only motors are not general purpose and have unique performance requirements that complicate expressions of efficiency. (NEMA, No. 26 at p. 7) Regal also opposed including inverter-only motors within the scope of DOE's test procedure. They stated that they already test the motors according to DOE requirements for the equipment into which these motors are installed, and that regulating these motors separately would increase costs for no benefit. (Regal, No. 28 at p. 1) Trane commented that inverter-only motors should not be included in the scope because, in its view, there are no energy savings gained and that testing related to these electric motors should occur as part of the overall system in which they are installed. (Trane, No. 31 at pp. 3, 5–6)

In contrast, several stakeholders supported the inclusion of inverter-only electric motors as part of the test procedure's scope. (Joint Advocates, No. 27 at p. 4; Grundfos, No. 29 at p. 2; CA IOUs, No. 32.1 at p. 19; Advanced Energy, No. 33 at pp. 3–4; NEEA/NWPCC, No. 37 at p. 3) The CA IOUs commented that the inclusion of inverter-only motors will provide end-users with a representative method to compare these motors with conventional induction motors combined with variable-frequency drives. (CA IOUs, No. 32.1 at p. 19) The CA IOUs also provided examples of case studies where inverter-only motors have successfully substituted conventional induction motors combined with VFDs. (CA IOUs, No. 32.2 at pp. 1–15) The Joint Advocates commented that inverter-only motors with variable-speed capabilities may serve as more energy efficient replacements for currently covered and newly included (*e.g.,* SNEM) AC induction motors, and that inclusion of these more energy efficient motor types may unlock significant potential energy savings. (Joint Advocates, No. 27 at p. 4) Advanced Energy stated that in the past, DOE excluded inverter-only motors because these motors can only be operated continuously when connected to an inverter, and there may be difficulty testing the combined motor and inverter. However, it noted that in practice, there are induction machines marked as ''inverter-only'' that can be relatively more easily tested than synchronous motors. (Advanced Energy, No. 33 at pp. 3–4)

As discussed in section III.A.1, EPCA previously defined the term ''electric motor'' as encompassing specific motors that are general purpose. (*See* 42 U.S.C. 6311(13)(A) (2006)) Section 313(a)(2) of EISA 2007 removed that definition and the prior limits that narrowly defined what types of motors would be considered as electric motors. Further, section 313(b)(2) of EISA 2007 established energy conservation standards for four types of electric motors (42 U.S.C. 6313(b)(2)) The term ''electric motor'' was left undefined. EPCA does not limit ''electric motors'' to ''general purpose.''

In the May 2012 Final Rule, DOE determined a regulatory definition for ''electric motor'' was necessary, and therefore DOE adopted the broader definition of ''electric motor'' currently found in 10 CFR 431.12. Specifically, DOE noted that the absence of a definition may cause confusion about which electric motors are required to comply with mandatory test procedures and energy conservation standards. 77 FR 26608, 26613. Further, DOE noted that this broader approach would allow DOE to fill the definitional gap created by the EISA 2007 amendments while providing DOE with the flexibility to set energy conservation standards for other types of electric motors without having to continuously update the definition of ''electric motors'' each time DOE sets energy conservation standards for a new subset of electric motors. *Id.*

In addition, the statute does not limit DOE's authority to regulate an electric motor with respect to whether ''electric motors'' are stand-alone equipment items or components of a covered product or covered equipment. See 42 U.S.C. 6313(b)(1) (providing that standards for electric motors be applied to electric motors manufactured ''alone or as a component of another piece of equipment'') As such, inverter-only electric motors not being general purpose or components of another covered product or equipment have no bearing on whether DOE may regulate these motors.

Further, an inverter-only electric motor requiring an inverter to operate also has no bearing on whether DOE may regulate these motors. An electric motor is defined as a machine that converts electrical power into rotational mechanical power. 10 CFR 431.12. Inverter-only electric motors require the inverter to operate in the field to convert electrical power into rotational mechanical power. Inverter-only motors cannot be run continuously when directly connected to a 60-hertz, AC polyphase sinusoidal power source. Therefore, a separate, special electronic controller, called an inverter, is used to alter the power signal to the motor. The inverter can be physically combined with the motor into a single unit, may be physically separate from the motor, or may not be included in the motor, but the motor is unable to operate without a drive. As such, this electric motor would remain inoperable if it does not include an inverter and would need to include both the inverter-only electric motor and the inverter-component to convert electrical power into rotational mechanical power. For this reason, the combination of these two components, in DOE's view, meets the definition of an electric motor and DOE has included this combination within the scope of its test procedure.

In the December 2013 Final Rule, DOE considered inverter-only electric motors as part of the scope and only excluded these motors from the test procedure due to the absence of a reliable and repeatable method to test them for efficiency. 78 FR 75962, 75989. In the December 2021 NOPR, DOE noted that in the interim since the December 2013 Final Rule, the industry has developed several methods to test inverter-only motors. 86 FR 71710, 71725–71726. These industry test methods are discussed further in section III.D.3.

Accordingly, DOE is including inverter-only electric motors within the scope of this test procedure. Establishing test procedures for these motors would allow for standardized representations of efficiency of motors.

As proposed in the December 2021 NOPR, DOE will only be including within scope the following inverter-only electric motors: (1) AC induction inverter-only electric motors that meet the criteria listed at 10 CFR 431.25(g); and (2) Inverter-only motors that meet the SNEM definition. In addition, as discussed in section III.A.3 of this document, DOE is not including air-over inverter-only electric motors. In response to stakeholder comments, DOE is clarifying some of the requirements. First, the criteria in 10 CFR 431.25(g) and the SNEM scope presented in section III.A.5 both require that the motor be rated for continuous duty. Therefore, non-continuous duty motors are not included. Second, per 10 CFR 431.25(g) and the SNEM definition, in-scope inverter-only electric motors would be those motors built using certain NEMA (or IEC equivalent) frame sizes. Third, DOE is requiring that the rated frequency be limited to 60 Hz (see section III.G.1). As such, the scope of the test procedure is limited to inverter-only electric motors with a rated frequency of 60 Hz, where the rated frequency corresponds to the frequency of the electricity supplied to the inverter (see section III.G.1). Finally, DOE is requiring that inverter-only electric motors be tested with an inverter (see section III.D.3); therefore, the efficiency determined would be a combined efficiency of the motor and inverter, not just the efficiency of the motor or the inverter measured individually and would account for any interactions between the motor and the inverter (*e.g.* increase in harmonics). As such, only inverter-only electric motors that meet the specific requirements in 10 CFR 431.25(g) and are SNEMs, including those discussed in this paragraph, would be included in scope of the test procedure.

In this final rule, DOE is incorporating the proposed inverter-only electric motors in scope. Further discussion on the test procedure is provided in section III.D.3 of this document, and discussion of the metric is provided in section III.E. of this document.

7. Synchronous Electric Motors

The current electric motor test procedures apply only to induction electric motors. 10 CFR 431.25(g)(1), appendix B, Note.

The ''induction motor'' criteria exclude synchronous electric motors from the scope. A ''synchronous electric motor'' is an electric motor in which the average speed of the normal operation of the motor is exactly proportional to the frequency of the power supply to which it is connected, regardless of load.[18] In contrast, in an induction electric motor, the average speed of the normal operation of the motor is not proportional to the frequency of the power supply to which the motor is connected.[19] For example, a 4-pole synchronous electric motor will rotate at 1800 rpm when connected to 60 Hz power even when the load varies while a 4-pole induction electric motor in the same setup will slow down as load increases.

Synchronous electric motors can operate as either direct-on-line (connected directly to the power supply) or inverter-fed (connected to an inverter). Some inverter-fed electric motors require being connected to an inverter to operate (*i.e.,* inverter-only electric motors) while others are capable of operating both direct-on-line or connected to an inverter (*i.e.,* inverter-capable electric motors).

In the December 2021 NOPR, DOE stated that it identified new industry standards that apply to synchronous electric motors, and on the basis of this finding, proposed to include within the test procedure's scope synchronous electric motors with the following characteristics:[20]

TABLE III–3—SYNCHRONOUS ELECTRIC MOTORS PROPOSED FOR INCLUSION IN SCOPE

Criteria No.	Description
1	Are not dedicated-purpose pool pump motors as defined at 10 CFR 431.483.
2	Are synchronous electric motors;
3	Are rated for continuous duty (MG 1) operation or for duty type S1 (IEC);
4	Capable of operating on polyphase or single-phase alternating current 60-hertz (Hz); sinusoidal line power (with or without an inverter);
5	Are rated 600 volts or less;
6	Have a 2-, 4-, 6-, 8-, 10-, or 12-pole configuration.
7	Produce at least 0.25 horsepower (hp) (0.18 kilowatt (kW)) but not greater than 750 hp (373 kW).

86 FR 71710, 71726–71727.

Several stakeholders agreed with including synchronous electric motors in scope and with the proposed criteria. (Grundfos, No. 29 at p. 2; NEEA/NWPCC, No. 37 at p. 3) The Joint Advocates supported DOE's proposed expansion of scope to include synchronous motors. (Joint Advocates, No. 27 at pp. 4–5)

On the other hand, several commenters urged continuing to exempt synchronous electric motors from the test procedure's scope, with some suggesting that DOE evaluate these motors in a separate dedicated rulemaking. (ABB, No. 18 at p. 3; CEMEP, No. 19 at p. 2; AI Group, No. 25 at p. 4; NEMA, No. 26 at p. 8) Specifically, ABB commented that synchronous motors could be used in widely differing product categories, like AC servo motors, which are not used for continuous load applications but for incremental motion and positioning as on machine tools and industrial robots. It added that other larger synchronous motors are often used in freshwater pumps and fans, both extended products that have a DOE regulation in effect or in development. (ABB, No. 18 at p. 3) CEMEP also did not support the scope of the definition as it would include servo-motors. (CEMEP, No. 19 at p. 2) AI Group stated that synchronous motors are not general purpose motors and have many different designs, characteristics, and definitions as to what constitutes a synchronous

[18] NEMA MG 1–2016 Paragraph 1.17.3.4 defines a ''synchronous machine,'' as an ''alternating-current machine in which the average speed of the normal operation is exactly proportional to the frequency of the system to which it is connected.''

[19] NEMA MG 1–2016 Paragraph 1.17.3.3 defines an ''induction machine,'' as an ''an asynchronous machine that comprises a magnetic circuit interlinked with two electric circuits or sets of circuits, rotating with respect to each other and in which power is transferred from one circuit to another by electromagnetic induction.''

[20] DOE notes that while the preamble section of the December 2021 NOPR proposed to specify that synchronous electric motors ''are rated for continuous duty (MG 1) operation or for duty type S1 (IEC),'' (*see* 86 FR 71710, 71727) the proposed regulatory text of the notice did not include that requirement (*see* 86 FR 71710, 71780). DOE is clarifying in this final rule that the regulatory text mistakenly excluded this requirement.

motor, and as such should be excluded from the scope of the test procedure. (AI Group, No. 25 at p. 4)

As already discussed in section III.A.1 and section III.A.7 of this document, EPCA, as amended through EISA 2007, provides statutory authority for the regulation of expanded scope of motors. EPCA does not limit ''electric motors'' to ''general purpose.'' In addition, the statute does not limit DOE's authority to regulate an electric motor with respect to whether they are stand-alone equipment items or are components of a covered product or covered equipment. See 42 U.S.C. 6313(b)(1) (providing that standards for electric motors be applied to electric motors manufactured ''alone or as a component of another piece of equipment'') Whether synchronous electric motors fall outside the category of being general purpose (*i.e.,* being special purpose or definite purpose) or are used as components of other covered products and equipment have no bearing on DOE's authority to regulate these motors.

Further, as DOE presented in the December 2021 NOPR, industry standards exist that apply to in-scope synchronous electric motors. 86 FR 71710, 71726–71727. Establishing test procedures for these motors would allow for standardized representations of motor efficiency. DOE notes that these motors are typically used as higher efficiency replacements for single-speed induction motors that DOE currently regulates. Accordingly, establishing a test procedure for standardized representations of synchronous electric motors would reduce market confusion by providing comparable ratings for substitutable induction motors. As discussed in section III.E, DOE is requiring expanded scope motors, including synchronous electric motors, to be represented based on average full-load efficiency, similar to current in-scope electric motors. Accordingly, a test procedure for synchronous electric motors would ensure that end users are provided with ratings from a uniform test method that can be used to compare and select between electric motors of competing technologies that would ultimately be used in the same end-use applications. DOE notes that, as proposed in the December 2021 NOPR, DOE is only including within the test procedure's scope those synchronous motors that are rated for continuous duty (MG 1) operation. As a result, non-continuous duty synchronous electric motors would continue to remain out of scope.

The following paragraphs summarize comments and responses regarding several specific criteria for synchronous electric motors that DOE proposed in the December 2021 NOPR (See Table III–3 describing the proposal).

The Joint Advocates stated that DOE should clarify the definition of synchronous motors to more explicitly include inverter-fed synchronous motors. Specifically, the Joint Advocates noted potential concerns about whether the proposed definition could be interpreted as requiring a synchronous motor to start and run on sinusoidal line power (*i.e.,* not inverter-fed), which would conflict with their understanding that DOE intended to exclude only those synchronous motors that start and run directly from a DC power source. (Joint Advocates, No. 27 at pp. 4–5) In the December 2021 NOPR, DOE's intention for the synchronous electric motor scope was to include those that operate either direct-on-line (connected directly to the power supply) or as inverter-fed (connected to an inverter). 86 FR 71710, 71727; See Criterion 4 in Table III.8. DOE acknowledged a number of inverter-fed synchronous electric motors that are not currently included in the test procedures for electric motors, including line start permanent magnet (''LSPM''); [21] permanent magnet AC (''PMAC,'' also known as permanent magnet synchronous motor (''PMSM'') or brushless AC); switched reluctance (''SR''); synchronous reluctance motors (''SynRMs''); and electronically commutated motor (''ECMs'').[22] 86 FR 71710, 71726. Accordingly, to clarify in this final rule, DOE has updated the description that motors used with an inverter that operate on polyphase or single-phase alternating current 60-hertz (Hz) sinusoidal line power are included in the synchronous electric motor scope.

While Advanced Energy supported including synchronous motors in scope, it requested a modification to the proposed pole criteria. Advanced Energy explained that synchronous motors cannot be classified in the same manner as induction motors regarding magnetic pole configuration. It noted that some synchronous motors have significantly more poles than what designates the operating speed, and this designation may be present on the motor nameplate. Rather than pole count, Advanced Energy suggested DOE use rated speed. (Advanced Energy, No. 33 at p. 4)

DOE's proposal to include the pole configuration in the synchronous electric motors description sought to maintain consistency with how DOE describes current in-scope electric motors in 10 CFR 431.25(g)(6). The synchronous speed of any electric motor is determined by the pole count and the input frequency to the motor. For direct-on-line induction motors, the input frequency is a fixed value determined by the electricity supply grid the motor is connected to, so the synchronous speed would then only vary as the pole count varies. For synchronous motors, the input frequency to the motor is not fixed because the inverter supplying power to the motor can supply different frequencies on command, allowing two synchronous motors with different pole counts to have the same synchronous speed. As such, DOE agrees with Advanced Energy that pole configuration is not as critical a characteristic of synchronous electric motor compared to induction motors. Because of this inconsistency between synchronous motors and induction motors, DOE no longer sees a need to maintain consistency on the pole count scope criterion between the two groups of electric motors. Since pole count is not nearly as critical to the operation of a synchronous motor, DOE is removing the proposed pole configuration requirement from the synchronous electric motor description.

ebm-papst commented that synchronous air-over motors do not fit into the scope of NEMA MG 1–2016 Part 34's air-over electric motor test method. (ebm-papst, No. 23 at p. 3) DOE clarifies in this final rule that DOE is not including in the test procedure's scope synchronous electric motors that are also air-over electric motors. DOE agrees that the test procedure for air-over electric motors is only specific to induction motors and not the synchronous electric motors at issue in this rulemaking. (See further discussion in section III.D.1 of this document).

Accordingly, in this final rule, DOE is defining synchronous electric motor as follows:

[21] Advanced Energy noted that LSPM motors are synchronous motors. Though these motors have a squirrel cage, they do not operate on the principle of induction as is attributed to regular induction motors. The cage is simply for starting the motor and these motors are essentially synchronous motors. (Docket No. EERE–2017–BT–TP–0047; Advanced Energy, No. 25 at p. 3) This technology is described further in Chapter 3 of the technical support document accompanying the May 2014 Final Rule: During the motor transient start up, the squirrel cage in the rotor contributes to the production of enough torque to start the rotation of the rotor, albeit at an asynchronous speed. When the speed of the rotor approaches synchronous speed, the constant magnetic field of the permanent magnet locks to the rotating stator field, thereby pulling the rotor into synchronous operation. See DOE Technical Support Document (Electric Motors Standards Final Rule) (May 2014) (Docket No. EERE–2010–BT–STD–0027–0108).

[22] All 5 topologies are referred to as ''advanced motor technologies'' and represent motor technologies that have been more recently introduced on the market and have variable speed capabilities.

A Synchronous Electric Motor means an electric motor that:

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

(b) Is a synchronous electric motor;

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

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

(e) Is rated 600 volts or less; and

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

8. Submersible Electric Motors

DOE defines a ''submersible electric motor'' as an electric motor that: (1) is intended to operate continuously only while submerged in liquid; (2) is capable of operation while submerged in liquid for an indefinite period of time; and (3) has been sealed to prevent ingress of liquid from contacting the motor's internal parts. 10 CFR 431.12. These motors are currently exempt from the energy conservation standards. 10 CFR 431.25(l)(4). In the December 2021 NOPR, DOE proposed to include submersible electric motors within the test procedure's scope. 86 FR 71710, 71718–71719. DOE's proposal was informed in part by its initial determination that the air-over test methods developed by NEMA could be adapted as a test method for submersible electric motors either by using an external blower to cool the motor or without the need to submerge the motor in a liquid during testing to cool the motor. With this potential modification to the air-over test method in mind, DOE proposed to include submersible electric motors within the scope of DOE's test procedures. 86 FR 71710, 71749–71750.

Several commenters suggested that the current definition of submersible electric motors is too broad for the purpose of adding them to the test procedure scope, in that the definition could cover a wide range of products, each of which have different design constraints and should be tested differently. (CEMEP, No. 19 at p. 2; Franklin Electric, No. 22 at p. 2; HI, No. 30 at p. 1; WSC, No. 35 at p. 1) The CA IOUs recommended refining the definition of submersible electric motors based on appropriate classifications for different designs of submersible motors, and recommended DOE consider multiple industry definitions. (CA IOUs, No. 32.1 at p. 18) Several commenters also raised concerns with having a single test procedure for all types of submersible electric motors. They noted that several different types of submersible motors exist, each having different technical performances and design constraints. Accordingly, they suggested that type-specific test procedures may be needed to provide accurate representations of efficiency. (CEMEP, No. 19 at p. 2; Grundfos, No. 29 at p. 1; HI, No. 30 at p. 1; WSC, No. 35 at p. 1)

NEMA questioned the merits of testing submersible motors in open air conditions, as these motors are designed to operate submerged. It noted that because the proposed test procedure does not require submersion for cooling, it is neither representative, nor accurate, nor repeatable. (NEMA, No 26 at p. 6) It stated that submersible motors are often designed with a much higher power density than open-air motors because the specific heat capacity of water is approximately 4 times that of air, allowing much more heat dissipation to be accounted for in the design. It noted that because of the design difference, in most cases it is not sufficient to rely on air flow to cool submersible electric motors with such high power densities. It provided motor performance modeling data for a 15 hp submersible motor built in a NEMA 184 frame. NEMA showed that using a typical value of minimum required air velocity for the manufacturer's air-over motors at the same frame size (*i.e.,* at 12 mph), the AEDM predicts that the maximum horsepower at which the motor would stabilize is at 12.5 hp, at which point the predicted average winding temperature rise would reach 442 °C. Because IEEE 112–2017 requires that the load temperature test be performed before taking efficiency measurements, conducting the load temperature test at an average winding temperature rise of 442 °C would likely result in motor failure even before the efficiency measurements could be made, which in turn would subject personnel performing the measurements to potential safety hazards. Even at the maximum air velocity that this manufacturer's AEDM is capable of reaching (*i.e.,* at 114 mph), the AEDM predicts this motor would stabilize at 14.8 HP, for which the predicted average winding temperature rise is 322.2 °C, which would also likely result in motor failure. (NEMA, No. 26 at pp. 21–22)

CEMEP stated that NEMA part 34.4 was not applicable to submersible motors. (CEMEP, No. 19 at p. 4) CEMEP stated that some submersible motors would not be sufficiently cooled by air alone as would occur under the proposed test procedure. They provided an example of a 45 kW motor needing to dissipate 8 kW of heat losses while operating. They also stated that the bearings and seals would not be properly lubricated when tested under the conditions of the proposed test procedure—which would effectively be by air rather than by a liquid as would occur during the normal operation of submersible motors. (CEMEP, No. 19 at p. 8)

Franklin Electric opposed using NEMA 34.4 as the test method for submersible motors, arguing that no standardized test procedure exists; the proposed test procedure was not validated on a diverse enough group of motors; many submersible motor bearings require liquid to be used to lubricate seals and bearings during operation, the lack of which would damage the motor and present additional frictional losses not representative as part of the motor's intended use; many submersible motors are not designed to operate in a horizontal configuration as proposed by the test procedure; the leads for submersible motors are often designed with liquid cooling in mind, and using thermocouples on the surface of the motor is not a reliable means of evaluating the winding temperature—particularly when different liquids are used to encapsulate the windings. (Franklin Electric, No. 22 at pp. 3–4) Further, Franklin Electric noted that no non-manufacturer test lab has the capability to certify a motor using the proposed method, (Franklin Electric, No. 22 at p. 5), and added that submersible motor manufacturers already have custom in-house tests that accommodate water cooling and vertical orientation of the motor to provide accurate and repeatable efficiency testing. It stated that using air-cooling would actually be more burdensome than liquid for submersible motors larger than 5 hp. (Franklin Electric, No. 22 at p. 4)

In response to DOE's comments on whether the proposed test procedure should only apply to a certain horsepower range, Franklin Electric stated that even if the submersible test method scope was limited to 10 hp, that limit would exclude from scope most sizes other than 4-inch diameter submersible motors. It noted that this cut-off would result in a very small fraction of products being added to the test procedure and therefore, would create confusion around efficiency ratings of an in-scope submersible motor vs. out of scope submersible motor. (Franklin Electric, No. 22 at p. 5) For these reasons, Franklin Electric argued that the submersible test procedure is both technologically infeasible and not economically justified and disagreed with DOE's initial view that the proposed changes would not constitute a ''significant'' regulatory action. (Franklin Electric, No. 22 at p. 6)

AI Group stated that submersible motors should be tested according to a procedure that has them submerged in water. (AI Group, No. 25 at p. 3) Grundfos offered a similar critique, asserting that the proposed submersible motor test procedure is inadequate because these motors are designed to operate while submerged in a liquid and the proposed test method has them tested in air. Grundfos stated that testing these motors in air rather than submerged in water would not accurately reflect their efficiency in their intended application. It explained that the proposed method for determining winding temperatures is impractical and for some motors impossible—and it specifically noted that DOE's proposed test method in air does not consider the ''heat rejection'' efficiency of the motors and forces them to reach winding temperatures the motor may never reach under normal operating conditions. (Grundfos, No. 29 at pp. 1, 7–8) Grundfos added that no amount of modification to the air-over method would make it an appropriate method for accurately evaluating the efficiency of submersible motors (Grundfos, No. 29 at p. 1)

HI also criticized the proposed approach. It stated that no internationally recognized test standard exists for evaluating the efficiency of borehole and submersible wastewater motors and that the proposed approach of using air cooling will not result in an accurate measurement of motor performance. It argued that any test procedure for submersible wastewater motors would need to better reflect the specific aspects of these motors and require multiple product categories, definitions, and test methods to properly test and represent the efficiencies for these specialized motors. HI also stated that many submersible motors rely liquid for lubrication. Further, it asserted that the proposed test method was not repeatable and reproducible across test facilities and that DOE's testing of only two small motors does not adequately address this concern. HI also stated that the proposed temperature measurement provisions do not address all submersible motor designs required to accurately obtain winding temperature measurements to ensure testing is conducted within the defined temperature tolerances. (HI, No. 30 at pp. 1–2)

WSC commented that testing submersible motors in air will not result in accurate values of motor performance. It noted that submersible motors have multiple designs, and any test procedure will need multiple product testing categories and methods to accurately separate out the motor losses from these different designs. It also noted manufacturers have developed their own specialized methods that are capital intensive. It added that wastewater submersible motors have specific designs (oil filled, air filled, single seal, dual seal, lip seal, seal materials) that impact utility, which in turn would require any test method that DOE adopts to consider these factors through the use of multiple product testing categories and appropriate testing methods for each. WSC also asserted that DOE's sample size was too small to prove a repeatable test method. (WSC, No. 35 at pp. 1–2)

CEMEP, WSC, and Grundfos all recommended that a test method for submersible motors should be developed by international standardization committees. (CEMEP, No. 19 at pp. 8–9; WSC, No. 35 at p. 2; Grundfos, No. 29 at p. 1)

In contrast to those commenters who objected to the adoption of DOE's proposed test method for submersible electric motors, other commenters supported DOE's proposal—but with reservations. Advanced Energy stated that the submersible test method appears repeatable for 5 hp or smaller submersible motors, and that there is opportunity to evaluate this test method for larger hp motors. (Advanced Energy, No. 33 at p. 16) The Joint Advocates and CA IOUs supported including submersible electric motors in scope and encouraged DOE to continue to investigate options for submersible motor testing to support development of test procedures. (Joint Advocates, No. 27 at p. 2; CA IOUs, No. 32.1 at pp. 17–18) The CA IOUs commented that Japan, China, and Brazil have standards for submersible motors. They noted that China has published testing standards for waste submersible motor-pumps, submersible motors for deep wells, and submersible motor-pumps. Further, they noted that India has published a case study and three test methods for submersible motors. (CA IOUs, No. 32.1 at p. 17) The CA IOUs also stated that IEEE is developing a submersible motor test standard and provided links to the currently published IEEE recommendations for testing submersible motors. They also suggested that NEMA Part 34 would need more modification to be used as the test procedure, or that a completely new test procedure needs to be developed for these motors. (CA IOUs, No. 32.1 at pp. 17–18)

DOE re-evaluated the proposed test method based on concerns noted by stakeholders. DOE agrees that further testing is needed to ensure that any test method(s) would be both applicable and representative for submersible electric motors of all designs and sizes. Further, DOE also agrees that a test procedure based on air cooling as opposed to water cooling may not accurately capture intended performance. In addition, DOE acknowledges concerns that liquid is needed to lubricate seals and bearings during operation, the lack of which could potentially damage the motor and present additional frictional losses. Finally, DOE understands that the applicability of the proposed test procedure at higher horsepowers may result in winding temperature rises that may cause motor failure. Accordingly, based on comments received and further review, DOE is not including submersible electric motors within scope of this test procedure. Therefore, submersible electric motors will continue to be exempt from the test procedures and energy conservation standards.

9. Other Exemptions

Currently, DOE exempts (1) component sets of an electric motor; and (2) liquid-cooled electric motors. 10 CFR 431.25(l)(2) and (3).

DOE defines ''component set'' as a combination of motor parts that require the addition of more than two endshields (and their associated bearings) to create an operable motor. These parts may consist of any combination of a stator frame, wound stator, rotor, shaft, or endshields. 10 CFR 431.12. DOE defines ''liquid-cooled electric motor'' as a motor that is cooled by liquid circulated using a designated cooling apparatus such that the liquid or liquid-filled conductors come into direct contact with the parts of the motor. *Id.* DOE is amending the definition for ''liquid-cooled electric motor'' in this final rule, as discussed in section III.B.5 of this document. In the December 2021 NOPR, DOE requested comment on maintaining the exemptions. 86 FR 71710, 71727–71728.

Certain stakeholders supported continuing to exempt components set of electric motors from the scope of the test procedure. (CEMEP, No. 19 at p. 2; ebm-papst, No. 23 at p. 3; NEMA, No. 26 at p. 8; Grundfos, No. 29 at p. 2) Certain stakeholders also supported excluding liquid-cooled electric motors from scope. (CEMEP, No. 19 at p. 3; NEMA, No. 26 at p. 8; Grundfos, No. 29 at p.

3) Advanced Energy supported continuing to exclude liquid-cooled electric motors stating that they are highly specialized motors and often prioritize power density over other performance requirements. (Advanced Energy, No. 33 at p. 5) Comments received regarding the liquid-cooled definition are addressed in section III.B.5. of this document.

Based on the discussion presented in the December 2021 NOPR and in the preceding paragraphs in this final rule, DOE is continuing to exempt component sets of an electric motor and liquid-cooled electric motors from the scope of the electric motors test procedure.

B. Definitions

In this final rule DOE is modifying 10 CFR 431.12 by amending and adding certain definitions applicable to electric motors. These amendments and additions are discussed in further detail in the following sections.

1. Updating IEC Design N and H Motors Definitions and Including New Definitions for IEC Design N and H ''E'' and ''Y'' Designations

As discussed in section III.A.2 of this document, DOE is clarifying in this final rule that IEC Design HE, HEY, HY, NE, NEY, and NY motors are within the scope of the test procedure. In the December 2021 NOPR, DOE proposed to add definitions for these ''E'' and ''Y'' designations for IEC Design N and H motors based on IEC 60034–12:2016. 86 FR 71710, 71728–71729.

In response to this proposal, Advanced Energy stated that the proposed updates are not consistent with the definitions as they appear in IEC 60034–12:2016. It stated the IEC standard states a ''Y'' designation represents ''star-delta starting'' as opposed to ''direct-on-line'' starting for both IEC Design HEY and NEY. Further, Advanced Energy also commented that the upper limit of output power for IEC Design H was not consistent with Section 5.5 of IEC 60034–12:2016. (Advanced Energy, No. 33 at p. 5) DOE did not receive any other comments regarding the definition of the ''E'' and ''Y'' variants of IEC Design N and H motors.

Based on the comment from Advanced Energy and additional review of IEC 60034–12:2016, DOE agrees that the IEC Design N and H motors with the ''Y'' variant are capable of star-delta starting, not direct-on-line starting. DOE is finalizing the definitions for IEC Design N and H that include the Y variant (IEC Design HY, HEY, NY, NEY) accordingly.

Regarding the upper limit for the Design H definition, DOE notes that the current DOE definition for IEC Design H motor in 10 CFR 431.12 extends to 1600 kW. DOE established this definition in the December 2013 Final Rule. 78 FR 75962, 75969–75970. In the December 2013 Final Rule, DOE explained that in defining IEC Design H and IEC Design N motors, DOE specified the characteristics and features that identify these types of motors, so that manufacturers designing to the IEC standards can easily tell whether their motor is subject to DOE's regulatory requirements. DOE could not identify a justification for why DOE's definition of IEC Design H included an upper limit of 1600 kW instead of the 160 kW limit consistent with the IEC definition of Design H. Although standards are limited by a horsepower range (*see* 10 CFR 431.25(g)(8)), DOE stated that it does not need to limit the DOE definitions to the same power range as the standards to describe whether a given motor falls under Design H or Design N. *Id.* Since the definition of Design H in IEC 60034–12:2016 already limits Design H motors to 160 kW, bringing the upper limit in DOE's definitions to be consistent with IEC 60034–12:2016 will not change the scope of the test procedure. Accordingly, in this final rule, DOE is amending the upper horsepower limit for Design H (and E and Y variations) to 160 kW.

2. Updating Definitions To Reference Current NEMA MG 1–2016

In the December 2021 NOPR, DOE proposed to revise a number of definitions at 10 CFR 431.12 by updating references from NEMA MG 1–2009 to NEMA MG 1–2016 (with 2018 Supplements). 86 FR 71710, 71729–71730. DOE noted that the following definitions reference provisions of NEMA MG 1–2009 that have changed between the 2009 and 2016 versions: ''definite purpose motor,'' ''definite purpose electric motor,'' ''general purpose electric motor,'' ''NEMA Design A Motor,'' ''NEMA Design B Motor,'' ''NEMA Design C motor,'' and ''nominal full-load efficiency.'' DOE initially determined that the changes in NEMA MG 1–2016 (with 2018 Supplements) do not substantively change these definitions. *Id.*

In response, NEMA commented that updating the reference of NEMA MG 1 to the 2016 version (with 2018 Supplements) would not substantially change the definitions currently prescribed in 10 CFR 431.12. It further stated the definitions of NEMA Design A, B, and C should be updated to reflect the revised subsection references of 12.35 in NEMA MG 1–2016. (NEMA, No. 26 at p. 10)

Since the December 2021 NOPR, NEMA has published a revised version of NEMA MG 1–2016. On June 15, 2021, ANSI approved the revised version, which is referred to in this document as NEMA MG 1–2016. DOE understands that NEMA continues to title this standard as ''NEMA MG 1–2016,'' even with the latest 2021 updates. In reviewing the latest standard, DOE notes that this revision only appears to unify the supplements and the rest of NEMA MG 1 into one continuous document and does not include any substantial changes to the content of the standard that was reviewed in the December 2021 NOPR. While the December 2021 NOPR requested comment on the definitions based on the latest version at the time [NEMA MG 1–2016 (with 2018 Supplements)], because DOE has since concluded that the latest version [NEMA MG 1–2016 ((Revision 1, 2018) ANSI-approved 2021)] is not substantially different, the assessment conducted in the December 2021 NOPR is still relevant for the latest version of the standard. As such, in this final rule, DOE is incorporating by reference and including within the definitions the latest NEMA MG 1–2016 standard.

In addition, DOE reviewed the subsection references contained in the definitions of NEMA Design A, B, and C in NEMA MG 1–2016 and notes that there have been no updates to the content of the updated subsections. Accordingly, in this final rule, DOE has updated the definitions to include the new subsection references as they appear in NEMA MG 1–2016.

3. Inverter, Inverter-Only, and Inverter-Capable

DOE defines an ''inverter-only electric motor'' as an electric motor that is capable of rated operation solely with an inverter, and is not intended for operation when directly connected to polyphase, sinusoidal line power.'' DOE also defines an ''inverter-capable electric motor'' as an ''electric motor designed to be directly connected to polyphase, sinusoidal line power, but that is also capable of continuous operation on an inverter drive over a limited speed range and associated load.'' 10 CFR 431.12. Inverter-only and inverter-capable electric motors can be sold with or without an inverter.

In the December 2021 NOPR, DOE proposed to revise the definitions for ''inverter-only electric motor'' and ''inverter-capable electric motor.'' Further, DOE also proposed a definition for ''inverter.'' 86 FR 71710, 71730. DOE noted that, in addition to not being designed for operation when directly connected to polyphase, sinusoidal power, inverter-only motors are also not designed for operation when directly connected to single-phase, sinusoidal line power or to DC power. *Id.* To provide a more complete definition, DOE proposed to revise the definition of inverter-only electric motor as follows: ''an electric motor that is capable of continuous operation solely with an inverter, and is not designed for operation when directly connected to AC sinusoidal or DC power supply.'' *Id.* Similarly, DOE proposed to revise the definition of an inverter-capable electric motor as follows: ''an electric motor designed to be directly connected to AC sinusoidal or DC power, but that is also capable of continuous operation on an inverter drive over a limited speed range and associated load.'' *Id.*

Finally, Paragraph 30.2.1.5 of NEMA MG 1 2016 defines the term ''control'' for motors receiving AC power, as ''devices that are also called inverters and converters. They are electronic devices that convert an input AC or DC power into a controlled output AC voltage or current''. Converters can also be found in motors that receive DC power and also include electronic devices that convert an input AC or DC power into a controlled output DC voltage or current. Therefore, to support the definition of ''inverter-only motor,'' in the December 2021 NOPR, DOE proposed to define an inverter as ''an electronic device that converts an input AC or DC power into a controlled output AC or DC voltage or current. An inverter may also be called a converter.'' *Id.*

Grundfos and Advanced Energy supported the proposed definitions for ''inverter,'' ''inverter-only electric motor,'' and ''inverter-capable electric motors.'' (Grundfos, No. 29 at p. 3; Advanced Energy, No. 33 at p. 6) NEMA, CEMEP, and AI commented that the definitions should be amended to harmonize with the definitions in IEC 60034–1 Edition 14. (NEMA, No. 26 at p. 11; CEMEP, No. 19 at p. 3; AI Group, No. 25 at p. 4)

In response to these comments, DOE reviewed the definitions contained in IEC 60034–1 Ed. 14. IEC 60034–1 Ed. 14 contains specifications for the ratings and performance of rotating electrical machines and defines a ''converter duty machine'' as an ''electrical machine designed specifically for operation fed by a power electronic frequency converter with a temperature rise within the specified insulation thermal class or thermal class.'' DOE notes that this definition was not in edition 13 of IEC 60034–1 and was not available for consideration in the December 2021 NOPR since edition 14 was published in 2022. DOE also notes that the IEC definition is generally similar to the definition proposed in the December 2021 NOPR with only minor differences. The IEC definition uses the term ''electrical machine'' where DOE used ''electric motor'' and ''power electronic frequency converter'' where DOE used ''inverter.'' DOE also understands that the temperature rise clause in the IEC definition is similar to the ''continuous operation'' clause of the DOE definition since overheating (potentially through gradually breaking down the motor's insulation) is a common mode of failure caused by an inverter feeding a non-inverter-rated motor. As such, DOE is adopting the IEC definition to harmonize with industry standards, with only minor modifications to be consistent with the terminology currently used in the rulemaking process. Specifically, in this final rule, DOE is defining an ''inverter-only electric motor'' as an ''electric motor designed specifically for operation fed by an inverter with a temperature rise within the specified insulation thermal class or thermal limits.''

IEC 60034–1 Ed. 14 also defines a ''converter capable machine'' as an ''electrical machine designed for direct online start and suitable for operation on a power electronic frequency converter without special filtering.'' DOE understands that the IEC definition for ''converter capable machine'' is largely similar to the term ''inverter-capable electric motor'' in the same way as how the IEC definition for ''converter duty machine'' is largely similar to the term ''inverter-only electric motor.'' Specifically, the IEC definition uses the clause ''suitable for operation'' whereas the proposed DOE definition included an analogous clause ''capable of continuous operation.'' Further, the IEC definition uses the term ''power electronic frequency converter,'' whereas the proposed DOE definition included the term ''inverter.''

In reviewing the IEC definition for ''converter capable machine'' and the proposed definition for ''inverter-capable electric motor,'' DOE identified two additional differences. The first difference DOE identified was the proposed inclusion of the clause ''over a limited speed range and associated load''—a qualification not included with the IEC definition. However, DOE understands that this additional clause would not create a significant difference between the two definitions as all motors effectively have a limited speed range or associated load by nature of their construction. Therefore, DOE concludes that adopting the IEC definition would not modify the currently proposed scope of this test procedure.

The second difference DOE identified was the clause ''without special filtering,'' which is included in the IEC definition but not in the DOE proposed definition. DOE understands that the inclusion of this clause in the IEC definition is to ensure that non-inverter-rated motors are not considered inverter-capable when a filter is used between the inverter and motor to filter out the higher-order harmonics to prevent damage to the non-inverter-rated motor. This understanding is consistent with the intent of the DOE proposed definition of ''inverter-capable electric motor.'' Therefore, to harmonize with industry standards, DOE is adopting the IEC definition with minor modifications to keep the terminology consistent. Specifically, in this final rule, DOE is defining an ''inverter-capable electric motor'' as an ''electric motor designed for direct online start and suitable for operation on an inverter without special filtering.''

4. Air-Over Electric Motors

Certain general-purpose electric motors have an internal fan attached to the shaft that forces air through the motor and prevents it from overheating during continuous use. Air-over electric motors do not have a factory-attached fan and require a separate means of forcing air over the frame of the motor. The external cooling maintains internal motor winding temperatures within the permissible temperature rise for the motor's insulation class or to a maximum temperature value specified by the manufacturer.[23] Without an external means of cooling, an air-over electric motor would overheat during continuous operation. Air-over motors can be found in direct-drive axial fans, blowers, and several other applications; for example, single-phase air-over motors are widely used in residential and commercial HVAC systems, appliances, and equipment as well as in agricultural applications. The current definition for air-over electric motors in 10 CFR 431.12 is as follows: an electric motor rated to operate in and be cooled by the airstream of a fan or blower that is not supplied with the motor and

[23] Sections 12.42 and 12.43 of NEMA MG 1–2016 specifies the maximum temperature rises corresponding to four insulation classes (A, B, F, and H). Each class represents the maximum allowable operating temperature rise at which the motor can operate without failure, or risk of reducing its lifetime.

whose primary purpose is providing airflow to an application other than the motor driving it.

In the December 2021 NOPR, DOE noted that the absence of a fan is not a differentiating feature specific to air-over electric motors. 86 FR 71710, 71730–71731. For example, there is little difference between a totally enclosed fan-cooled electric motor (''TEFC'') and a totally enclosed air-over electric motor (''TEAO''). A user could remove the fan on a TEFC electric motor, and then place the motor in an airstream of the application to obtain an air-over electric motor configuration. Further, other motor categories such as totally enclosed non-ventilated (''TENV'') electric motors do not have internal fans or blowers and are similar in construction to TEAO electric motors.[24] Finally, DOE also noted that to differentiate air-over motors from totally-enclosed pipe-ventilated (''TEPV'') motors, it needed to specify that the external cooling is obtained by a free flow of air rather than external cooling that is directed onto the motor via a duct or a pipe.[25] *Id.*

In the December 2021 NOPR, DOE explained that what differentiates air-over motors from non-air-over motors is that air-over motors require external cooling by a free flow of air to prevent overheating during continuous operation.[26] 86 FR 71710, 71730–71731. Further, DOE noted that the free flow of air was needed for the air-over motor to thermally stabilize. Accordingly, DOE proposed a revised definition of air-over electric motor in consideration of the above specifications—*i.e.,* ''an electric motor that does not reach thermal equilibrium (*i.e.,* thermal stability) during a rated load temperature test according to section 2 of appendix B, without the application of forced cooling by a free flow of air from an external device not mechanically connected to the motor.'' 86 FR 71710, 71730–71731.

In response to DOE's proposal, Advanced Energy supported DOE's proposed definition of air-over electric motor. (Advanced Energy, No. 33 at p. 6) NEMA commented that the definition was adequate, but pointed out that DOE should preserve and allow all three potential stabilization methods. (NEMA, No. 26 at p. 11) Lennox commented that while it supported the proposed definition, it stated that DOE must continue to exempt HVACR air-over motors from component level-regulation when such motors are used in equipment already regulated at the systems level. (Lennox, No. 24 at p. 7)

Trane commented that the current definition of air-over electric motor is appropriate and that changing it to include thermal equilibrium is inappropriate because the motor could still reach equilibrium without forced-air through heat dissipation. However, the same motor would still be defined as an air-over motor because the manufacturer specifies certain minimum airflow requirements to maintain winding temperatures within permissible limits. (Trane, No. 31 at p. 4)

As discussed previously, DOE proposed the updated definition to ensure that air-over electric motors are correctly distinguished from TEFC, TENV, and TEPV motors. The proposed definition for air-over electric motor specifies reaching thermal equilibrium with forced cooling at a target temperature[27] according to section 2 of appendix B, which is the air-over electric motor test procedure. As discussed in section III.D.1 of this document, the air-over electric motor test procedure allows the use of the motor temperature rise if it is indicated by the manufacturer to specify the target temperature, or if it is not indicated, requires use a target temperature of 75 °C. Based on the updated definition, if the electric motor can thermally stabilize below the target temperature without airflow, then that motor is not considered an air-over electric motor. Without an external means of cooling, an air-over electric motor would overheat during continuous operation. Therefore, if the motor is able to stabilize and operate below the target temperature, then there is no requirement for external means of cooling. On the other hand, the electric motor would still be considered an air-over electric motor if it can thermally stabilize without airflow at a temperature above the target temperature. The updated definition does not limit this occurrence, as it is only specifying that thermal equilibrium must be met during a rated load temperature test according to section 2 of appendix B (*i.e.,* using the temperature rise indicated by the manufacturer to determine target temperature, or if it is not indicated, a target temperature of 75 °C). Accordingly, having an external means of cooling would still be required during continuous operation at the manufacturer specified target temperature.

AMCA stated that the proposed definition for air-over motors is ambiguous and would exclude many intended air-over motors because of the provision ''without the application of forced cooling by a free flow of air from an external device not mechanically connected to the motor'' would exclude air-over motors which are cooled by an external fan driven by the motor's shaft. AMCA recommended as an alternate definition: ''an electric motor that does not reach thermal equilibrium (*i.e.,* thermal stability) during a rated load temperature test according to section 2 of appendix B, without the application of forced cooling by a free flow of air from an external device not supplied for permanent use with the motor.'' (AMCA, No. 21 at pp. 2–3) ebm-papst supported AMCA's suggested definition of an air-over motor and stated that DOE's proposed definition was too broad. (ebm-papst, No. 23 at p. 5)

As described in the NOPR, air-over motors do not have a factory-attached fan and require a separate means of forcing air over the frame of the motor. 86 71710, 71730. DOE interprets the concerns from AMCA and ebm-papst as being that requiring the free flow of air to come from an external device *not mechanically connected to the motor* would unintentionally exclude certain air-over electric motors that should be included, such as air-over motors that are sold with a fan mechanically connected to the motor's shaft (in this case, the fan is used to provide function beyond cooling of the motor and an air over-motor is used to drive the fan). DOE agrees with AMCA and ebm-papst, that such motors must not be excluded from the air-motor electric motor definition. DOE's intent in specifying ''external device'' and ''not mechanically connected'' in the proposed definition was to distinguish air-over motors that do not incorporate a fan within the motor's enclosure from motors that do incorporate a fan in the motor's enclosure, where the fan is used for the sole purpose of cooling the motor. Therefore, in response to the recommendations by AMCA and ebm-

[24] TENV electric motors are ''built in a frame-surface cooled, totally enclosed configuration that is designed and equipped to be cooled only by free convection'' 10 CFR 431.12.

[25] DOE did not find any pipe-ventilated motors in the proposed scope of applicability of this test procedure but is aware that some motors may exist in such configurations. TEPV motors are cooled by supply air which is piped into the motor and ducted out of the motor. They are typically used to overcome heat dissipation difficulties and when air surrounding the motor is not clean (*e.g.,* dust).

[26] Without the application of free-flowing air, the internal winding temperatures of an air-over electric motor would exceed the maximum permissible temperature (*i.e.,* the motor's insulation class's permissible temperature rise or a maximum temperature value specified by the manufacturer).

[27] The amount of ventilation required during the test is based on motor winding temperature reaching a target temperature. See section III.D.1 of this document.

papst, for clarification, DOE is adopting a modified version of the proposed definition instead. DOE is specifying that the external device should also not be supplied within the motor enclosure. In general, DOE prefers to rely on physical features instead of intended usage (*i.e.,* ''for permanent use'') when establishing equipment definitions.

As such, in this final rule, DOE adopts the following definition of air-over electric motor: an electric motor that does not reach thermal equilibrium (*i.e.,* thermal stability), during a rated load temperature test according to section 2 of appendix B, without the application of forced cooling by a free flow of air from an external device not mechanically connected to the motor within the motor enclosure.

5. Liquid-Cooled Electric Motors

Liquid-cooled electric motors are definite-purpose motors typically designed for high power density applications. The higher power density from these applications causes a liquid-cooled electric motor to generate more heat over a given volume than a conventional air-cooled electric motor. To prevent the motor from overheating, it relies on a liquid to be forced through and over components of the motor to provide better cooling than an internal fan would. DOE currently defines a liquid-cooled electric motor as: a motor that is cooled by liquid circulated using a designated cooling apparatus such that the liquid or liquid-filled conductors come into direct contact with the parts of the motor. 10 CFR 431.12.

In the December 2021 NOPR, DOE proposed to revise this definition to read as ''a motor that is cooled by liquid circulated using a designated cooling apparatus such that the liquid or liquid-filled conductors come into direct contact with the parts of the motor, but is not submerged in a liquid during operation.'' DOE proposed this revision to better distinguish liquid-cooled electric motors from submersible electric motors. 86 FR 71710, 71731–71732.

NEMA supported the proposed definition of liquid-cooled electric motor. (NEMA, No. 26 at p. 11) Grundfos commented that ''designated cooling apparatus'' is not clearly defined and believe that the proposed definition makes it unclear as to what constitutes a liquid-cooled motor. (Grundfos, No. 29 at p. 3)

In the December 2013 Final Rule, DOE discussed that liquid-cooled electric motors rely on a special cooling apparatus that pumps liquid into and around the motor housing. 78 FR 75962, 75987–75988. The liquid is circulated around the motor frame to dissipate heat and prevent the motor from overheating during continuous-duty operation. The December 2013 Final Rule amended the definition of liquid-cooled electric motor to better differentiate liquid-cooled electric motors from other types of electric motors, and the term ''designated cooling apparatus'' was added to specify that a cooling apparatus is required for a motor to be designated as a liquid-cooled electric motor. *Id.* In this final rule, DOE further specifies that a ''designated cooling apparatus'' is any apparatus that circulates a liquid in order to cool a liquid-cooled electric motor. One example of such an apparatus is an external pump that forces a liquid through the motor for cooling purposes.

For the reasons discussed in the December 2021 NOPR and with the modification discussed in the preceding paragraph, DOE is adopting the definition of liquid-cooled, as proposed.

6. Basic Model and Equipment Class

In the December 2021 NOPR, DOE proposed to amend the definition of ''basic model'' in 10 CFR 431.12 to make it similar to the definitions used for other DOE-regulated products and equipment, and to eliminate an ambiguity found in the current definition. 86 FR 71710, 71732. The definition in 10 CFR 431.12 specifies that basic models of electric motors are all units of a given type manufactured by the same manufacturer, which have the same rating, and have electrical characteristics that are essentially identical, and do not have any differing physical or functional characteristics that affect energy consumption or efficiency. For the purposes of this definition, the term ''rating'' is specified to mean one of 113 combinations of horsepower, poles, and open or enclosed construction. *See id.* The reference to 113 combinations dates from the Department's implementation of EPACT 1992, which established initial standards for motors based on that categorization. Since then, EISA 2007 and DOE's regulations have established standards for additional motor categories. *See* 10 CFR 431.25. To clarify that the concept of a ''basic model'' reflects the categorization in effect under the prevailing standard, as it stands today, and as it may evolve in future rulemakings, DOE proposed to refer only to the combinations of horsepower (or standard kilowatt equivalent), number of poles, and open or enclosed construction for which 10 CFR 431.25 prescribes standards; and to remove the current reference to 113 such combinations. 86 FR 71710, 71732. As such, DOE proposed to replace the term ''rating'' with the term ''equipment class'' in the basic model definition. In addition, DOE proposed to define ''equipment class'' as one of the combinations of an electric motor's horsepower (or standard kilowatt equivalent), number of poles, and open or enclosed construction, with respect to a category of electric motor for which § 431.25 prescribes nominal full-load efficiency standards. *Id.* This proposal would also limit confusion between the use of the term ''rating'' in this specific case and the use of the term as it applies to represented values of other individual characteristics of an electric motor, such as its rated horsepower, voltage, torque, or energy efficiency. *Id.*

DOE did not receive any comments on these definitions and adopts the definitions of equipment class and basic model as proposed.

C. Updates to Industry Standards Currently Incorporated by Reference

In the December 2021 NOPR, DOE reviewed each of the industry standards that are currently incorporated by reference as test methods for determining the energy efficiency of electric motors or that are referenced within the definitions prescribed in 10 CFR 431.12, and identified updates for each as provided in Table III–4 of this document. 86 FR 71710, 71732–71734.

TABLE III–4—UPDATED INDUSTRY STANDARDS PROPOSED IN THE DECEMBER 2021 NOPR

Existing reference	Updated version	Type of update
IEC 60034–12 Edition 2.1 2007–09	IEC 60034–12 Edition 3.0 2016	Revision.
NFPA 20–2010	NFPA 20–2019	Revision.
CSA C390–10	CSA C390–10 (Reaffirmed 2019)	Reaffirmed.
NEMA MG 1–2009	NEMA MG 1–2016	Revision.

Through the review, DOE tentatively concluded that updating the industry standards to the latest version would not alter the measured efficiency of electric motors and would not be unduly burdensome to conduct. Therefore, DOE proposed to incorporate by reference the updated versions of the industry standards. *Id.*

DOE also proposed to incorporate by reference IEC 60079–7:2015 as it is referenced within IEC 60034–12:2016 and is necessary for the test procedure. Sections 5.2.7.3 and 5.2.8.2 of IEC 60079–7:2015 describe the additional starting requirements of increased safety ''eb'' and ''ec'' motors. The ''eb'' and ''ec'' designations are the two levels of protection offered by the increased safety ''e'' designation and are intended for use in explosive gas atmospheres, according to Section 1 of IEC 60079–7:2015. Section 5.2.7.3 specifies the application of protective measures to prevent airgap sparking while Section 5.2.8.2 specifies the application of starting current requirements and when a current-dependent safety device is required. 86 FR 71710, 71733. Also, to ensure consistency in the versions of the referenced standards used when testing, DOE proposed to specify the publication year for each of the industry standards referenced by Section 12.58.1 of NEMA MG 1–2016, which are as follows: IEEE 112–2017, CSA C390–10, and IEC 60034–2–1:2014. 86 FR 71710, 71734.

In response, CEMEP agreed that DOE's assessment of the updates to NEMA 12.58.1 of MG 1–2016 with its 2018 Supplements was accurate, and supported updating the IEEE, CSA, and IEC standards to their latest versions. (CEMEP, No. 19 at p. 4) However, CEMEP stated that IEC 60079–7:2015 contains some specific requirements for 'eb' motors related to the safety of such protection type, and for 'ec' motors, there are no requirements regarding starting performance. Accordingly, CEMEP recommended against including IEC 60079–7:2015. (CEMEP, No. 19 at p. 4)

NEMA agreed with DOE's assessment of the updates to IEC 60034–12:2016, and supported referencing both IEC 60034–12:2016 and IEC 60079–7:2015. It commented that while IEC 60034–12 is currently under revision, substantial changes were not expected. (NEMA, No. 26 at p. 11) Further, NEMA agreed with DOE's assessment of the updates to Paragraph 12.58.1 of NEMA MG 1–2016, and asserted that updating the references to IEEE 112–2017, CSA C390–10, and IEC 60034–2–1:2014 should not affect the measured efficiency of electric motors currently in scope of the test procedure. (NEMA, No. 26 at pp. 11–12) Finally, NEMA also supported DOE updating to the 2019 version of NFPA 20. *Id.* NEMA stated that ''including any IEC equivalent'' should remain in DOE's definition of fire pump for clarity even if NFPA 20 section 9.5 now includes that clause. (NEMA, No. 26 at p. 11)

Grundfos did not believe updating to the 2016 version of NEMA MG 1 (with 2018 Supplements) would alter the measured efficiency of electric motors. (Grundfos, No. 29 at p. 3) Further, Grundfos agreed with DOE's assessment and proposed inclusion of IEC 60034–12:2016 and the proposed updates to Section 12.58.1 of NEMA MG 1. It also supported including IEC 60034–2–1:2014 as part of the DOE test procedure. (Grundfos, No. 29 at pp. 3–4) Advanced Energy agreed with DOE's assessment on the updates to Section 12.58.1 of NEMA MG 1–2016 (with 2018 Supplements), and agreed with updating DOE's test procedures to reference the most recent IEEE, CSA, and IEC standards because it would be consistent with current industry practice. (Advanced Energy, No. 33 at p. 7)

Since the December 2021 NOPR, there have been updates to two of the standards: (1) NFPA 20–2019 has been revised to a 2022 version; and (2) NEMA MG 1–2016 has been updated to an ANSI approved June 15, 2021, version that includes updates to parts 0, 1, 7, 12, 30, and 31, along with Part 34 (separately published).

For the 2022 update to NFPA–20, new requirements were added to address numerous recent advancements in the field of stationary pumps for fire protection, which is not relevant for the scope of this rulemaking. The updates to Section 9.5 of NFPA–20 provide further clarifications on calculating values for locked rotor current for motors rated at voltages other than 230 V presented in that section. Otherwise, section 9.5 remains the same as the 2019 version. Accordingly, referencing the most current version (NFPA 20–2022) would not change the applicability of the definition of fire pump electric motor for the purposes of DOE's regulations. Further, DOE is maintaining ''including any IEC equivalent'' within the fire pump electric motor definition.

For the 2021 update to NEMA MG 1–2016, this revision consolidates the supplements and the rest of NEMA MG 1 into one document. DOE did not identify any substantial changes compared to the prior version of NEMA MG 1. Accordingly, as with the updates to NFPA–2020, referencing the most current would not alter the measured efficiency of electric motors, and would not be unduly burdensome to conduct.

Further, as discussed in the December 2021 NOPR, IEC 60034–12:2016 references IEC 60079–7:2015 to determine locked rotor apparent power for motors with type of protection ''e'' '—which are eligible to be considered IEC Design N or H motors. 86 FR 71710, 71733. Considering IEC 60079–7:2015 is necessary to test using IEC 60034–12:2016, DOE is incorporating by reference both test procedures in this final rule.

Accordingly, for the reasons discussed in the December 2021 NOPR and discussed in the preceding paragraphs, DOE is updating its test procedure regulations to incorporate the current industry standards to the latest references, as summarized in Table III–5.

TABLE III–5—UPDATED INDUSTRY STANDARDS IN THIS FINAL RULE

Existing reference	Updated version	Type of update
IEC 60034–12 Edition 2.1 2007–09	IEC 60034–12 Edition 3.0 2016 (including IEC 60079–7:2015).	Revision.
NFPA 20–2010	NFPA 20–2022	Revision.
CSA C390–10	CSA C390–10 (Reaffirmed 2019)	Reaffirmed.
NEMA MG 1–2009	NEMA MG 1–2016	Revision.

D. Industry Standards Incorporated By Reference

This section discusses industry test standards that DOE is incorporating by reference for testing the additional electric motors for inclusion in the scope of the DOE test procedure.

EPCA includes specific test procedure-related requirements for electric motors subject to energy conservation standards under 42 U.S.C. 6313. The provisions in EPCA require that electric motors be tested in accordance with the test procedures specified in NEMA Standards Publication MG1–1987 and IEEE Standard 112 Test Method B for motor efficiency, as in effect on October 24, 1992 (*See* 42 U.S.C. 6314(a)(5)) As discussed in section III.C of this document, both publications have been replaced with the more recent version IEEE 112–2017 and NEMA MG 1–2016.

The additional electric motors DOE is adding to the scope of the DOE test procedure are not addressed by the standards that are currently applicable under 42 U.S.C. 6313. DOE notes that the industry test procedures incorporated by reference for air-over electric motors and for SNEMs are included in NEMA MG 1–2016. *See* Section IV, Part 34: Air-Over Motor Efficiency Test Method and Section 12.30. Section 12.30 of NEMA MG 1–2016, specifies the use of IEEE 112 and IEEE 114 for all single-phase and polyphase motors.[28] As further discussed in section III.D.2 of this document, DOE is requiring testing of SNEMs other than air-over and inverter-only electric motors according to IEEE 112–2017 (or CSA C390–10 or IEC 60034–2–1:2014, which are equivalent to IEEE 112–2017) and IEEE 114–2010 (or CSA C747–09 or IEC 60034–2–1:2014, which are equivalent to IEEE 114–2010). This amendment satisfies the test procedure requirements under 42 U.S.C. 6314(a)(5).

The methods listed in Section 12.30 of NEMA MG 1–2016, for testing AC motors apply only to AC induction motors that can be operated when directly connected to the power supply (direct-on-line) and do not apply to electric motors that are inverter-only or to synchronous electric motors that are not AC induction motors. Therefore, for these additional electric motor types, DOE is specifying the use of different industry test procedures, as further discussed in section III.D.3. of this document.

[28] As previously mentioned, NEMA MG 1–2016 does not specify the publication year of the referenced test standards and instead specifies that the most recent version should be used.

AI Group stated that DOE should harmonize with IEC international standards with respect to the electric motor test procedures, efficiency classes, and scope of regulation. (AI Group, No. 25 at p. 2)

DOE's test procedures currently incorporate by reference several IEC test methods for testing current in-scope electric motors. *See* 10 CFR 431.15(c). As part of this rulemaking, DOE reviewed a number of industry standards that would be relevant for testing the additional electric motors that DOE proposed to include within the scope of the DOE test procedure. Several of those industry standards include IEC standards, which are discussed in sections III.D.2 and III.D.3 of this document.

1. Test Procedures for Air-Over Electric Motors

a. Test Method

In the December 2021 NOPR, DOE evaluated three test methods published by NEMA in NEMA MG 1–2016 that are used to measure the efficiency of an air-over electric motor. 86 FR 71710, 71735–71739. The first alternative test method (*i.e.,* Part 34.3) specifies that the temperature test must be conducted by thermally stabilizing the motor at the rated full-load conditions using an external airflow according to the end user specifications in terms of air-velocity ratings in feet per minute. The second alternative test method (*i.e.,* Part 34.4) includes a temperature test conducted with the use of an external blower, but the amount of airflow is not specified; therefore, the amount of ventilation required is based on motor winding temperature reaching a target temperature. Finally, the third alternative test method (*i.e.,* Part 34.5) includes a temperature test performed without the use of an external blower while not loading the motor at its rated load. Instead, the motor is gradually loaded until the motor winding temperature reaches the required target temperature. *Id.*

As part of the review of the test methods, in the December 2021 NOPR, DOE did not consider Part 34.3 because testing with an external airflow according to the customer or application specific requirements as specified in the first alternative test method could result in testing the same motor at different winding temperature during the test, which would impact the measurement of efficiency. Therefore, DOE tentatively concluded that results from applying the first test method according to Part 34.3 would not ensure relative comparability of efficiency for air-over electric motors. 86 FR 71710, 71737–71738.

Otherwise, DOE considered the other two test methods (Parts 34.4 and 34.5) and conducted testing to evaluate the repeatability and equivalency of the methods. 86 FR 71710, 71737–71738. DOE conducted a series of efficiency tests for a test sample that included seven air-over motor models spanning a range of 0.25 to 20 hp and represented both single-phase and polyphase motors. DOE observed the percentage difference in losses between Parts 34.5 and 34.4 range from −0.4 (on the lower end) to +10.9 (on the higher end), and the units at the higher end of the percentage difference spanned a wide range of hp ratings. These units included both single-phase and polyphase motor types, indicating no clear or consistent trend that could be used to define criteria by which the two methods would produce equivalent results. As such, DOE found that the two test methods could not be considered equal. *Id.*

To determine which of the two test methods (Part 34.4 or 34.5) to propose for air-over electric motors, DOE tested a subset of the seven air-over motors to evaluate the repeatability of each test methods. 86 FR 71710, 71737. The test results indicated that for three units, Part 34.4 showed less variation between subsequent tests compared to the Part 34.5. However, for one unit, Part 34.4 test method showed greater variation than Part 34.5. Based on these results, DOE concluded that Part 34.4 may provide more repeatability than Part 34.5 for air-over motors. *Id.* As such, DOE proposed to require that air-over motors be tested only according to Part 34.4. *Id.*

Regarding the test method, CEMEP supported using Part 34.4 but recommended allowing the use of other methods present in NEMA Part 34, but offered no specific justification for its view. (CEMEP, No. 19 at p. 1) AI Group referred DOE to Australian standards that included efficiency requirements for air-over motors and what test procedure Australia uses to test these motors.[29] (AI Group, No. 25 at p. 3) AMCA supported the use of Section 34.4 as the test method for air-over motors only if the motor is: (1) induction, (2) constructed in a NEMA/IEC standard frame, and (3) the motor target temperature test is verified by means of the winding resistance method or a temperature detector closely

[29] The Australian test method includes a requirement for an externally- and independently-generated air-steam, similar to Parts 34.3 and 34.4. *https://www.legislation.gov.au/Details/F2019L00968.*

coupled to the stator winding. (AMCA, No. 21 at p. 3) ebm-papst agreed with AMCA that the scope of the air-over test procedure should be limited to induction motors built in standard NEMA/IEC frames. (ebm-papst, No. 23 at p. 5)

The CA IOUs stated that they conducted testing on the proposed air-over test method and reported their preliminary findings as follows: (1) NEMA MG 1 Parts 34.4 and 34.5 appear to be repeatable, (2) some totally enclosed air-over (TEAO) motors stabilize before the target temperature is reached, suggesting the need for modifications to the test procedure for those motors, (3) manufacturer-specified airflow differs across different designs, with some having no specification, and (4) TEAO motor designs have varying responses to airflow and varying relationships to measured efficiency and target winding temperature. Relying on their preliminary test data, the CA IOUs agreed with DOE's initial finding that Part 34.4 meets DOE's test procedure requirements for repeatability and supported the use of Part 34.4 for rating TEAO motors. However, the CA IOUs also suggested an approach that they anticipated would significantly increase the representativeness of the test procedure for a broader range of field applications (which are discussed in section III.D.1.b) (CA IOUs, No. 32.1 at pp. 10–11)

Advanced Energy stated that the air-over test method has proven to be repeatable and reliable. Advanced Energy also supported the conclusion that Part 34.4 of NEMA Part 34 is more repeatable than Part 34.5 for air-over electric motors. It commented that boths Part 34.4 and 34.5 are repeatable but that the data presented by DOE suggest Part 34.4 is more repeatable. (Advanced Energy, No. 33 at pp. 2, 8–9) Further, Advanced Energy stated it has tested air-over motors up to 20 hp and has not found blower capacity to be a limiting factor. It stated that if its testing were limited by the blower, a larger blower could be used to permit the test to be conducted according to the test procedure. (Advanced Energy, No. 33 at p. 9)

NEMA disagreed with the December 2021 NOPR's conclusion that Part 34.4 is less repeatable than Part 34.5. NEMA further noted that the methods in Part 34.4 and Part 34.5 are useful depending on in-situ factors and should both remain available as needed. NEMA commented that a fair assessment of repeatability required understanding the potential sources of variations in test results. NEMA suggested certain potential sources of error to investigate for discrepancies, specifically: power meter capability, temperature measurement, torque acquisition, tachometer, and torque transducer capability. (NEMA, No. 26 at pp. 13–14) NEMA recommended that air-over motors be tested in accordance with any of the three test methods in Part 34, without exception and modification, and provided reasoning why Part 34.3 and Part 34.5 test methods should also be allowed: (1) for Part 34.3, NEMA noted that motor manufacturers are approached by OEMs to develop a motor with application specific fit, form, and function constraints, and motor design and development is frequently performed as a system approach and includes the motor, the OEM's fan, baffles, support structure and ducting. Accordingly, it commented that reproducing system operating conditions of airflow and temperature while coupled to a dynamometer is the most desirable case for determining motor efficiency; (2) for Part 34.5, it stated that not all laboratories have the equipment and resources to design a blower system and measure the airflow while the motor is coupled to a dynamometer, and therefore a test without airflow is an effective test method in these cases. NEMA did not directly comment on the accuracy and equivalency of the test methods, asserting simply (without offering more) that there is a significant risk that an equivalent test procedure option could be rejected for inclusion in the electric motor test procedure if feedback is submitted based on data comprised of unexplained test error. (NEMA, No. 26 at pp. 13–15) Lennox stated that a generic component-level test method would not yield results that are representative of an average use cycle for definite purpose motors because a component-level test procedure would fail to capture system operating characteristics that affect motor efficiency. Lennox also identified relevant system operating characteristics—*e.g.,* motor mounting, motor tuning, and how the air moving systems relate to the heat exchanging equipment—as variables that factor into the system efficiency of the finished product. (Lennox, No. 24 at p. 3)

DOE notes that neither NEMA nor CEMEP provided data supporting equivalency of the three test methods in Part 34. The CA IOUs also did not provide the data underlying their preliminary findings. Absent data other than that generated by the DOE testing, DOE is unable to conclude that Parts 34.4 and 34.5 are equivalent.

DOE understands that the different test methods in Part 34 may be useful depending on in-situ factors. However, this test procedure rulemaking focuses solely on the electric motor independent of the product or equipment into which the electric motor may be installed. This focus necessarily means that DOE must consider a test method that is repeatable for the electric motor as stand-alone equipment. As noted, Part 34.3 allows testing with an external airflow according to the customer, which could result in testing the same motor at different winding temperature during the test, which would impact the measurement of efficiency. With regard to Parts 34.4 and 34.5, testing performed as part of the December 2021 NOPR indicated that they did not provide equivalent results. Further, DOE has not received any new test data that indicates the three test methods in Part 34 are equivalent. Accordingly, at this time DOE cannot conclude that the three test methods in Part 34 are equivalent. Therefore, in this final rule, DOE is adopting Part 34.4 as the only test method for air-over electric motors.

b. Target Temperature Specification

Part 34.4 specifies that, if a motor temperature rise is not indicated, polyphase air-over electric motors use a target temperature that depends on the motor's insulation class. This target temperature is then used as the temperature at which the load test is conducted. In contrast, for all single-phase motors, the target temperature is specified at 75 °C, regardless of insulation class. In the December 2021 NOPR, DOE reported that it conducted testing to understand how much the temperature target could affect measured efficiency. 86 FR 71710, 71738. That testing demonstrated different measurements of efficiency at different test temperatures, and therefore, DOE tentatively concluded that defining a single test temperature, rather than using a target temperature that depends on the motor's insulation class, would produce measured efficiency values that are more comparable across insulation classes. Accordingly, DOE proposed to use a single target temperature for polyphase motors regardless of insulation class. 86 FR 71710, 71738–71739.

In response, the Joint Advocates opposed a single target temperature for all air-over motors and asserted that this single target temperature could give a testing advantage to motors that are designed to run hotter than the target temperature. (Joint Advocates, No. 27 at p. 3) AMCA stated that testing a motor of an insulation class higher than insulation class A (a 75 °C limit) at a target temperature of 75 °C would result in lower I^2R losses than when the motor is used as intended. (AMCA, No. 21 at p. 3) CEMEP stated that a fixed temperature target would penalize or reward certain motors depending on the temperatures at which they were designed to operate. (CEMEP, No. 19 at pp. 4–5) ebm-papst commented that higher temperatures lead to higher losses in the stator, rotor, and other current-carrying components of the motor. (ebm-papst, No. 23 at p. 5) ebm-papst also stated that many definite purpose motors would stabilize under the 75 °C target temperature and would be unable to use the proposed test procedure. (ebm-papst, No. 23 at pp. 6)

NEMA disagreed with modifying Section 34.4 to have a single target temperature of 75 °C, regardless of insulation class. It commented that although the proposal indicated that the single target temperature would apply to all motors even if the temperature rise is indicated, the proposed updates to the regulatory text in section 2.2.1 of appendix B appear to only apply to motors without an indicated temperature rise.[30] NEMA commented that if a manufacturer does not want its motor to be tested at the upper bounds of its insulation class, then all the manufacturer has to do is indicate the temperature rise. NEMA suggested that DOE adopt Section 34.4 without modification. In support, NEMA provided data from a motor performance simulation that predicted the required airflow for different target temperatures. In cases where a motor is designed to have a higher temperature rise than the 75 °C target, NEMA stated that the motor could need an unfeasibly large amount of airflow to get to the temperature to the proposed 75 °C target. (NEMA, No. 26 at pp. 12–15) It explained that in situations where the motor temperature rise under testing is significantly higher than the motor temperature rise in the actual application, the efficiency test would be biased towards higher losses and lower efficiency than the intended application. NEMA recommended that a manufacturer in that situation should simply indicate the motor temperature rise. (NEMA, No. 26 at p. 12) Separately, NEMA also noted that a default 75 °C condition could be specified for cases where a manufacturer does not indicate motor temperature rise, although NEMA still preferred that the test procedure in Part 34.4 be followed without modification. (NEMA, No. 26 at p. 15)

AHAM and AHRI disagreed that a single temperature should be used to test air-over motors, due to potential impracticalities of test setup. For example, AHAM and AHRI stated that some motors may not reach 75°C during normal operation at the intended load and that air-over motors constructed with open enclosures may incorporate an internal cooling fan and operate continuously at rated load with a total temperature less than 75 °C. They stated that one reason an open motor with self-ventilation may be applied to an air over application is because the hub diameter of the fan may prevent sufficient air velocity from flowing over the surface of the motor and that temperature rises of 20 °C to 40 °C are not uncommon for small motors with open enclosures. They cited this as an example where thermally stabilizing the motor at 75 °C would result in a full-load operating temperature that is greater than the full-load operating temperature of the motor while it is operating in its intended air-over application. (AHAM and AHRI, No. 36 at p. 9)

Lennox did not support the single target temperature and stated that the operating temperature of motors used in HVAC applications vary widely. It also commented that air-over motors can be designed to stabilize below the proposed target temperature. (Lennox, No. 24 at p. 8) Trane commented that testing motors without their associated appliance is not beneficial to the end-user or the appliance manufacturer. To this end, Trane provided performance data showing that efficiency varied with horsepower and operating temperature for a given motor and stated that the test conditions need to reflect the operating conditions within the appliance. (Trane, No. 31 at p. 2)

The CA IOUs suggested using two target temperatures and taking the average efficiency of the two temperatures to be the most representative of field use. They commented that certain TEFC-like and TENV-like TEAO motors may be capable of thermally stabilizing below the rated insulation class temperature without added airflow, suggesting the need for a TEAO custom testing approach that can address temperature stabilization issues. Accordingly, they suggested a two-target temperature approach in which the first temperature would be the temperature at which the motor stabilizes if less than 75 °C, or 75 °C if the motor stabilizes above that, and the second would be the insulation class target temperature. They stated that if the motor stabilizes below 75 °C, that is the measured efficiency; if above, the measured efficiency would be the average of the 75 °C and insulation class target. They provided data regarding how varied manufacturer specified airflow is, and stated that the minimum airflows would stabilize the motors at much lower temperatures than the required 75 °C. They also provided data regarding winding temperature response vs. applied airflow for three different air-over motors. (CA IOUs, No. 32.1 at pp. 11–15)

Advanced Energy supported the 75 °C target temperature for air-over electric motors. (Advanced Energy, No. 33 at p. 8) Advanced Energy also stated that many air-over motors they have tested have stabilized below the 75 °C target temperature, and that when this occurs, the motor should be treated as a totally enclosed, non-ventilated (''TENV'') motor since it does not need air from an external source to stabilize. (Advanced Energy, No. 33 at p. 9)

In considering the comments received, in this final rule, DOE is specifying a single target temperature requirement for polyphase motors that do not indicate a specified temperature rise. DOE understands that the indicated motor insulation class does not correlate to the intended target temperature and is adopting its proposed modification to Section 34.4. As discussed in the December 2021 NOPR, DOE understands that if a particular motor that was designed with a higher temperature insulation class than a second motor, that fact does not necessarily mean that the first motor would operate or is designed to operate at a higher temperature than the second motor; instead it means that the first motor is capable of running at the higher temperature associated with its insulation class. 86 FR 71710, 71736. Therefore, determining target temperature based on insulation class when motor temperature rise is not indicated would not necessarily be the most representative of motor operation.

As adopted in this final rule, the test procedure specifies the use of motor temperature rise if it is indicated in terms of insulation class (*i.e.,* the temperature rise being defined in terms of an insulation class) or numerical value (*i.e.,* the actual temperature rise), as specified in Sections 34.4.1.b and 34.4.1.c of NEMA MG 1–2016. For units for which the motor temperature rise is not otherwise indicated (*i.e.,* in Section 34.4.1.a.1 of NEMA MG 1–2016), DOE is requiring a target temperature of 75 °C for both polyphase and single-phase

[30] In the December 2021 NOPR, the proposed section 2.2.1 of appendix B stated ''the provisions in Paragraph 34.4.1.a.1 NEMA MG 1–2016 (with 2018 Supplements) related to the determination of the target temperature for polyphase motors must be replaced by a single target temperature of 75 °C for all insulation classes.'' 86 FR 71710, 71780. However, Paragraph 34.4.1.a.1 NEMA MG 1–2016 (with 2018 Supplements) is a method for determining target temperature only if a motor temperature rise is not otherwise indicated.

electric motors, as proposed in the December 2021 NOPR.

In section III.B.4 of this document, DOE discussed that in-scope air-over electric motors are those that reach thermal equilibrium during a rated load test according to section 2 of appendix B, and with the application of forced cooling by a free flow of air from an external device. Therefore, any motor not meeting these criteria would not meet the air-over electric motor definition as finalized in this final rule. If a motor can thermally stabilize during a load test below the target temperature (whether it be based on motor temperature rise if it is indicated in terms of insulation class, numerical value; or whether it be based on 75 °C when motor temperature rise is not indicated) without applying forced cooling by a free flow of air from an external device, then it would not be an in-scope air-over electric motor. DOE notes that Section 34.4.1.c of NEMA MG 1–2016 provides that if a motor temperature rise is indicated as a numerical value, then the target temperature for the test is the sum of that temperature rise and the reference ambient temperature of 25°C, which can be less than 75 °C.

As such, DOE's approach for the test procedure is consistent with NEMA MG 1–2016, except for polyphase motors that do not indicate a specified temperature rise. Otherwise, allowing the use of manufacturer indicated temperature rise, as required by NEMA MG 1–2016, maintains current industry requirements and is the most representative because the manufacturer indicated temperature rise generally reflects motor operation in the field. While DOE acknowledges the CA IOUs two-temperature approach, DOE cannot currently determine that this approach is more representative than what industry has developed as part of NEMA MG 1–2016. In addition, as presented in this final rule, DOE is not requiring testing at the same target temperature for all air-over electric motors, regardless of manufacturer indicated temperature rise. As previously discussed, one of the CA IOUs' main concerns was that testing at one target temperature would not credit motors with efficient heat shedding designs. To avoid this potential problem, this final rule specifies that the requirement to use a single target temperature of 75 °C only applies to air-over motors that do not have a specified temperature rise and that if the temperature rise is specified on the motor, such temperature rise will be used to determine the target temperature.

2. Test Procedures for SNEMs

In the December 2021 NOPR, DOE proposed to require testing of SNEMs (other than inverter-only, and air-over electric motors) according to the industry test methods identified in Table III–6 of this document. 86 FR 71710, 71739.

TABLE III–6—ADDITIONAL INDUSTRY TEST STANDARDS PROPOSED IN THE DECEMBER 2021 NOPR FOR INCORPORATION BY REFERENCE FOR SNEMS

Topology	Industry test standard incorporated by reference
Single-phase	IEEE 114–2010, CSA C747–09, IEC 60034–2–1:2014.
Polyphase with rated horsepower less than 1 horsepower	IEEE 112–2017, CSA C747–09, IEC 60034–2–1:2014.
Polyphase with rated horsepower equal to or greater than 1 horsepower.	IEEE 112–2017, CSA C390–10, IEC 60034–2–1:2014.

DOE initially determined that polyphase motors at or above 1 hp can be tested with the same methods as would be applicable to electric motors currently subject to the DOE test procedure (*i.e.,* IEEE 112–2017, CSA C390–10, and IEC 60034–2–1:2014). See section 2 of appendix B. The referenced industry standards applicable to electric motors are also consistent with those referenced for small electric motors that are for polyphase motors greater than 1 hp. 10 CFR 431.444(b). For SNEMs that are polyphase motors with a horsepower less than 1 hp and for SNEMs that are single-phase motors, DOE initially determined that, consistent with the DOE test method established for regulated small electric motors (which also include polyphase motors with rated motor horsepower less than 1 hp and single-phase motors), IEEE 114–2010, CSA C747–09 and IEC 60034–2–1:2014 are appropriate test procedures for SNEMs. Additionally, DOE notes that Section 12.58.1 of NEMA MG 1–2016 also lists IEEE 114 and CSA C747 as the selected industry standards for measuring and determining the efficiency of polyphase motors below with a horsepower less than 1 hp and single-phase motors. 86 FR 71710, 71739.

The CA IOUs agreed with the proposed test methods and suggested that industry-accepted test methods exist for the SNEM topologies. (CA IOUs, No. 32.1 at p. 43) CEMEP stated that single-phase motors should be tested using a ''direct measurement'' according to IEC 60034–2–1, CSA 747, or IEEE 114 and that polyphase motors should be tested using a separation of losses method according to IEC 60034–2–1, CSA C390, IEEE 112. (CEMEP, No. 19 at p. 5) Grundfos agreed with the test methods proposed for SNEMs. (Grundfos, No. 29 at p. 5) Grundfos also separately recommended breaking this large category of motors down into smaller subcategories to make testing requirements clearer. (*e.g.,* single-phase, 2-digit NEMA (excluding 56) fractional motors). (Grundfos, No. 29 at p. 2). Advanced Energy agreed with the prescribed test methods DOE proposed for SNEMs and stated that these methods are consistent with the many tests it has conducted on these motors. (Advanced Energy, No. 33 at p. 10)

NEMA stated that single-phase motors should not be tested with the summation of losses method, and instead should use a direct output/input power measurement. It provided data of a 10 hp single-phase motor tested 30 times that indicated how the range and average efficiency measured was different for the two test types. NEMA also cited a 2009 paper published by Advanced Energy comparing the differences in measured efficiency produced by the direct vs. indirect methods.[31] In the paper, Advanced Energy found that the direct method would vary in measured efficiency within a range of 1.26 percent points higher or 1.86 percent points lower compared to the indirect method and is too large of a difference for reporting purposes.[32] NEMA stated that results

[31] DOE notes that the cited paper analyzed polyphase induction motors and did not focus on single-phase motors.

[32] E.B. Agamloh, ''A Comparison of direct and indirect measurement of induction motor efficiency,'' 2009 IEEE International Electric Machines and Drives Conference, 2009, pp. 36–42, doi: 10.1109/IEMDC.2009.5075180. Available at: *ieeexplore.ieee.org/document/5075180* (last accessed on 6/29/22).

obtained from the direct method should have different loss tolerances applied from those measured through the indirect method. NEMA also stated that single-phase motors should be removed from this rulemaking and given its own, separate rulemaking. (NEMA, No. 26 at pp. 8–9)

The December 2021 NOPR proposed the following test methods for single-phase SNEMs: IEEE 114–2010, CSA C747–09, and Method 2–1–1A of IEC 60034–2–1:2014. 86 FR 71710, 71739. These test methods are consistent with those currently applicable to single-phase small electric motors in 10 CFR 431.444(b)(2). All of the proposed test methods for single-phase SNEMs are direct output/input power measurement test methods. Specifically, the test methods require determining efficiency as follows: (1) Section 8.2 of IEEE 114–2010 states, ''A determination of efficiency is based on measurements of input power and output power. Efficiency is calculated as the ratio of the measured output power to the corrected input power, where the measured input power is corrected for ambient temperature;'' (2) Section 6.10 of CSA C747–09 requires efficiency to be calculated using direct measurements of input power torque and speed; and (3) Method 2–1–1A of IEC 60034–2–1:2014 is titled as the ''direct measurement of input and output.'' Comments provided by the CA IOUs (CA IOUs, No. 32.1 at p. 43), and comments DOE received in response to the July 2009 small electric motors test procedure rulemaking,[33] also indicated that these test procedures rely on direct measurement of input and output. Given the support from interested parties and consistency with the test methods for SEMs, DOE concludes that the proposed test methods are relevant for single-phase SNEMs that are not air-over electric motors and not inverter-only electric motors and is therefore finalizing the proposed test methods in this final rule.

3. Test Procedures for AC Induction Inverter-Only Electric Motors and Synchronous Electric Motors

a. Test Method

In the December 2021 NOPR, DOE proposed test methods for various inverter-only electric motors and synchronous electric motors. These proposed test methods are presented in Table III–7 of this document. In addition, DOE proposed that for inverter-only electric motors sold without an inverter, testing would be performed using an inverter that is listed as recommended in the manufacturer's catalog. If more than one inverter is listed as recommended in the manufacturer's catalog or if more than one inverter is offered for sale with the electric motor, DOE noted that it would consider requiring that testing be performed using the least efficient inverter. 86 FR 71710, 71742.

TABLE III–7—TEST STANDARDS PROPOSED FOR INCORPORATION BY REFERENCE FOR SYNCHRONOUS ELECTRIC MOTORS AND AC INDUCTION INVERTER-ONLY MOTORS

Motor configuration	Equipment tested	Industry test standard incorporated by reference
Synchronous motors that are direct-on-line or inverter-capable	Motor	IEC 60034–2–1:2014.
Synchronous or AC Induction Inverter-only	Motor + Inverter	IEC 61800–9–2:2017.

In response to this proposal, both CEMEP and AI Group stated that IEC 60034–2–3 is the correct test procedure for inverter-only motors sold without an inverter and IEC 61800–9–2 is the correct procedure if the motor is sold with an inverter. (CEMEP, No. 19 at p. 6; AI Group, No. 25 at p. 5)

Advanced Energy supported testing synchronous motors according to IEC 60034–2–1 and IEC 61800–9–2. It stated that in the case of switched reluctance inverter-only motors, it would be difficult to measure only the motor's efficiency, because measuring the power input to the motor is not straightforward. Accordingly, for such motors, Advanced Energy stated that they supply system efficiency only for the motor drive system and not a separate motor efficiency and inverter efficiency. (Advanced Energy, No. 33 at pp. 10–11) Advanced Energy also stated that DOE should designate the motor wire to be used when testing inverter-only or inverter-capable motors with inverters unless the manufacturer documentation states differently. With regard to this point, it provided the wire requirements of AHRI 1210 Section 5.1.6. (Advanced Energy, No. 33 at pp. 11–13) Advanced Energy also stated that an inverter-only motor should be allowed to be certified with any of the recommended inverters listed in the manufacturer catalog and that different inverters will produce different measured efficiencies when paired with a motor. It commented that the settings of the inverter could influence measured efficiency, and that these values should be specified either directly or through reference to an industry standard. To this end, it provided the settings listed in AHRI 1210 Section 5.1.5. (Advanced Energy, No. 33 at p. 12)

For inverter-only electric motors, NEEA/NWPCC agreed with DOE that these motors should be tested using IEC 61800–9–2:2017, and for inverter-only motors that do not include an inverter, testing must be conducted using an inverter as recommended in the manufacturer's catalogs or that is offered for sale with the electric motor. For inverter-only motors that do not include an inverter, NEEA/NWPCC recommended that the efficiency should include the losses of an inverter. NEEA/NWPCC commented that if the inverter losses are not accounted for, this would create an unlevel playing field when compared to inverter-only motors sold with an inverter (*e.g.,* ECMs). NEEA/NWPCC commented that they do not recommend adding ''Reference Complete Drive Module (RCDM)'' losses as laid out in IEC 61800–9–2:2017, because these losses are not well aligned with actual inverter losses. NEEA/NWPCC recommended that such equipment be tested and rated using an inverter recommended by the manufacturer or that DOE develop its own default losses that are more representative of equipment currently available on the market. (NEEA/NWPCC, No. 37 at p. 6) Grundfos further stated that these equipment should require ratings that reflect the inverter and motor efficiency. (Grundfos, No. 29 at p. 2)

For inverter-capable electric motors, NEEA/NWPCC recommended that they be tested with IEC 61800–9–2 instead of DOE's proposed IEC 60034–2–1. They

[33] See comments from Advanced Energy and NEEA in the small electric motor test procedure final rule published on July 7, 2009. 74 FR 32059, 32065.

commented that IEC 60034–2–1 does not account for harmonic losses that are present when motors are supplied by inverters. By testing to IEC 60034–2–1 and not including the harmonic losses, this approach would create an unlevel playing field for inverter-capable motors that compete with inverter-only motors. NEEA/NWPCC commented that when a consumer is in the market for a variable-speed motor, it can choose to purchase either inverter-capable or inverter-only motors. NEEA/NWPCC stated that if all inverter-capable motors appear to have a higher efficiency because of a difference in test procedure, the consumer would be more likely to choose that motor over a lower-rated inverter-only motor. They contended that if inverter-only motors are not rated or rated with a different metric, end users will not be able to evaluate them equitably. Accordingly, NEEA/NWPCC recommended that both inverter-only and inverter-capable motors should be tested and rated with the same test procedure. (NEEA/NWPCC, No. 37 at pp. 3; 7)

ebm-papst stated that switched-reluctance motors are not in the scope of IEC 61800–9–2, and suggested that wire-to-shaft testing of these motors requires a combination of two standards: IEC 60034–2–3 to measure shaft output and IEC 61800–9–2 to measure converter input. (ebm-papst, No. 23 at p. 3)

NEMA stated that IEC 60034–2–3 is the correct test procedure for all inverter motors, but that it is not structured for use in testing for energy conservation standards. It stated that IEC 61800–9–2 is for complete drive modules, a factor that led NEMA to suggest that DOE conduct a separate rulemaking because of the unique rules and definitions needed for these motors. NEMA stated that aspects needing additional consideration are: inverter switching frequency, cable distance between motor and inverter, voltage ramp and boost settings, inverter capacitance values, and inverter control. (NEMA, No. 26 at p. 17)

IEC 61800–9–2:2017 specifies test methods for determining inverter (or complete drive module, ''CDM'')[34] and motor-inverter combination (*i.e.,* power-driven system or ''PDS'') losses.[35] Using this test method, the motor is tested with its inverter (either integrated or non-integrated), and the measured losses includes the losses of the motor and of the inverter. Inverter-capable electric motors subject to the current test procedures are currently required to be tested without the use of an inverter, and rely on the test set-ups used when testing a general purpose electric motor. *See* 78 FR 75962, 75972. DOE is not adopting to change the test procedure for currently regulated induction inverter- capable electric motors. The approach for testing inverter-capable synchronous electric motors without the use of an inverter therefore aligns with the existing method for induction inverter-capable electric motors.

Further, DOE understands that many general purpose induction motors are rated as inverter-capable but are more commonly operated as direct-on-line motors (*i.e.,* without an inverter), and as such, the results of testing without an inverter would be more representative. Additionally, because inverter-capable motors are more commonly operated direct-on-line, such electric motors would more closely compete with typical induction electric motors rather than inverter-only electric motors. DOE further notes that not including the inverter when testing inverter-capable motors is consistent with how the efficiency classification of inverter-capable motors is established in accordance with IEC 60034–30–1:2014. Accordingly, DOE is requiring inverter-capable synchronous electric motors to be tested without the use of an inverter.

Regarding NEMA's comment that additional definitions are needed for inverter-only motor testing and Advanced Energy's comment that the inverter settings should be further specified, DOE reviewed Section 5.1.5 ''Drive Settings'' of AHRI Standard 1210 (I–P):2019 and considered if new definitions were required. Section 5.1.5 specifies that the VFD [referred to in this document as an inverter] shall be set up according to the manufacturer's instructional and operational manual included with the product specifies that manufacturers must provide a parameter set-up summary that at least includes the: (1) carrier switching frequency, (2) max frequency, (3) max output voltage, (4) motor control method, (5) load profile setting, and (6) saving energy mode (if used). DOE notes that testing at the manufacturer's recommended operating conditions would be consistent with how other input values for electric motors are treated in the test procedure, like rated voltage. Accordingly, in this final rule, DOE specifies inverter set-up requirements consistent with Section 5.1.5 of AHRI 1210 (I–P):2019.

To address those comments claiming that switched-reluctance motors do not fall within the scope of IEC 61800–9–2, DOE reviewed this testing standard and how switched-reluctance motors operate. These motors do not use a permanent magnet rotor and the rotor itself does not carry a current. Torque is generated by making use of the different values of reluctance[36] the rotor will have in different positions. The rotor will attempt to orient itself to give the magnetic flux a path of least reluctance through the rotor while the current in each stator pole is switched to create a continuous rotation in the rotor. While these motors are similar to synchronous reluctance motors in how they generate torque, the two main differences in their construction are how the stators are built and how the inverter supplies current to the motor. Synchronous reluctance stators are built in a way that resembles an induction motor stator whereas a switched-reluctance motor has a concentrated winding for each stator tooth. The inverters used for switched-reluctance motors have to be built to handle higher phase currents (for a given horsepower output) compared to an inverter used for a synchronous reluctance motor. DOE also reviewed the scope of IEC 61800–9–2 and notes that Section 1 of that testing standard states that the standard includes methods for determining the losses of the PDS (*i.e.,* motor and inverter combination) and does not limit its application to specific motor topologies. DOE also notes that the input-output method described in Section 7.7.2 requires measuring the electrical input to the PDS and the mechanical output of the PDS, both of which would be feasible when evaluating switched-reluctance motors. Accordingly in this final rule, as proposed in the December 2021 NOPR, DOE is specifying that Section 7.7.2 of IEC 61800–9–2 is the test method to be used to determine the efficiency of all synchronous and inverter-only electric motors.

[34] IEC 61800–9–2:2017 defines a CDM, or drive, or drive controller as a ''drive module consisting of the electronic power converter connected between the electric supply and a motor as well as extension such as protection devices, transformers and auxiliaries.''

[35] IEC 61800–9–2:2017 also provides a mathematical model to determine the losses of a reference CDM, reference motor and reference PDS which are then used as the basis for comparing other CDMs, motors, and PDSs and establishing efficiency classes (IES classes). PDS shall be classified as ''IES 0'' if its losses are more than 20 percent higher than the value specified for a reference PDS. *See* Section 6.4 of IEC 61800–9–2:2017.

[36] Reluctance is the resistance to magnetic flux in a given magnetic circuit. In electric motors, the motor contains a magnetic circuit where the flux flows to and from the stator poles through the rotor.

b. Comparable Converter

In the 2021 December NOPR, DOE proposed to require testing inverter-only synchronous electric motors that include an inverter, and inverter-only AC induction motors that include an inverter, in accordance with Section 7.7.2 of IEC 61800–9–2:2017, and using the test provisions specified in Section 7.7.3.5 and testing conditions specified in Section 7.10 of that same testing standard. DOE proposed to test inverter-only synchronous electric motors that do not include an inverter, and AC induction inverter-only motors that do not include an inverter, in accordance with IEC 61800–9–2:2017 [37] and to specify that testing must be performed using an inverter as recommended in the manufacturer's catalogs or offered for sale with the electric motor. If more than one inverter is available in manufacturer's catalogs or offered for sale with the electric motor, DOE considered requiring that testing occur using the least efficient inverter. 86 FR 71710, 71742. DOE further requested feedback in the December 2021 NOPR on how to test an inverter-only motor that is sold without an inverter, and on whether DOE should consider testing these motors using a comparable converter as specified in Section 5.2.2. of IEC 60034–2–3:2020. 86 FR 71710, 71742–71743.

In response, the CA IOUs recommended that DOE develop a method for testing an inseparable PDS (*i.e.,* motor and inverter combinations) as a paired unit. Since the PDS is inseparable, the CA IOUs noted that such an approach would be appropriate for a PDS unlikely to be distributed in commerce with other CDM drive (*i.e.,* inverter) components and suggested IEC 61800–9–2 as a starting point for testing these motors. The CA IOUs also commented that DOE should specify a ''comparable inverter'' for testing inverter-only motors that are distributed in commerce for use with various CDMs, including motors paired with a drive on-site. The CA IOUs suggested IEC 61800–9–2 as a starting point for this approach as well. (CA IOUs, No. 32.1 at p. 38) The CA IOUs recommended testing with a ''comparable inverter'' for products sold without a paired drive module, and that this comparable inverter be evaluated in each rulemaking to keep up with advancing drive technology. They cautioned that applying IEC 61800–9–2 to a ''comparable inverter'' for current products is challenging because of what they described as the high reference inverter losses used by the standard to calculate the losses of a minimum-performance inverter. The CA IOUs provided data that they stated show how IE 0, the least efficient class of inverters defined by IEC 61800–9–2, is estimated to yield significantly higher losses than any inverter they found on the market and that the inverter efficiency classes in IEC 61800–9–2 were developed before the adoption of Silicon Carbide converters. The CA IOUs asserted that the disparity between reference losses and real-world converter losses is even greater for smaller output drives (<7.5 kW output) and noted that these drives make up two-thirds of the low-voltage drive market. They suggested that DOE work with the project managers of a study currently being conducted on inverter efficiency, and to use the data provided from that study to inform how DOE considers inverter losses in the test procedure. (CA IOUs, No. 32.1 at pp. 36–37) The CA IOUs also recommended that DOE follow the IEC's test procedure framework for inverter-only motors and drives. (CA IOUs, No. 32.1 at p. 33)

Advanced Energy stated that it would be beneficial if DOE provided guidance on what inverter to use for testing if an inverter is not recommended in a manufacturer's catalog, and it suggested the use of a ''comparable converter'' according to IEC 60034–2–3 in this case. (Advanced Energy, No. 33 at p. 10)

NEMA opposes the use of a reference converter during testing. NEMA stated that the only way a fair test could be conducted on an inverter-only motor is to use the exact inverter specified by the manufacturer, and that a reference inverter that was ''close'' would incur a heavy risk of having the motor test as less efficient than it would with the intended inverter. (NEMA, No. 26 at p. 18) Grundfos stated that a ''comparable inverter'' as stated in IEC 60034–2–3:2020 should only be used when a manufacturer does not sell an inverter to go with the motor. (Grundfos, No. 29 at pp. 5–6) Trane commented that a ''comparable inverter'' would result in inaccurate representations of energy use and that testing the inverter and motor combinations separately provides no value to the appliance manufacturer or end user. (Trane, No. 31 at p. 6)

DOE notes that the test method proposed for inverter-only motors according to Section 7.7.2 of IEC 61800–9–2:2017 does not make use of inverter efficiency classes outlined in that document. Accordingly, DOE will not be addressing concerns about those efficiency classes. Regarding the CA IOUs comment suggesting the use of a ''comparable converter'' for inverter-only motors that have multiple CDMs (*i.e.,* inverters) recommended, DOE disagrees because the efficiency of the motor/inverter combination depends on the inverter chosen for selection and the ''comparable converter'' may not be one of manufacturer recommended inverters. To ensure the test results are representative of average use, one of the inverters recommended by the manufacturer should be the inverter used during the efficiency test since the motor is most likely to be paired with one of those inverters during field use.

In cases where no inverter is specified by the manufacturer to pair with an inverter-only motor, DOE still needs to choose an inverter to pair with the motor during the test. NEMA's concern regarding the use of a ''comparable converter'' does not apply because no inverter was specified for use with the motor, and Trane's concern does not apply because the motor and inverter are not tested separately. As such, DOE cannot at this time identify an option more representative of average use than the ''comparable converter'' in cases where no inverter is specified for use with an inverter-only motor.

After reviewing the comments submitted by stakeholders, DOE has decided to adopt the method proposed in the December 2021 NOPR for testing synchronous and AC induction inverter-only motors that include an inverter, in accordance with IEC 61800–9–2:2017. DOE is also adopting the methods proposed in the December 2021 NOPR for synchronous and AC induction inverter-only motors that do not include an inverter, and to specify must be tested in accordance with IEC 61800–9–2:2017 and to specify that testing must be performed using an inverter as recommended in the manufacturer's catalogs or offered for sale with the electric motor. In addition, DOE did not receive any comments on selecting the least efficient inverter. Under the approach taken in this final rule, if more than one inverter is listed as recommended in the manufacturer's catalog or if more than one inverter is offered for sale with the electric motor testing using the least efficient inverter will be required. DOE is requiring the use of ''the least efficient inverter'' to ensure consistent testing of inverter-only motors with multiple recommended inverters. DOE notes that the test specified in Section 7.7.2 of IEC 61800–9–2 is based on an input-output measurement and does not rely on

[37] Specifically, in accordance with Section 7.7.2 of IEC 61800–9–2:2017, and using the test provisions specified in Section 7.7.3.5 and testing conditions specified in Section 7.10. The proposed method corresponds to an input-output test of the motor and inverter combination.

''reference losses'' [38] in IEC 61800–9–2:2017 to characterize the inverter performance. Instead, the motor and inverter combination are tested using an input-output test.

In addition, to address the case where there are no inverters recommended in the manufacturer's catalogs or offered for sale with the electric motor, DOE is specifying the use of a ''comparable converter'' based on Section 5.2.2 of IEC 60034–2–3, and to require that the motor manufacturer specify the manufacturer, brand and model number of the inverter used for the test.

E. Metric

The represented value of nominal full-load efficiency is currently used to make representations of efficiency for electric motors subject to standards in subpart B of part 431, based on the average full-load efficiency as measured in accordance with the provisions at 10 CFR 431.17.

In the December 2021 NOPR, for electric motors subject to energy conservation standards at 10 CFR 431.25 (which are AC induction single-speed motors), DOE proposed to maintain the current use of the nominal full-load efficiency metric. For the additional electric motors proposed for inclusion within the scope of the test procedures, DOE also proposed to use the nominal full-load efficiency as the metric. DOE proposed to evaluate the efficiency of the motor with or without the inclusion of the inverter depending on the motor configuration: (1) for the additional non-inverter-only electric motors proposed for inclusion within the test procedure's scope (*i.e.,* direct-on-line or inverter-capable),[39] DOE proposed to determine the efficiency of the motor at full-load (*i.e.,* measure the full-load efficiency), consistent with how electric motors currently subject to standards at 10 CFR 431.25 are evaluated; (2) for the additional inverter-only electric motors proposed for inclusion within the test procedure's scope, DOE proposed to evaluate the efficiency of the motor and inverter combination at 100 percent rated speed and rated torque (*i.e.,* measure the full-load efficiency). In addition, DOE stated that it may consider requiring manufacturers to disclose the part-load performance efficiency of the additional motors proposed for inclusion within the scope of this test procedure as part of any future energy conservation standard related to these electric motors.[40] Finally, similar to currently regulated electric motors, for the additional electric motors proposed for inclusion, DOE proposed sampling requirements to calculate the average full-load efficiency of a basic model and provisions to determine a tested motor's nominal full-load efficiency. (*See* section III.N of this document). 86 FR 71710, 71743–71745.

CEMEP stated that an efficiency metric that includes both inverter and motor efficiency should not be used for inverter-only and inverter-capable electric motors sold without an inverter. In its view, the efficiency metric DOE adopts should reflect only the efficiency of the motor itself. (CEMEP, No. 19 at p. 7)

The scope of the current test procedure includes inverter-capable electric motors, which are tested without the use of an inverter.[41] DOE is not changing the current test procedure for inverter-capable motors, and continues to require testing these motors without the use of an inverter. Further, as discussed in section III.D.3 of this document, DOE is adopting an approach to test inverter-only motors inclusive of the inverter. Therefore, DOE is adopting a metric inclusive of the inverter efficiency for these motors. As stated in the December 2021 NOPR, because inverter-only motors require an inverter to operate, measuring the motor efficiency independent of the inverter would not be as representative of field performance as would measuring the combined motor and inverter efficiency. 86 FR 71710, 71743. In addition, some inverter-only motors are sold with an integrated [42] inverter such that measuring motor-only efficiency is not technically feasible.

In response to the December 2021 NOPR, Grundfos supported measuring motor efficiency at the proposed load points. (Grundfos, No. 29 at p. 6).

Several stakeholders opposed using a full-load metric, as discussed in the next paragraphs.

The Joint Advocates recommended that DOE amend the test procedure to incorporate efficiency at multiple load points to ensure a level playing field for manufacturers and to better inform purchasers. The Joint Advocates stated that while it is generally true that an AC induction electric motor with a tested full-load efficiency will have smaller losses than another electric motor with a lower tested full-load efficiency within its typical range of operation, many advanced motor technologies (*e.g.,* synchronous motors) included in the proposed expanded scope have loss profiles (*e.g.,* losses as a function of load) that deviate significantly from those of single-speed AC induction motors. In particular, the Joint Advocates stated that advanced motor technologies typically maintain higher efficiency at low loads and evaluating electric motor efficiency at a single load point is therefore not representative of real-world energy use and will not provide accurate relative rankings across different motor topologies. In addition, citing data from DOE's Motor Systems Market Assessment report,[43] the Joint Advocates also commented that motors operating in variable-load applications with an average load factor between 40 and 75 percent represent the largest portion of motor energy use, and that a metric that included part-load efficiency would be more representative.[44] (Joint Advocates, No. 27 at pp. 5–6)

With regard to inverter-only motors, the CA IOUs commented that DOE should incorporate a weighted part-load efficiency metric rather than using a full-load efficiency metric. The CA IOUs provided data from DOE's Motor Systems Market Assessment report and from the California Public Utilities Commission showing (in their view) that the majority of motors operate at variable-load.[45] The CA IOUs expressed concern that the proposed full-load metric for inverter-only motors would not meet DOE's statutory requirement that metrics be ''representative of average use.'' Instead, the CA IOUs recommended that DOE collaborate with industry stakeholders to develop a metric for inverter-only motors. The CA IOUs referenced other rules that have incorporated part-load metrics. (CA IOUs, No. 32.1 at pp. 2–3; 20–24) The CA IOUs also commented that the largest differences in performance

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[38] IEC 61800–9–2 provides references losses for inverters that can be used to calculate the combine motor and inverter efficiency based on a calculation-based method.

[39] These include air over electric motors, electric motors larger than 500 hp, certain SNEMs, and certain synchronous motors.

[40] DOE did not propose to require this in the December 2021 NOPR, as labelling requirements are typically not in the scope of the test procedure and included as part of energy conservation standards.

[41] The test methods described in section 2 of Appendix B to Subpart B do not require the use of an inverter.

[42] Integrated means that the drive and the motor are physically contained in a single unit.

[43] Rao, P., Sheaffer, P., Chen, Y., Goldberg, M., Jones, B., Cropp, J., and J. Hester. *U.S. Industrial and Commercial Motor System Market Assessment Report Volume 1: Characteristics of the Installed Base.* Lawrence Berkeley National Laboratory, January 2021, *https://eta-publications.lbl.gov/sites/default/files/u.s._industrial_and_commercial_motor_system_market_assessment_report_volume_1-_characteristics_of_the_installed_base_p_rao.pdf.*

[44] *Note:* the data provided by the Joint Advocates were in terms of relative energy consumption and not motor counts.

[45] *Note:* the data provided by the CA IOUs were in terms of relative energy consumption and not motor counts.

between synchronous inverter motors and induction inverter motors occur at low loads and that a full-load metric would not capture this difference. To illustrate this point, they provided efficiency curves for a 5 hp and a 20 hp permanent magnet inverter-only electric motor as well as for a 5 hp and 2 0hp induction electric motor, showing that the permanent magnet inverter-only motor had a higher efficiency than the induction electric motor, specifically at lower load. (CA IOUs, No. 32.1 at p. 25) The CA IOUs added that a full-load efficiency metric would not enable the comparison of inverter-only motors and induction motor/inverter combinations that have peak efficiencies at different operating speeds and different positions on the torque curve. The CA IOUs provided part-load efficiency data showing that different motor topologies of synchronous inverter-only motors (*e.g.,* synchronous reluctance motors, permanent magnet motors) and induction motor/inverter combinations each experienced increases in efficiency at different load regions. The CA IOUs explained that the selected load point would change the rank order of the motor performance of inverter-only motors (CA IOUs, No. 32.1 at pp. 26–28) To illustrate this point, the CA IOUs compared the efficiency rankings for a synchronous reluctance motor, a permanent magnet motor, and an induction motor/inverter combination in selected load-profiles, using part-load and full-load metrics. For the selected load-profiles in the example, the CA IOUs claimed that the weighted part load metrics provided a performance ranking that was more representative of the expected performance in the field and the CA IOUs recommended that DOE adopt a metric that can differentiate motors with peak efficiencies at different operating speeds and different positions on the torque curve. (CA IOUs, No. 32.1 at pp. 26–31)

NEMA agreed in concept with the proposed metrics except for synchronous and inverter-only motors—both of which NEMA opposes for inclusion as part of the test procedure's scope. NEMA commented that these motors are not intended to be operated at full-load. NEMA did not recommend alternate approaches to test the performance of these motors, but instead voiced its general opposition to their inclusion in the scope of the test procedure. NEMA added that inverter-only and synchronous motors lend themselves to be evaluated with system efficiency, rather than motor-only efficiency, and that inverter-only motors should be regulated in a separate rulemaking due to the complexity of their testing and applications. (NEMA, No. 26 at p. 19) NEMA stressed that the extended product rulemakings (commercial and industrial pumps, fans and compressors) are the appropriate path to energy savings and that component level regulation does not assure energy savings in the overall application. (NEMA, No. 26 at p. 4)

Regal opposed using a full-load efficiency metric for inverter-type motors and stated that this metric does not capture any of the value added by an inverter-only motor's higher efficiency at part-load conditions. (Regal, No. 28 at p. 1) Trane commented that measuring synchronous motors with a full-load only metric is not useful to the end-user nor applicable to the equipment in which the motor is installed. (Trane, No. 31 at p. 3) AHAM and AHRI were concerned with the use of a full-load metric for inverter-only and synchronous electric motors, which by definition are not intended to be operated at full-load. (AHAM and AHRI, No. 36 at p. 9)

NEEA/NWPCC recommended that DOE add representative load points and implement a weighted-average metric that accounts for performance at part-load. NEEA/NWPCC commented that a weighted metric that takes into account various load points will not be unduly burdensome and is essential to showing the actual performance of motors. NEEA/NWPCC cited data from DOE's Motor Systems Market Assessment report showing that the majority of motor-connected horsepower operates below 75 percent load, and commented that a test procedure that does not include load points below full-load is not representative an average period of use. (NEEA/NWPCC, No. 37 at pp. 4–6) NEEA/NWPCC added that while using full-load efficiency may have been adequate when considering induction electric motors only, many of the synchronous motor topologies claim to have flatter efficiency curves compared to induction motors: the motor maintains its efficiency at reduced loads or reduced speeds better than induction motors. NEEA/NWPCC commented that a test procedure that measures efficiency only at full-load would not capture the difference in performance of synchronous motors at lower loads compared to induction motors. In addition, NEEA/NWPCC noted that the majority of commercial and industrial motors are not operated at full-load and commented that a metric that does not include part-load points is not representative of an average period of use as required by EPCA. (NEEA/NWPCC, No. 37 at p. 8)

Currently regulated electric motors typically have flat efficiency profiles, *i.e.,* efficiency does not substantively vary based on the loading condition. The efficiency profile of smaller motors (less than one hp) is almost flat in the 40–100 percent load range, and the profile of larger motors (at or above 20 hp) is almost flat between 30–100 percent load.[46] DOE found that the estimates published in DOE's Motor Systems Market Assessment report for polyphase motors show that the majority of electric motors operate above the 40 percent loading point. The report also indicates that significantly underloaded motors (*i.e.,* those under a variable or constant load below a 0.4 loading factor) represent a small percentage of the installed base (4 percent).[47] A motor is considered underloaded when it is operated in the range where efficiency drops significantly with decreasing load. Therefore, DOE has determined that the majority of polyphase motors (which include regulated electric motors) operate in a range where efficiency is relatively flat as a function of load.

Further, DOE reviewed the data provided by the Joint Advocates and the CA IOUs indicating that electric motors primarily operate at variable-load. DOE notes that the estimates provided were based on a percentage of energy use or connected load and not motor counts (*i.e.,* number of motor units included in the sample). DOE believes motor counts are a better indicator when assessing representativeness because each individual motor basic model is certified regardless of its size or energy use. When using motor counts, the DOE Motor Systems Market Assessment report shows that in the industrial sector, constant load motors operating at motor load factors greater than 0.75 represent 43 percent of all industrial motor systems. Overall, in the industrial

[46] A. de Almeida, H. Falkner, J. Fong, *EuP Lot 30, Electric Motors and Drives. Task 3: Consumer Behaviour and Local Infrastructure.* ENER/C3/413–2010, at p.6, Final April 2014. Available at: *https://www.eceee.org/static/media/uploads/site-2/ecodesign/products/special-motors-not-covered-in-lot-11/eup-lot-30-task-3-april-2014.pdf.* DOE also analyzed published part-load efficiency data for regulated electric motors and found that on average, the efficiency at 50 percent load is 99 percent of the full-load efficiency, while the efficiency at 75 percent load is 1.004 percent of the full-load efficiency (average based on 7,199 units).

[47] *See: motors.lbl.gov/inventory/analyze/9–0713.*

sector, the report finds that there are nearly twice as many constant-load motors as variable-load motors.[48] In the commercial sector, the report states that variable-load motors operating at load factors between 0.4 and 0.75 represent 36 percent of all commercial sector motor systems, followed by constant load systems operating at motor load factors greater than 0.75, at 27 percent. Overall, in the commercial sector, the report states that constant-load motors represent 43 percent and variable-load motors represent 52 percent of electric motors (with 5 percent unknown). Across both sectors, the report shows that constant-load represents 44 percent of electric motors and variable-load represents 48 percent of electric motor systems (with 7 percent unknown).[49] Further, the estimated average load factor for motors between 1 and 500 hp ranges from approximately 0.52 to 0.68 depending on the motor horsepower.[50]

DOE has determined that currently regulated electric motors are used equally in both constant-load and variable-load applications and primarily operate in a range where efficiency is relatively flat as a function of load. For these reasons, DOE has determined that measuring the performance of these motors at full-load is representative of an average use cycle. In addition, given the variability in applications and load profiles, an average load profile may not be representative. For example, a constant torque load application cannot be represented using the load profile of a variable torque application. Further, currently regulated electric motors have internationally-harmonized efficiency test standards and efficiency classes (*e.g.,* IE3 and NEMA Premium classes)[51] and using a metric based on a weighted-average efficiency across different part-load points would be a departure from internationally harmonized practices without adding benefits in terms of better representation. As noted in the December 2021 NOPR, for motors that are not inverter-only, although the IEC 60034–2–1:2014 test standard includes testing at part-load, IEC 60034–30–1:2014 establishes efficiency classes (*e.g.,* IE3) based on the motor full-load efficiency. 86 FR 71710, 71744. In addition, rating these motors at full-load or part-load would not change the rank order by performance (*i.e.,* if motor A is better than B based on full-load efficiency, motor A will perform better than motor B in the field). For these reasons, in this final rule, DOE maintains the current nominal full-load efficiency metric for currently regulated motors. DOE may consider requiring manufacturers to display the part-load efficiency as part of any future energy conservation standard related to these electric motors.

For those additional motors that DOE is incorporating in the scope of the test procedure, which are not inverter-only, given that the operating load data from the DOE Motor Systems Market Assessment report apply to all polyphase motors above 1 horsepower, DOE determined that the findings discussed for regulated electric motors also apply to those additional in-scope polyphase electric motors that are not inverter-only and are above 1 horsepower (*i.e.,* polyphase air-over motors and electric motors larger than 500 hp). Therefore, for these electric motors, DOE is adopting the nominal full-load efficiency metric. Further, for synchronous motors that are not inverter-only (*i.e.* line-start permanent magnet motors), DOE found that the efficiency curve as a function of load is also flat in the typical motor operating range.[52] Therefore, DOE has determined that measuring the performance of these motors at full-load is representative of an average use cycle and DOE adopts the nominal full-load efficiency metric as proposed for synchronous motors that are not inverter-only.

Finally, for SNEMs that are not inverter-only (including air-over motors), DOE did not find data specific to SNEMs (the DOE Motor Systems Market Assessment report only considered polyphase motors above 1 horsepower). Assuming these motors operate at an average load between 0.66 and 0.67,[53] and considering the relatively flat efficiency curve in that range,[54] DOE believes a metric based on full-load efficiency is appropriate and representative of an average use cycle for these motors. In addition, rating these motors at full-load or part-load would not change the rank order by performance (*i.e.,* if motor A is better than B based on full-load efficiency, motor A will perform better than motor B in the field). Further, a metric based on full-load efficiency is consistent with the test method for small electric motors and would enable performance comparisons between SNEMs and SEMs.[55] For these reasons, DOE is adopting the nominal full-load efficiency metric as proposed. For the additional non-inverter-only motors that DOE is incorporating in the scope of the test procedure, DOE may consider requiring manufacturers to display the part-load efficiency as part of any future energy conservation standard related to these electric motors.

For inverter-only electric motors, DOE agrees that synchronous motors typically maintain a flatter efficiency at lower loads compared to inverter-only induction motors.[56] However, as previously discussed, very few electric motors operate at these lower loads (*i.e.,* below 40 percent). Instead, electric motors, including inverter-only electric motors, typically operate in a region where the efficiency is relatively flat. Therefore, although inverter-only motors operate at part-load, DOE has determined that a metric based on full-load efficiency is representative of an average energy use cycle. In addition, because inverter-only motors tend to also have flat efficiency curves above a 40 percent load, rating these motors at

[48] *See* pp. 76 and 81 of the DOE's Motor Systems Market Assessment report available at: *https://eta-publications.lbl.gov/sites/default/files/u.s._industrial_and_commercial_motor_system_market_assessment_report_volume_1-_characteristics_of_the_installed_base_p_rao.pdf.*

[49] *See: https://motors.lbl.gov/inventory/analyze/9–0713.*

[50] *See* pp. 78 and 83 of the DOE's Motor Systems Market Assessment report available at: *https://eta-publications.lbl.gov/sites/default/files/u.s._industrial_and_commercial_motor_system_market_assessment_report_volume_1-_characteristics_of_the_installed_base_p_rao.pdf.*

[51] An IE class is a table of full-load efficiency ratings provided at different motor rated power and poles. For example, the IE class ''IE3'' is considered largely equivalent to the current energy conservation standards in Table 5 at 10 CFR 431.25 or ''NEMA Premium.''

[52] *See* Arash Hassanpour Isfahani, Sadegh Vaez-Zadeh, Line start permanent magnet synchronous motors: Challenges and opportunities, Energy, Volume 34, Issue 11, 2009, Pages 1755–1763, ISSN 0360–5442, *https://www.sciencedirect.com/science/article/pii/S0360544209001303 and* A. T. De Almeida, F. J. T. E. Ferreira and A. Q. Duarte, ''Technical and Economical Considerations on Super High-Efficiency Three-Phase Motors,'' in IEEE Transactions on Industry Applications, vol. 50, no. 2, pp. 1274–1285, March–April 2014, doi: 10.1109/TIA.2013.2272548.

[53] This estimate is based on the average load factor for motors between 1 and 5 hp as provided in DOE's Motor Systems Market Assessment report. *See* pp. 78 and 83 of the DOE's Motor Systems Market Assessment report available at: *https://eta-publications.lbl.gov/sites/default/files/u.s._industrial_and_commercial_motor_system_market_assessment_report_volume_1-_characteristics_of_the_installed_base_p_rao.pdf.*

[54] DOE analyzed published part-load efficiency data for SNEMs and found that on average, the efficiency at 75 percent load is 97 percent of the full-load efficiency (average based on 2,585 units).

[55] DOE notes however that SEMs do not rely on nominal full-load efficiency values but rather on average full-load efficiency.

[56] DOE notes that in their comment, the CA IOUs provide an example which compares the efficiency of 5 and 20 hp synchronous permanent magnet motors with an inverter-only induction motor and variable frequency drive at loads between 12.5 and 50 percent. (CA IOUs, No. 32.1 at p. 29) While the example shows that the difference in efficiency between the synchronous permanent magnet motor with an inverter-only induction motor increases at load (below 40 percent) the example shows that this difference is relatively constant between a 40 and 50 percent load. *Id.*

full-load or part-load would not change the rank order by performance (*i.e.,* if motor A is better than B based on full-load efficiency, motor A will perform better than motor B in the field).[57] Further, as noted in the December 2021 NOPR, for inverter-only and inverter combination electric motors, although the IEC 61800–9–2:2017 test standard includes eight standardized test points, the IEC efficiency classification is based on the performance at a unique point at full-load (100 percent rated speed and 100 percent rated torque) and establishing a metric based on a weighted average load would be a departure from internationally harmonized practices without adding significant (if any) benefits in terms of better representation. 86 FR 71710, 71744. For these reasons, DOE is adopting the nominal full-load efficiency as the metric for inverter-only motors.

The Joint Advocates further commented that the current electric motors test procedure does not capture the energy saving benefits associated with speed control. The Joint Advocates commented that motors with controls may be at a disadvantage relative to single-speed AC induction motors since the energy usage of the inverter (*e.g.,* in a inverter-equipped inverter-only AC induction motor) would be included in the overall efficiency, while the benefits of the inverter (*e.g.,* speed reduction at part load) are not. The Joint Advocates stated that the test procedure should capture the benefits of speed control capability. (Joint Advocates, No. 27 at p. 6).

The CA IOUs recommended that DOE establish a metric for inverter-only motors that will capture the energy saving benefits of variable-speed control as these motors are most often used in variable load and variable torque applications. In addition, the CA IOUs noted that speed control can provide energy savings benefits in constant-load applications by matching the load to the motor output power to meet the requirements of the application instead of using throttling valves or dampers.

The CA IOUs commented that 90 percent of inverter-only motors are used in variable torque applications such as air compressors, pumps, fans and blowers. (CA IOUs, No. 32.1 at pp. 20–21)

NEEA/NWPCC also recommended that DOE adopt a metric that would capture the energy savings of speed control for all electric motors. NEEA/NWPCC noted that DOE already has several test procedures and metrics that have switched from full-load efficiency to more representative metrics[58] and recommended that a weighted-average input power metric be used for electric motors in line with the Pump Energy Index metric used for pumps and the recent Power Index Metric as described in a standard published by NEMA.[59] NEEA/NWPCC commented that a motor weighted-average input power metric would be calculated for both constant-speed motors and variable-speed motors (both inverter-capable and inverter-only) and suggested calculation methods and recommended weights at each recommended load point (*i.e.,* load profiles). NEEA/NWPCC stated that a weighted-average input power metric is more representative than a weighted-average efficiency metric because inverter-controlled motors will inherently have an ''efficiency'' loss at each independent load point but will generally use less energy overall. Therefore, NEEA/NWPCC asserted that using a weighted input power metric instead of efficiency will show the lower input power more equitably. (NEEA/NWPCC, No. 37 at pp. 8–11)

Similar to the approach taken in the commercial and industrial pump and air compressor rulemakings,[60] DOE proposed to evaluate equipment with variable-speed capability separately from single-speed equipment. The metric adopted for inverter-only motors, which includes the inverter efficiency, is not directly comparable with the metric proposed for electric motors that are not inverter-only, as these motors are not tested using an inverter. As such, DOE does not believe that motors with controls would be at a disadvantage relative to single-speed AC induction motors when testing and evaluating them under the proposed conditions.

Regarding the adoption of a metric that would capture the benefits of controls, such as the approach suggested by NEEA/NWPCC, which uses an input power-based metric and a load profile based on a variable-torque load profile for inverter-motors (both inverter-only and inverter-capable), inverter-motors would always show better ratings (*i.e.,* a lower weighted average input power) than single-speed motors due to the cubic relationship between power and speed (*i.e.,* affinity laws)[61] specific to variable-torque load applications (*e.g.,* a reduction in speed by a factor of 3 is associated to a reduction in power by a factor of 9).[62] Variable-speed capability can provide energy savings in some applications compared to single-speed operation. However, not all applications benefit equally from variable-speed control. DOE estimates that 90 percent of the installed base of variable-load electric motor applications are variable-torque.[63] Applying speed control to these applications (primarily fans, compressors, and pumps), will provide energy savings due to the affinity laws specific to these applications. However, affinity laws do not apply to other variable-load applications that are not variable-torque (*e.g.,* material handling, material processing) where speed control is not expected to provide the same level of energy savings, if any. In addition, AC induction inverter-only motors are primarily used in constant torque applications.[64] Applying a metric based on an average load profile that captures the benefits of speed control

[57] DOE notes that in the example provided by the CA IOUs, where the rank order of inverter-only motors changes based on considering a load profile vs. a full-load operation, the motor is assumed to operate 40 percent of the time at low load which is not representative of typical inverter-only motors (load in percent of horsepower is the product of speed and torque, in the CA IOUs example, 15 and 10 percent load points were considered *i.e.,* 50 percent speed, 30 percent torque and 50 percent speed, 20 percent torque). In addition, in the example provided, the inverter-only induction motor has a flatter efficiency curve than the synchronous reluctance motor which is contrary to what is expected from a typical synchronous motors and not representative. (CA IOUs, No. 32.1 at p. 29).

[58] NEEA and NWPCC cited the example of the seasonal energy efficiency ratio used for air conditioning equipment and the Pump Energy Index used for commercial and industrial pumps.

[59] Available at *https://www.techstreet.com/nema/standards/nema-mg-10011-2022?product_id=2247918.*

[60] For air compressors and pumps, variable speed or variable-load and single speed or constant load equipment are in separate equipment classes and evaluated separately. 10 CFR 431.345 and 10 CFR 431.465.

[61] The affinity laws express the relationship between power, speed, flow, and pressure or head. Specifically, power is proportional to the cube of the speed.

[62] In addition, DOE reviewed the load points recommended for variable speed moors by NEEA and NWPCC and found that the points recommended do not reflect the load points for variable load motors in the DOE Motor Systems Market Assessment report (which are provided in terms of percentage of horsepower divided by the motor full-load horsepower). NEEA and NWPCC characterized the load range from 0 to 40 percent using a (25,25) (% speed, % torque) point which is equal to 6.25 percent load; the load range between 40 and 75 percent using a (50,50) (% speed, % torque) point which is equal to 25 percent load, and the range above 75 percent using (75,75) and (100,100) (% speed, % torque) points which is equal to 56.25 percent and 100 load. As such the points recommended do not reflect the typical motor loads for inverter-only motors.

[63] See counts of motors by load factor by application as provided by the DOE Motor Systems Market Assessment report, available at *https://motors.lbl.gov/inventory/analyze/3-0825.*

[64] Inverter-only motors are capable of providing full-rated torque at zero speed as well as operating well over their nominal speed and are typically selected when operating at extremely low speeds, particularly when serving a constant torque load. *See: https://www.nrel.gov/docs/fy13osti/56016.pdf.*

(*i.e.,* a variable-torque load profile as recommended by NEEA/NWPCC), would assume that benefits of speed controls are always realized and could potentially significantly underestimate the input power experienced by a consumer. In the case of electric motors, such a metric could be misleading to consumers purchasing an electric motor for a non-variable torque applications. In other contexts where a more specific application was identified as in the case for pumps (which are all variable-torque applications), DOE was able to identify a specific load profile and use a metric that captures the energy savings potential of speed controls. However, for electric motors, because of the variability in applications, and because the majority of AC induction inverter-only electric motors are used in constant-torque applications, it is more representative to rely on a full-load efficiency metric rather than to rely on a weighted power-input metric based on a variable torque load profile, and to provide disaggregated information on the electric motor's part-load efficiency (inclusive of the inverter or not) to consumers to allow them to perform the power input calculation that is specific to their application. In addition, as previously stated, DOE understands that many general purpose induction motors are rated as inverter-capable but are more commonly operated direct-on-line, and as such, the results of testing without an inverter would be more representative. Consequently, DOE is not including an input power-based metric in the electric motors test procedure. DOE may consider requiring manufacturers to disclose the part-load performance efficiency of the additional motors proposed for inclusion within the scope of this test procedure as part of any future energy conservation standard related to these electric motors.[65]

F. Rated Output Power and Breakdown Torque of Electric Motors

The current energy conservation standards for electric motors at 10 CFR 431.25 are segregated based on rated motor horsepower, pole configuration, and motor enclosure. Pole configuration and motor enclosure are both observable properties of a motor and straightforward to use for testing purposes. In contrast, the rated motor horsepower (*i.e.,* rated output power) is not easily observable and DOE has not discerned a single uniform method to determine this value through testing. In the December 2021 NOPR, DOE proposed to specify rated output power based on the electric motor's breakdown torque for those electric motors that are subject to energy conservation standards at 10 CFR 431.25, electric motors above 500 horsepower, air-over electric motors, and SNEMs. 86 FR 71710, 71745–71747. DOE based this proposal on the already-established definitions for rated output power and breakdown torque as they relate to small electric motors (*see* 10 CFR 431.442). *Id.*

In the December 2021 NOPR, DOE reviewed NEMA MG 1–2016 (with 2018 Supplements), and noted the complexity identified by CA IOUs in determining rated output power based on breakdown torque, in that the performance requirements for a NEMA Design A, B or C motor in Section 12.39 specify the minimum breakdown torque as a percentage of full-load torque; therefore, the breakdown torque can only describe the largest possible rated output power but cannot uniquely identify a rated output power. However, DOE also noted that it understands that the economics of motor manufacturing prevent manufacturers from down-rating the output power of motors (*i.e.,* manufacturers are disincentivized to down-rate motors because of the implications of cost-competitiveness), but NEMA MG 1–2016 (with 2018 Supplements) does not inherently eliminate that possibility. Regardless, DOE proposed to specify how to determine the rated output power of an electric motor based on its breakdown torque to provide further specificity. 86 FR 71710, 71745–71747.

Grundfos stated that rated output power is a manufacturer declaration (and should not be included as a regulatory requirement), and that breakdown torque is only published for informational purposes. (Grundfos, No. 29 at p. 6)

AI Group disagreed with the use of breakdown torque to determine power rating. It warned that running a motor above its rated torque to the breakdown torque limit will result in high winding temperature, winding failure and unsafe operation should the motor stall. It commented that a motor will not be able to continuously deliver power exceeding its rated power without high over-temperature and eventual failure through winding burnout. (AI Group, No. 25 at p. 6) CEMEP also disagreed with the use of breakdown torque in determining rated output power and stated that breakdown torque has never been a design criterion for efficiency. It stated that output power ratings are based on frame sizes and other motor performance metrics. (CEMEP, No. 19 at p. 7)

NEMA stated that the proposed specification of rated output power does not accurately describe how manufacturers are currently determining the rated output power for polyphase motors. (NEMA, No. 26 at p. 19) It stated that breakdown torque only establishes the output power the motor can momentarily deliver successfully and does not establish the output power the motor can deliver continuously. NEMA commented that other parameters, such as temperature rise, must be considered to determine the output power the motor can deliver continuously. Further, NEMA provided examples of how a motor's output power would be rated if DOE's proposal were considered for adoption. According to NEMA, rated output power based on DOE's proposal would result in much higher values than manufacturer-declared output power, which in turn would result in motors overheating during the rated load temperature tests and potentially being ineffective for the efficiency test.[66] *Id.* at pp. 19–20.

Further, NEMA commented that Section 12.39 of NEMA Standard MG–1 2016 (with 2018 Supplements) only defines a lower bound for breakdown torque and not an upper bound, and that there is nothing in that procedure prohibiting manufacturers from designing motors that are subject to that section with a breakdown torque value much higher than the minimum required value when attempting to optimize other aspects of the motor's performance. (NEMA, No. 26 at p. 20) On the other hand, NEMA noted that motors subject to Section 12.37 of NEMA Standard MG–1 2016 (with 2018 Supplements) (polyphase small motors) have a defined lower breakdown torque limit they do not have an upper limit. As such, NEMA asserted that the possibility of overheating the electric motor makes the proposal unfeasible. In addition, NEMA asserted that the proposal may also be unfeasible for single-phase induction motors because there is a tolerance on the breakdown torque values for these motors that the proposal does not address. (NEMA, No. 26 at p. 20)

After receiving feedback from stakeholders and reviewing the capabilities of motor test labs, DOE has concerns regarding the feasibility of determining the breakdown torque of larger motors and how breakdown

[65] DOE did not propose to require this in the December 2021 NOPR. DOE typically includes such requirements (*e.g.,* labeling) as part of its energy conservation standards rulemakings.

[66] IEEE 112–2017 Test Method B (currently incorporated by reference in 10 CFR 431.15 and one of the test methods in Section 2 of appendix B) requires that a rated load temperature test be performed prior to taking efficiency measurements.

torque could be used to determine rated output power. DOE understands that motors above 100 horsepower are rarely physically tested due to the complexity and cost of supplying a load of that size during testing. Instead, manufacturers rely on simulations and performance modeling to determine the performance characteristics of motors this size.

DOE also understands that while breakdown torque may be used to determine the rated output power of small electric motors (or ''small motors'' as the term is generally used), manufacturers do not typically use only this value for larger motors, and there are other parameters used to determine rated output power. DOE has determined that there is no single uniform method that manufacturers currently use to determine rated output power; manufacturers instead view this issue as an optimization problem that changes depending on what function the motor is providing. Electric motors designed for higher horsepower outputs tend to have more electrically-active and inactive material to safely achieve the higher power output. Due to this relationship between active material and power output, DOE understands that rating a motor at a lower horsepower rather than the maximum that can be safely achievable for an application would result in a motor with more active and inactive material than the other motors at the lower horsepower. The added cost of excess material in the oversized motor would result in a motor that is not cost-competitive with motors at the lower horsepower. As such, DOE understands that the under-rating of motor horsepower is not a significant issue since manufacturers are incentivized to rate a motor at a higher hp based on cost-effectiveness.

In light of the difficulty of determining breakdown torque for larger motors and the potential of overheating when determining rated output power based on DOE's proposal, at this time, DOE is not adopting its proposed specification of rated output power. Therefore, the test procedure and representations will be based on manufacturer representations of the rated output power of an electric motor. DOE is also declining to define the term ''breakdown torque'' as it will not be needed in light of the absence of a requirement to determine the rated output power of an electric motor.

G. Rated Values Specified for Testing

1. Rated Frequency

Electricity is supplied at a sinusoidal frequency of 60 Hz in the United States while other regions of the world (*e.g.,* Europe) use a frequency of 50 Hz. The frequency supplied to a motor (or to the inverter, if the motor is connected to an inverter) inherently affects the performance of the motor (or motors and inverter, if the motor is connected to an inverter). ''Rated frequency'' is a term commonly used by industry standards for testing electric motors (*e.g.,* Section 6.1 in IEEE 112–2004, and Section 6.1 in CSA C390–10), and refers to the frequency at which the motor is designed to operate. A motor's rated frequency is typically provided by the manufacturer on the electric motor nameplate. Multiple rated frequencies are sometimes provided if a manufacturer intends to sell a particular model in all parts of the world. In the case where an electric motor is designated to operate at either 60 or 50 Hz, the current test procedure does not explicitly specify the frequency value at which an electric motor is tested. Similarly, inverters used to operate inverter-only motors can be rated at multiple frequencies.

In the December 2021 NOPR, DOE proposed to add the term ''rated frequency'' to the definitions located at 10 CFR 431.12 and to define the term as ''60 Hz.'' 86 FR 71710, 71747. DOE stated that because the test procedures and energy conservation standards established under EPCA apply to motors distributed in commerce within the United States, DOE expressly proposed to use 60 Hz. *Id.*

Grundfos commented that DOE should make it clear that the definition for rated frequency would not apply for inverter-only motors. (Grundfos, No. 29 at p. 6) DOE did not receive any other comments on this proposal.

In this final rule, DOE specifies that the rated frequency describes the frequency of the electricity supplied either: (1) directly to the motor, in the case of electric motors capable of operating without an inverter; or (2) to the inverter in the case of inverter-only electric motors. Accordingly, DOE is adopting the following definition for ''rated frequency'': Rated frequency means 60 Hz and corresponds to the frequency of the electricity supplied either: (1) directly to the motor, in the case of electric motors capable of operating without an inverter; or (2) to the inverter in the case on inverter-only electric motors.

2. Rated Load

The term ''rated load'' is a term used in industry standards to specify the load that is applied to an electric motor during testing. This rated load typically equals the rated output power of an electric motor, and efficiency representations of ''full-load efficiency'' are in reference to the rated full-load (or the rated load) of a motor. In the December 2021 NOPR, DOE proposed to define ''rated load'' as ''the rated output power of an electric motor.'' DOE also proposed qualifying that the term ''rated output power is equivalent to the terms ''rated load,'' ''rated full-load,'' ''full rated load,'' or ''full-load'' as used in the various industry standards used for evaluating the energy efficiency of electric motors. 86 FR 71710, 71747.

DOE received a comment from Grundfos in support of this proposed definition, (Grundfos, No. 29 at pp. 6–7), and received no comments opposing it.

For the reasons discussed in the December 2021 NOPR and in the preceding paragraphs, DOE is adopting the definition of rated load as proposed in the December 2021 NOPR and clarifying that the term is interchangeable with the terms full-load, full rated load, and rated full-load as used in other current industry testing standards for electric motors.

3. Rated Voltage

The rated voltage of a motor typically refers to the input voltage(s) that an end-user can supply to the motor and expect the motor to deliver the performance characteristics detailed on its nameplate. When performing an efficiency test at the rated load, the motor is supplied with one of the voltages listed on its nameplate. Currently, the referenced industry standards listed in appendix B direct that motors to be tested at the rated voltage, without specifying how to test when multiple voltages are provided on the nameplate and marketing material. DOE has found that some motor nameplates are labeled with a voltage rating including a range of values, such as ''208–230/460 volts,'' or other qualifiers, such as ''230/460V, usable at 208V.''

In the December 2021 NOPR, DOE presented the results of electric motors that were tested at two rated voltages of 230V and 460V. The results indicated that the tests that were conducted at the higher voltage rating (460V) resulted in fewer losses than at the lower voltage rating (230V). 86 FR 71710, 71747–71749. DOE noted that under current industry practice, a manufacturer can select the voltage for testing; however, the electric motor must meet all performance requirements of NEMA MG 1–2016 (with 2018 Supplements) at all rated voltages. Therefore, in the December 2021 NOPR, DOE proposed to define the term ''rated voltage'' as ''any of the nameplate input voltages of an electric motor or inverter, including the voltage selected by the motor's manufacturer to be used for testing the motor's efficiency.'' 86 FR 71710, 71748. DOE further clarified that the proposed definition would also require a motor to meet all performance requirements at any voltage listed on its nameplate. Therefore, a manufacturer would not be permitted to make representations regarding other voltages at which an electric motor could operate unless that motor also satisfied all of the related performance standards. DOE sought comment on this proposal and the proposal to allow voltages that appeared on the nameplate as ''Usable At'' to be selected for testing. *Id.*

In response, CEMEP stated that the rated voltage is the voltage at which the manufacturer provides all other rated values like current, torque, and power factor of a motor. (CEMEP, No. 19 at p. 8) AI Group stated that the rated voltage should be the voltage at which the manufacturer guarantees performance data of the motor (including efficiency). (AI Group, No. 25 at p. 6) Trane commented that having to test motors at all voltages on the nameplate creates an undue burden to the manufacturer due to the nature of the input rectification circuit, and that manufacturers should be allowed to test at only one voltage as long as that voltage is reported in the certification. (Trane, No. 31 at pp. 6–7)

NEMA commented that ''Usable At'' voltages are included to inform the customer that the motor could operate at that voltage but its inclusion on the nameplate makes no claims regarding efficiency at that voltage. (NEMA, No. 26 at p. 21) Grundfos opposed including ''Usable At'' voltages in the definition of rated voltage, stating that this proposed change will force manufacturers to design motors for specific voltages and limit motor utility and consumer options. It stated that this requirement would have a large impact on manufacturers that ship to multiple markets with different voltages (*e.g.* U.S., Brazil, Japan, EU) and that it could force them to double their offerings to design motors specifically optimized for their ''Usable At'' voltages, and that DOE needs to account for the added costs for the design and certification of these motors if the proposed change is adopted. (Grundfos, No. 29 at p. 7)

DOE notes that Section 12.50 of NEMA MG 1–2016 states that ''When a small or medium polyphase motor is marked with a single (*e.g.,* 230 V), dual (*e.g.,* 230/460), or broad range (*e.g.* 208–230) voltage in the Voltage field, the motor shall meet all performance requirements of MG 1, such as efficiency, at the rated voltage(s).'' The section further states that ''When a voltage is shown on a nameplate field (*e.g.,* ''Useable at 208 Volts'') . . . other than the Voltage field, the motor is not required to meet all performance requirements of this standard (*e.g.,* torques and nameplate nominal efficiency) at this other voltage.'' DOE understands that these ''Usable At'' voltages and broad range voltages allow manufacturers to serve multiple national markets with a single product offering.

In this final rule, DOE clarifies that its proposal to allow any nameplate voltage to be selected for testing does not mean a manufacturer will have to certify a motor's efficiency at every rated voltage. Instead, DOE is requiring that a manufacturer will only have to certify the efficiency of the motor at one voltage, but that DOE could select any nameplate voltage for enforcement testing. DOE considers ''Usable At'' voltages that appear on the nameplate as a nameplate voltage, and thus could be selected for testing. In DOE's view, at any voltage at which the manufacturer declares that an electric motor may be installed and operated by making a representation in its nameplate, the electric motor must meet the standards when measured by the DOE test procedure. However, DOE notes that if a ''Usable At'' voltage is included in marketing materials but is not printed on the nameplate, then that voltage would not be selected for testing as it would be for reference only.

Grundfos also stated that DOE needs to consider that the rated voltage for an inverter-only motor may be different than the rated voltage of the inverter to which it is connected. (Grundfos, No. 29 at p. 7) NEMA commented that the term ''inverter'' should be removed from the definition of rated voltage (without providing further details). (NEMA, No. 26 at pp. 20–21) Regarding how rated voltage should be defined for expanded scope, NEMA commented that motors that are not inverter-only should be tested at the rated voltage on the nameplate; motors with an inverter (inverter-only, converter-only, or synchronous motors) should be tested in accordance with the requirements of the inverter, in accordance with IEC 60034–2–3. (NEMA, No. 26 at p. 21)

As discussed in section III.D.3 of this document, DOE is requiring inverter-only electric motors to be tested with an inverter. As such, DOE notes that the voltage of the accompanying inverter to the inverter-only motor is important for determining its rated voltage. DOE specified in the proposal that ''any of the nameplate input voltages of an electric motor or inverter'' could be considered as the rated voltage, and that the motor would have to meet all performance requirements at any of the voltages listed on its nameplate (inverter or motor).

Accordingly, in this final rule, DOE is adopting its proposed rated voltage definition. Further, DOE is clarifying that a motor would have to meet all performance requirements at any voltage listed on its nameplate (inverter or motor's nameplate). DOE is also clarifying that for any motor that is tested with an inverter, the rated input voltages that could be selected for testing are only the voltages that appear on the inverter nameplate. This clarification is being added to ensure that when the motor input voltage differs from the inverter input voltage, the incorrect voltage does not get fed into the inverter.

H. Contact Seals Requirement

Certain electric motors come equipped with contact seals that prevent liquid, debris, and other unwanted materials from entering (or exiting) the motor housing. These contact seals cause friction on the shaft, which can cause a motor to have higher losses than if the motor were operating without those contact seals. In the December 2021 NOPR, DOE proposed to clarify that motors (other than immersible motors) that have contact seals should be tested with those seals installed. 86 FR 71710, 71750–71751.

NEMA, IEC, CEMEP, AI Group, AGMA, and Sumitomo all opposed the proposal. (NEMA, No. 26 at pp. 22–23; IEC, No. 20 at pp. 2–3; CEMEP, No. 19 at p. 9; AI Group, No. 25 at pp. 2, 6–7; AGMA, No. 14 at pp. 1–2; Sumitomo, No. 17 at pp. 1, 4–5) IEC, AI Group, and Sumitomo cited concerns about the added test burden if manufacturers were required to test every unique ''motor plus contact seal'' combination individually. (IEC, No. 20 at pp. 2–3; AI Group, No. 25 at pp. 2, 6–7; Sumitomo, No. 17 at pp. 6–7) CEMEP noted that numerous seal types are available, and the losses will be different in each case, which will lead to a high number of different basic models. (CEMEP, No. 19 at p. 9) IEC, and Sumitomo also cited concerns about the variability of frictional losses in contact seals and how this variability would make the test procedure less repeatable. (IEC, No. 20 at pp. 2–3; AI Group, No. 25 at pp. 2, 6–7; Sumitomo, No. 17 at pp. 6–7) Specifically, IEC, and Sumitomo stated that bearing friction and losses reduce as the motor runs and these bearings wear-in. *Id.* Further, NEMA and Sumitomo commented that some bearings can take up to 200 hours of run time to wear-in, an amount of run time they argued would be unduly burdensome for a single efficiency test. (NEMA, No. 26 at p. 23; Sumitomo, No. 17 at p. 5)

NEMA disagreed with requiring electric motors to be tested with the seals installed because of the larger number of new models that would need to be certified and the added uncertainty introduced to the test procedure because of the many variables that affect seal losses. It referenced a statement from Advanced Energy,[67] who noted that because the ''run-in'' period of seals is not uniform across all motors—and can be long enough to make testing infeasible—testing these motors without their seals would be the reasonable approach for DOE to take. (NEMA, No. 26 at p. 23)

Sumitomo stated that, unlike past requirements, if DOE requires motors to be tested with their contact seals installed, testing a combination of randomly-selected sample motors per DOE's established methodology to verify calculated efficiency models will be impossible. It commented that all the motors will need to be tested until a new AEDM is developed that compensates for the reality that seal drag varies by a variety of factors such as total time in operation, lubrication, seal design, and surface speed. Since dimensions may vary depending on ''reducer frame size,'' multiple AEDMs may be required for a given motor. (Sumitomo, No. 17 at p. 6) Further, Sumitomo stated that the DOE proposal on contact seals would cause undue burden and it requested that DOE confirm that any required shaft contact seal be deemed part of an electric motor's mating gearbox associated with the reducer and not a necessary part of the electrical motor itself, such that contact seals be removed for testing. Accordingly, Sumitomo recommended that DOE an approach where the electric motor shaft seals of any variety shall be removed for testing if they are contact seals—regardless of whether the motor under test is an immersible electric motor. It noted that the problem with including seals on a gearmotor for testing is that seal friction causes loss of energy power output, but the losses are inconsistent and vary depending on seal size, number of seals, seal design, seal material, lubrication, and time in operation. By comparison, Sumitomo stated that motor efficiency tests that include fresh, dry seals do not simulate real-world operating conditions and may not be indicative of actual efficiency. Accordingly, Sumitomo recommended that to allow for meaningful comparison between gearmotors and conventional motors, contact seals should be excluded from the test. (Sumitomo, No. 17 at pp. 1, 4–5)

ABB stated that tests will need to be performed to determine frictional losses for shaft seals and sealed bearings for each type of seal and seal combination by rating and frame size. (ABB, No. 18 at p. 2) CEMEP asked DOE to clarify whether the proposed approach would treat every unique motor plus contact seal combination as a new basic model requiring separate certification. (CEMEP, No. 19 at p. 10)

AGMA argued that, to allow for meaningful comparison between gearmotors and conventional motors, contact seals should be excluded from the test. It stated that modeling seal drag and its attendant increase in motor losses may be difficult and that seal losses are a function of run time and lubrication and can vary across manufacturers and among individual pieces. It mentioned that motor efficiency tests that include fresh, dry seals do not simulate real-world operating conditions and may not be indicative of actual efficiency. It stated that requiring an integral gear motor with the mechanically required shaft contact seal to meet the same energy efficiency levels as the vast majority of electrical motors that have no need for such a shaft contact seal is an inconsistent application of the DOE's motor efficiency mandate and will result in an ''unlevel playing field.'' It encouraged DOE to consider any required shaft contact seal as part of the motor's driven load and not a necessary part of the electrical motor. (AGMA, No. 14 at pp. 1–2)

Grundfos stated that the proposed clarification for contact seals is adequate but that DOE must clearly define the term ''contact seals'' with respect to immersible motors to ensure clarity. (Grundfos, No. 29 at p. 8)

Advanced Energy stated that the proposed clarification on shaft seals may be inconsistent with how manufacturers have interpreted DOE's regulations and suggested that DOE add language allowing manufacturers to request a no-load run-in prior to efficiency testing to allow the bearings and seals to wear-in. The no-load run-in ensures the shaft seals (along with bearings and lubricant) are well-seated prior to loading the motor. Advanced Energy also explained that when it performs efficiency testing, it conducts a no-load test and waits until the input power has stabilized before moving onto the next stage of the test, with run-in time varying based on the motor. (Advanced Energy, No. 33 at p. 16)

DOE reviewed the comments submitted and further researched the complexities of measuring the efficiency of an electric motor with the contact seals installed. DOE understands that the frictional losses of contact seals reduce as the motor runs but the rate that these losses reduce over time is not uniform across all types of contact seals. DOE considered allowing manufacturers to use a run-in period that allowed for motor losses to stabilize before the efficiency test is conducted but is concerned that this period could be arduously long in the case of contact seals that could take up to 200 hours of runtime before the frictional losses stabilized. At this time, DOE has not found a practical way to account for the variation in frictional losses of contact seals when testing with the seals installed. Accordingly, in this final rule, DOE is declining to adopt its proposal that motors (other than immersible motors) that have contact seals should be tested with those seals installed.

I. Vertical Electric Motors Testing

In the December 2021 NOPR, DOE proposed to modify the vertical electric motor test requirements in section 3.8 of appendix B to permit the connection of a dynamometer with a coupling of torsional rigidity greater than or equal to that of the motor shaft.[68] 86 FR 71710, 71750. DOE proposed this updated language in response to NEMA's comments that industry's common practice is to use a disconnectable coupling or adapter to connect hollow motor shafts to dynamometers rather than the current requirements direct welding of a solid shaft to the motor's drive end. NEMA commented that using an adaptor or coupling causes no loss of testing accuracy, but carries the advantage of easy reversibility; whereas welding may permanently alter the motor. (NEMA, No. 2 at p. 3) In the December 2021 NOPR, DOE tentatively concluded that so long as the coupling is sufficiently rigid, it would be unlikely that it would reduce test procedure repeatability, and permitting use of a coupling could reduce burden, as

[67] *https://www.regulations.gov/comment/EERE-2012-BT-TP-0043-0008.*

[68] Specifically, DOE proposed removing the instructional text reading, ''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'' to ''If necessary, the unit under test may be connected to the dynamometer using a coupling of torsional rigidity greater than or equal to that of the motor shaft.'' 86 FR 71710, 71750.

removal of such a connector may be less laborious than reversing a welding process. 86 FR 71710, 71750. Consequently, DOE proposed to update its vertical electric motor testing requirements in the manner NEMA suggested and sought comment on that approach. *Id*

NEMA agreed with the proposed changes to testing requirements for certain vertical electric motors and that the proposed changes for coupling torsion are adequate. (NEMA, No. 26 at p. 22) Advanced Energy supported the proposed change to the definition as it relates to vertical electric motors and stated that the change is consistent with its current testing practice. (Advanced Energy, No. 33 at p. 16) Further, Advanced Energy supported the additional requirement of torsional rigidity of the coupling used to measure the motor output power. *Id.* Grundfos also supported the specifications on torsional rigidity. (Grundfos, No. 29 at p. 8)

For the reasons discussed, DOE is adopting the December 2021 NOPR proposal in this final rule, which provides an alternate specification of using a coupling for testing vertical electric motors.

J. Proposed Testing Instructions for Those Electric Motors Being Added to the Scope of Appendix B

In the December 2021 NOPR, DOE discussed how sections 3.1 through 3.8 of appendix B provide additional testing instructions for certain electric motors. 86 FR 71710, 71751. Specifically, the testing instructions provided are for (1) brake electric motors; (2) close-coupled pump electric motors and electric motors with single or double shaft extensions of non-standard dimensions or design; (3) electric motors with non-standard endshields or flanges; (4) electric motors with non-standard bases, feet or mounting configurations; (5) electric motors with a separately-powered blower; (6) immersible electric motors; (7) partial electric motors; and (8) vertical electric motors and electric motors with bearings incapable of horizontal operation. In the December 2021 NOPR, DOE reviewed these instructions and found that they would also apply to the additional motors proposed for inclusion in scope, to the extent that the additional motors fall into one of the eight categories of electric motors already listed in sections 3.1–3.8 of appendix B. *Id.* DOE requested comments on the proposed application of the additional testing instructions in sections 3.1 through 3.8 of appendix B to the additional electric motors proposed for inclusion in scope of the test procedure. *Id.*

In response, two stakeholders supported DOE's view that the additional testing instructions for certain electric motors would also apply to the additional electric motors proposed for inclusion in scope of the test procedure. Grundfos stated that the additional test instructions in sections 3.1–3.8 of 10 CFR part 431 appendix B would apply to the additional motor types proposed in scope. (Grundfos, No. 29 at p. 8) NEMA commented that to the extent that existing test procedures can be accurately and repeatedly applied to the additional electric motors proposed for inclusion in scope, the accommodations in sections 3.1–3.8 of appendix B remain adequate. (NEMA, No. 26 at p. 24)

The test methods adopted in this final rule reference specific industry test methods. Further, as discussed in section III.D of this document, DOE has concluded that the test methods for those additional electric motors DOE is including within the scope of the test procedure are designed to produce results reflecting a motor's energy efficiency during a representative average use cycle and are not unduly burdensome to conduct. As such, because DOE has concluded that the test procedures can be accurately and repeatedly applied to the additional electric motors, DOE maintains that the additional testing instructions in sections 3.1–3.8 of appendix B also apply to the additional motors DOE is adding to the test procedure's scope, to the extent that the additional motors fall into one of the eight categories of electric motors listed in sections 3.1–3.8 of appendix B. Consequently, DOE is adopting these additional testing instructions as proposed.

In the December 2021 NOPR, DOE also proposed to amend the definition of standard bearing by expanding it to include 600 series bearings—*i.e.,* ''a 600 or 6000 series, either open or grease-lubricated double-shielded, single-row, deep groove, radial ball bearing.'' 86 FR 71710, 71751. DOE proposed this amendment to accommodate categories of bearings contained in motors with smaller shafts that are found in SNEMs. *Id.* DOE requested comment on this proposal but received none. Therefore, DOE is adopting this proposal in this final rule.

K. Testing Instructions for Brake Electric Motors

Section 3.1. of Appendix B to Subpart B currently includes testing instructions for brake electric motors. In the NOPR, DOE did not propose any changes to these testing instructions.

IEC commented that as long as auxiliary devices, such as mechanical brakes, are not an integral part of the basic motor design, the test for efficiency should be performed on basic motors without auxiliary devices installed. It recommended removing mechanical brakes from an electric motor during testing because testing with the brakes installed will significantly increase the uncertainty in the test results. Moreover, it noted that manufacturers offer different types of brakes with their electric motors, making it impracticable to test all of the variations that are produced. Finally, IEC explained that removing the brakes before testing is consistent with IEC 600034–30–1 and IEC 600034–30–2. (IEC, No. 20 at pp. 3–4)

DOE notes that section 3.1 of appendix B instructs that brake electric motors must be tested with the brake component not activated during testing. Specifically, the power supplied to prevent the brake from engaging is not included in the efficiency calculation. Further, the test procedure allows the brake to be disengaged from the motor if such a mechanism to disengage to brake is installed and if doing so does not yield a different efficiency value than when separately powering the brake electrically. Accordingly, in DOE's view, the current test methods already permit the brakes to be disengaged and exclude any energy use associated with the brake component from the motor's calculated efficiency.

L. Transition to 10 CFR Part 429

DOE proposed to amend its electric motor regulations by amending and moving those portions pertaining to certification testing and the determination of represented values from 10 CFR part 431 to 10 CFR part 429. (86 FR 71710, 71751–71752) DOE also proposed amending other sections of 10 CFR part 431, subpart B, to ensure the regulatory structure comprising 10 CFR part 431, subpart B, and 10 CFR part 429 remains coherent. *Id.* DOE also proposed making changes to the general provisions in 10 CFR part 429 to reflect the addition of electric motor provisions related to certification testing and to the determination of represented values. *Id.* DOE did not receive any comments related to transitioning the provisions pertaining to certification testing and the determination of represented values from 10 CFR part 431 to 10 CFR part 429 and is adopting these changes as proposed, consistent with other covered products and equipment.

In the December 2021 NOPR, DOE proposed to largely retain the procedures for recognition and withdrawal of recognition of accreditation bodies and certification programs as it exists at 10 CFR 431.21, with one change to the current provisions at 10 CFR 431.21(g) to clarify the timeline and process of withdrawal of recognition by DOE as follows: if the certification program is failing to meet the criteria of paragraph (b) of § 429.73 or § 429.74, DOE will issue a Notice of Withdrawal (''Notice'') stating which criteria the entity has failed to meet. The Notice will request that the entity take appropriate corrective action(s) specified in the Notice. The entity must take corrective action within 180 days from the date of the Notice of Withdrawal or dispute DOE's allegations within 30 days from the issuance of the Notice. If, after 180 days, DOE finds that satisfactory corrective action has not been made, DOE will withdraw its recognition from the entity. DOE did not receive comments related to this topic and is adopting the proposed provisions related to the recognition and withdrawal of recognition of accreditation bodies and certification programs. In DOE's view, these additional requirements to the procedures for recognition and withdrawal of recognition will provide added clarity for those entities that may be affected by this provision.

TABLE III–8—ELECTRIC MOTORS CERTIFICATION AND COMPLIANCE CFR TRANSITIONS

Subpart B—electric motors [69]	Proposed location	Final location
10 CFR 431.14 Sources for information and guidance	Moved to 10 CFR 429.3	Moved to 10 CFR 429.3.
10 CFR 431.17 Determination of efficiency	Moved to 10 CFR 429.64 and 10 CFR 429.70 as relevant, edits to general provisions in 10 CFR 429 as needed.	Moved to 10 CFR 429.64 and 10 CFR 429.70 as relevant, edits to general provisions in 10 CFR 429 as needed.
10 CFR 431.18 Testing laboratories	Retained and added additional provisions at 10 CFR 429.64.	Retained and added additional provisions at 10 CFR 429.64.
10 CFR 431.19 Department of Energy recognition of accreditation bodies.	Moved to 10 CFR 429.74	Moved to 10 CFR 429.74.
10 CFR 431.20 Department of Energy recognition of nationally recognized certification programs.	Moved to 10 CFR 429.73	Moved to 10 CFR 429.73.
10 CFR 431.21 Procedures for recognition and withdrawal of recognition of accreditation bodies and certification programs.	Moved to 10 CFR 429.75	Moved to 10 CFR 429.75.

In addition, the December 2021 NOPR included some revisions in 10 CFR 429.11 that were not discussed in the NOPR preamble. In this final rule, DOE does not implement those changes (other than to update the cross-reference to 10 CFR 429.65).

M. Certification of Electric Motors

Manufacturers must certify electric motors as compliant with the applicable standard through the use of an ''independent testing or certification program nationally recognized in the United States.'' (42 U.S.C. 6316(c)) DOE is adopting changes to the provisions related to certification testing to ensure consistency with the statutory language found in 42 U.S.C. 6316(c). These updates are described in section III.M.1 and section III.M.2 of this document.

1. Independent Testing

DOE codified at 10 CFR 431.17(a)(5) the statutory requirement prescribing that manufacturers must certify electric motors as compliant with the applicable standard through the use of an ''independent testing or certification program nationally recognized in the United States.'' (42 U.S.C. 6316(c)) In the existing regulations, DOE addresses the requirement to use an independent testing program nationally recognized in the United States by requiring that testing laboratories be accredited by the National Institute of Standards and Technology (''NIST'')/National Voluntary Laboratory Accreditation Program (''NVLAP''),[70] a laboratory accreditation program having a mutual recognition program with NIST/NVLAP, or an organization classified by DOE as an accreditation body. 10 CFR 431.18. The term ''accredited laboratory'' is used to designate a testing laboratory to which accreditation has been granted. 10 CFR 431.12.

In the December 2021 NOPR, DOE proposed that, prior to 180 days following the publication of this final rule, in those cases when a certification program is not used, certifying a new basic model pursuant to 10 CFR 431.36(e) must be based on testing conducted in an accredited laboratory that meets the requirements of § 431.18. However, on or after 180 days following the publication of this final rule, when certifying a new basic model pursuant to 10 CFR 431.36(e) and when a certification program is not used, DOE proposed to require that testing be conducted by a nationally recognized testing program as further described in the remainder of this section. DOE proposed to replace the use of the term ''accredited laboratory'' (currently defined at 10 CFR 431.12) with the term ''nationally recognized testing program'' to better reflect the requirement that the testing program be nationally recognized in the United States. (42 U.S.C. 6316(c)) 86 FR 71710, 71752. DOE further proposed to add a definition for ''independent'' to appear in 10 CFR 429.2 that would define the term as referring to an entity that is not controlled by, or under common control with, electric motor manufacturers, importers, private labelers, or vendors. It would also require that the entity have no affiliation, financial ties, or contractual agreements, apparently or otherwise, with such entities that would: (1) Hinder the ability of the program to evaluate fully or report the measured or calculated energy efficiency of any electric motor, or (2) Create any potential or actual conflict of interest that would undermine the validity of said evaluation. The proposed definition also provided that for the purposes of the proposed definition, financial ties or contractual agreements between an electric motor manufacturer, importer, private labeler or vendor and a nationally recognized testing program, certification program,

[69] As it appeared at 10 CFR part 431, subpart B, in the 10 CFR parts 200 to 499 edition revised as of January 1, 2020.

[70] A list of NIST/NVLAP accredited laboratories is available here: *https://www-s.nist.gov/niws/index.cfm?event=directory.results.*

or accreditation program exclusively for testing, certification, or accreditation services would not negate an otherwise independent relationship. 86 FR 71710, 71752–71753. This proposed definition was largely based on the descriptions of independence currently found in 10 CFR 431.19(b)(2), 431.19(c)(2), 431.20(b)(2) and 431.20(c)(2). DOE further proposed to remove these descriptions in their entirety and rely solely on the proposed definition of independent that would appear in 10 CFR 429.2. 86 FR 71710, 71752–71753. DOE indicated that these proposed requirements would apply starting 180 days after publication of the final rule.

In response to the December 2021 NOPR, DOE received many comments criticizing the proposal. AI Group strongly opposed not allowing accredited manufacturer laboratories to conduct testing and submit results for certification. (AI Group, No. 25 at p. 7) Franklin Electric, Trane, ABB, Regal, CEMEP, AHRI and AHAM, and NEMA all commented that requiring the use of third-party testing laboratories would add financial and time burdens on manufacturers. Franklin Electric opposed requiring manufacturers to certify through a third-party test facility and stated that imposing the proposed requirement to do so would be an expensive burden for motor manufacturers. It elaborated that this proposal would be particularly difficult to meet in the case of submersible motors because third-party facilities would need time to implement the new test procedure and there are currently no third-party certification bodies available to test and certify for these motors. (Franklin Electric, No. 22 at p. 6) Trane commented that testing all the new in-scope motors at independent facilities would not be possible in the timeframe allotted and that testing components of covered products creates unnecessary financial and time burdens on manufacturers. It added that requiring third-party laboratories to test and certify these motors will create a supply bottleneck. (Trane, No. 31 at p. 7) Regal stated that there are too few third-party labs to test the motors that would be added to the test procedure's scope and that this testing will create longer lead times and backlogs in an already supply-constrained environment. (Regal, No. 28 at p. 1) ABB commented that if all motor manufacturers are required to use the limited number of external partners (who all have finite testing capacity), it believed that the required testing could take longer than 3 years to complete. ABB commented that the 180-day time frame for requiring manufacturers to test at an independent, nationally recognized testing facility is unrealistic. (ABB, No. 18 at p. 2) Grundfos expressed concern with DOE's proposed definition of ''independent'' since it would preclude manufacturers from engaging with an independent third-party for purposes not related to certification—such as prototype testing. Grundfos did not elaborate on this point. Grundfos generally agreed, however, with the proposed methods of certification. (Grundfos, No. 29 at p. 8) Advanced Energy supported DOE's proposed definition of ''independent.'' (Advanced Energy, No. 33 at p. 17)

The industry trade associations harbored similar concerns. CEMEP commented that requiring the use of a third-party laboratory is an extreme burden and a trade barrier to manufacturers. It noted the potential for higher adverse impacts on small- and medium-sized businesses in the form of additional time, effort, and financial and administrative costs to meet the proposed requirement, particularly in light of the small number of motors that these entities produce for the U.S. market. (CEMEP, No. 19 at p. 9) AHAM and AHRI commented that they were aware of only three third-party labs and stressed that these labs would be unable to handle the magnitude of testing required under DOE's proposal, particularly within the specified 180-day timeframe. (AHAM and AHRI, No. 36 at p. 9) AHAM and AHRI also commented that the proposed certification changes may drive motor manufacturers to limit the number of motors currently available to downstream OEMs in an effort to reduce testing and certification burdens. AHRI and AHAM commented that this development would limit OEM choice, may increase costs, and could negatively impact the performance of the end-use products. *Id.* NEMA, in referencing the three third-party certification bodies noted by AHRI and AHAM, stressed that these testing entities will not have the capacity to handle the inflow of reports and become a bottleneck. It strongly opposed not allowing accredited manufacturer laboratories to conduct testing and submit results for certification. (NEMA, No. 26 at pp. 24, 28) In addition, NEMA noted that third-party test labs have lower capacities than in-house manufacturer test labs and are only able to test a smaller range of horsepower motors. (NEMA, No. 26 at p. 30)

In addition, AHAM and AHRI stated that because DOE has not provided adequate reasoning for its view that NIST/NVLAP-certified labs are not sufficiently independent, commenters have been prevented from providing meaningful comments on this topic. (AHAM and AHRI, No. 36 at p. 10) NEMA commented that DOE should examine potential changes with the individual NVLAP, International Laboratory Accreditation Cooperation (ILAC), and the Occupational Safety and Health Administration Nationally Recognized Testing Laboratory (NRTL) program if there are issues with the certification process and not impose on manufacturers without justification and analysis of the burden this change would incur. NEMA added that the industry has made investments to participate in these programs and that DOE should engage with the parent organizations to address its concerns. Industry participates in these programs in accordance with the current regulations and should not be penalized. NEMA commented that DOE's proposal could be interpreted to imply that the Department has lost control of the process and its certification database and added that the proposed changes would not address systemic failures in oversight, if they exist. NEMA added that DOE provided no justification or reasons for this change and cannot add this burden without justification and corresponding economic analysis of the time and burdens it conveys. (NEMA, No. 26 at p. 24)

EPCA requires that with respect to any electric motor for which energy conservation standards are established at 42 U.S.C. 6313(b), the Secretary shall require manufacturers to certify, through an independent testing or certification program nationally recognized in the United States, that such motor meets the applicable standard. (42 U.S.C. 6316(c)) DOE reviewed the requirements that a testing laboratory must meet to obtain NIST/NVLAP accreditation related to proficiency testing, resources (*e.g.,* personnel records, specific experience and competence of technical manager, competency review, training, equipment), process (*e.g.,* selection, verification and validation of methods, sampling, reporting results), and management systems (*e.g.,* control of records, internal audits).[71] In addition, NIST/NVLAP conducts on-site assessments that consist of an independent, documented process for determining laboratory competence and other relevant information by NVLAP assessors with the objective of determining the extent to which NVLAP

[71] See NIST/NVLAP requirement documents at *www.nist.gov/nvlap/efficiency-electric-motors-lap.*

requirements are fulfilled. Based on this review, DOE has determined that NIST/NVALP accreditation is sufficient to satisfy the statutory requirement to use an ''independent testing [. . .] nationally recognized in the United States'' (42 U.S.C. 6316(c)) and that no changes are necessary. Therefore, DOE has decided to not adopt its proposal to require the use of an independent testing program and to instead to continue permitting the use of accredited labs as currently described at 10 CFR 431.17(a)(5). These provisions would be moved, consistent with the proposal, to 10 CFR 429.64.

In response to the December 2021 NOPR, DOE did not receive any comments on its proposal to replace the descriptions of independence currently found in 10 CFR 431.19(b)(2), 431.19(c)(2), 431.20(b)(2) and 431.20(c)(2) with references to the proposed definition of independent as it relates to nationally recognized certification and accreditation programs. *Id.* In this final rule, DOE adopts the proposed definition of independent as it relates to nationally recognized certification and accreditation programs. DOE is also replacing the descriptions of independence currently in 10 CFR 431.19(b)(2), 431.19(c)(2), 431.20(b)(2) and 431.20(c)(2) by referring to the definition of independent.

In addition to the proposals discussed in the NOPR, DOE notes that the current description of the NIST/NVLAP accreditation program at 10 CFR 431.18(b) and the referenced NIST/NVLAP handbooks and IEC guides listed at 10 CFR 431.14 are outdated. The more recent versions of the NIST/NVLAP handbooks include references to DOE's latest test procedures and replace the references to various IEC guides, which have now been withdrawn, by a reference to IEC 17025:2017 ''General Requirements for the Competence of Testing and Calibration Laboratories.'' DOE did not receive any comments related to these reference documents. In this final rule, DOE updates these references to cite their most recent versions. (*See* Table III–9)

TABLE III–9—UPDATED SOURCES FOR INFORMATION AND GUIDANCE

Current version listed at 10 CFR 431.14	Updated version in final location at 10 CFR 429.3
NVLAP Handbook 150, Procedures and General Requirements, February 2006	NVLAP Handbook 150, Procedures and General Requirements, February 2020.
NVLAP Handbook 150–10, Efficiency of Electric Motors, February 2007	NVLAP Handbook 150–10, Efficiency of Electric Motors, February 2020.
NIST Handbook 150–10 Checklist, Efficiency of Electric Motors Program, (2007–05–04)	NIST Handbook 150–10 Checklist, (2020–06–25).
NVLAP Lab Bulletin Number: LB–42–2009, Changes to NVLAP Efficiency of Electric Motors Program, March 19, 2009.	Removed.
ISO/IEC Guide 25, General requirements for the competence of calibration and testing laboratories, 1990	ISO/IEC 17025:2017 General requirements for the competence of testing and calibration laboratories.
ISO Guide 27, Guidelines for corrective action to be taken by a certification body in the event of either misapplication of its mark of conformity to a product, or products which bear the mark of the certification body being found to subject persons or property to risk, 1983.	
ISO/IEC Guide 28, General rules for a model third-party certification system for products, 2004.	
ISO/IEC Guide 58, Calibration and testing laboratory accreditation systems—General requirements for operation and recognition, 1993.	
ISO/IEC Guide 65, General requirements for bodies operating product certification systems, 1996.	

2. Certification Process for Electric Motors

As mentioned previously, DOE codified at 10 CFR 431.17(a)(5) the statutory requirement that manufacturers must certify electric motors for which energy conservation standards are established at 42 U.S.C. 6313(b) as compliant with the applicable standard through the use of an ''independent testing or certification program nationally recognized in the United States.'' (42 U.S.C. 6316(c))

Consistent with the requirements of 42 U.S.C. 6316(c), DOE proposed continuing to permit the use of independent testing (via an independent, nationally recognized testing program) or a nationally recognized certification program and to further specify which parties can test electric motors and certify compliance with the applicable energy conservation standards to DOE. DOE proposed that these provisions be required starting on the compliance date for any amended standards for electric motors published after January 1, 2021, as this was the date of the most recent print edition of the Code of Federal Regulations. DOE proposed three options in this regard: (1) a manufacturer can have the electric motor tested using a nationally recognized testing program (as described in the proposed § 429.64(d)) and then certify on its own behalf or have a third-party submit the manufacturer's certification report; (2) a manufacturer can test the electric motor at a testing laboratory other than a nationally recognized testing program (as described in the proposed § 429.64(d)) and then have a nationally recognized certification program (as described in the proposed § 429.73) certify the efficiency of the electric motor; or (3) a manufacturer can use an alternative efficiency determination method (''AEDM,'' as described in the proposed § 429.70) and then have a third-party nationally recognized certification program certify the efficiency of the electric motor. Under the proposed regulatory structure, a manufacturer cannot both test in its own laboratories and directly submit the certification of compliance to DOE for its own electric motors. 86 FR 71710, 71753.

In response to the December 2021 NOPR, CEMEP commented against the three certification options as proposed in the December 2021 NOPR. CEMEP commented that the proposed time schedule was not suitable and suggested keeping the existing system for transmitting data and testing motors. (CEMEP, No. 19 at pp. 9–10) Lennox opposed requiring third-party certification and stated that it would significantly increase burden to HVACR manufacturers without any benefit to the consumer. (Lennox, No. 24 at p. 9) NEMA also opposed the three proposed certification options and stressed that

NEMA opposed any proposal that would prevent certification through accredited laboratories operated by manufacturers. (NEMA, No. 26 at p. 24) Advanced Energy supported the three offered motor certification options and saw them as being consistent with other motor certifications related to safety or efficiency that manufacturers must satisfy in other countries. (Advanced Energy, No. 33 at p. 17)

As already noted, this final rule will not require testing at an independent testing program and continues to allow the use of an accredited laboratory for testing and certification purposes. Therefore, in this final rule, DOE is revising its proposed Option (1) to reflect its current practice (detailed at 10 CFR 431.17(5)) by allowing a manufacturer to test an electric motor using an accredited laboratory (as described at 10 CFR 431.18) and then to certify that motor on its own behalf or have a third-party submit the manufacturer's certification report. DOE is adopting Option (2) as proposed, which is consistent with the current provisions at 10 CFR 431.17(5)—no changes are being made to the current manner in which a manufacturer who conducts testing at a non-accredited lab must certify its electric motor. As to Option (3), DOE does not view the requirements of an AEDM as satisfying the statutory requirement of ''independence.'' Therefore, DOE believes that when using an AEDM, the results of the AEDM must be certified by a third-party certification program that is nationally recognized in the United States under the newly adopted § 429.73.

In summary, consistent with the requirements of 42 U.S.C. 6316(c), DOE continues to offer the option of using independent testing (via an accredited laboratory) or a nationally recognized certification program and further specifies which parties can test electric motors and certify compliance with the applicable energy conservation standards to DOE. This final rule specifies three options in this regard: (1) a manufacturer can have the electric motor tested using an accredited laboratory (as described at 10 CFR 431.18) and then certify on its own behalf or have a third-party submit the manufacturer's certification report; (2) a manufacturer can test the electric motor at a testing laboratory other than an accredited laboratory (as described at 10 CFR 431.18) and then have a nationally recognized certification program (as described in the newly established § 429.73) certify the efficiency of the electric motor; or (3) a manufacturer can use an alternative efficiency determination method (''AEDM,'' as described in § 429.70) and then have a third-party nationally recognized certification program certify the efficiency of the electric motor. Under this structure, a manufacturer would retain the ability to test in its own laboratories and directly submit the certification of compliance to DOE for its own electric motors as long as the laboratory is an accredited laboratory in accordance with 10 CFR 431.18, 429.64(f) and 429.65(d).

In addition, DOE proposed that these provisions would be required starting on the compliance date for any new or amended standards for electric motors. DOE is adopting this timeline as proposed and believes this timeline and combination of three options will provide sufficient time and alternatives for manufacturers. In addition, the compliance date to certify using these three options would be on or after the compliance date of the final rule adopting new or amended energy conservation standards for electric motors, Any associated costs related to these aspects of this final rule will be addressed in conjunction with any potential energy conservation standards rulemaking that DOE conducts for these affected electric motors. (See section III.Q of this document for more details related to test procedure costs and impacts).

In response to the December 2021 NOPR, NEMA stated that DOE should invest in an AEDM certification body that is independent from the current facility that also offers AEDM services for manufacturers who may not have the resources to develop their own AEDM because of the conflict of interest that comes with the same entity being both a certifier and provider of AEDMs. (NEMA, No. 26 at pp. 29–30)

DOE is not aware of any third-party, nationally recognized certification body that would develop AEDMs and conduct AEDM simulations on behalf of manufacturers and also certify the resulting efficiencies. In addition, the current regulations at 10 CFR 431.20 require that a nationally recognized certification program must be independent of electric motor manufacturers, importers, distributors, private labelers or vendors. It cannot be affiliated with, have financial ties with, be controlled by, or be under common control with any such entity. 10 CFR 431.20(b)(2) In addition, any petitioning organization should identify and describe any relationship, direct or indirect, that it or the certification program has with an electric motor manufacturer, importer, distributor, private labeler, vendor, trade association or other such entity, as well as any other relationship it believes might appear to create a conflict of interest for the certification program in operating a certification system for compliance by electric motors with energy efficiency standards. It should explain why it believes such a relationship would not compromise its independence in operating a certification program. 10 CFR 431.20(c)(2). As previously noted, in this final rule, DOE is adopting a definition of ''independent'' as it pertains to certification program (and nationally recognized accreditation program) that requires that the entity be not controlled by, or under common control with, electric motor manufacturers, importers, private labelers, or vendors, and that has no affiliation, financial ties, or contractual agreements, apparently or otherwise, with such entities that would: (1) hinder the ability of the program to evaluate fully or report the measured or calculated energy efficiency of any electric motor, or (2) create any potential or actual conflict of interest that would undermine the validity of said evaluation. Therefore, the adopted definition of ''independent'' sufficiently addresses NEMA's concern. DOE notes the requirement to be independent ensures that the entity conducting the AEDM for a basic model would not be the same as the entity certifying that same basic model. Further as noted previously, this final rule requires that when a manufacturer relies on an AEDM, a third-party nationally recognized certification program must certify the efficiency of the electric motor.

NEMA also questioned who would be responsible for certification in the case of a motor and inverter being sold together, particularly when they are manufactured by separate companies. (NEMA, No. 26 at p. 17) DOE's test procedure applies to the inverter motor. The motor manufacturer would be responsible for testing and certifying the motor, based on the test procedure established in this final rule.

AHAM and AHRI commented that the changes proposed in the NOPR expanded the definition of ''manufacturer'' and questioned whether OEMs that attach, for example, an impeller to an otherwise finished air-over motor would be considered the manufacturer responsible for certification. AHAM and AHRI commented that, in the case of any finished goods manufactured overseas, DOE's proposal would treat the OEM as the electric motor manufacturer, and they opposed this change. (AHAM and AHRI, No. 36 at p. 11).

DOE's proposals did not change the definition of manufacturer. The manufacturer of the motor would be responsible for certification. Electric motors are comprised of several primary components that include a rotor, stator, stator windings, stator frame, two endshields, two bearings, and a shaft. As stated in section III.A.9, DOE continues to exclude component sets from the scope of the test procedure. A component set of an electric motor comprises any combination of these motor parts that does not form an operable motor. For example, a component set may consist of a wound stator and rotor component sold without a stator housing, endshields, or shaft. These components may be sold with the intention of having the motor parts mounted inside other equipment, with the equipment providing the necessary mounting and rotor attachments for the components to operate in a manner similar to a stand-alone electric motor. Component sets may also be sold with the intention of a third-party using the components to construct a complete, stand-alone motor. In such cases, the end manufacturer that ''completes'' the motor's construction must certify that the motor meets any pertinent standards. (*See* 42 U.S.C. 6291(1)(10) (defining ''manufacture'' to include manufacture, produce, assemble, or import.))

N. Determination of Represented Values

For electric motors subject to standards, DOE established sampling requirements applicable to the determination of the nominal full-load efficiency. 10 CFR 431.17. The purpose of these sampling plans is to provide uniform statistical methods for determining compliance with any prescribed energy conservation standards and for making representations of energy consumption and energy efficiency on labels and in other locations such as marketing materials. The current regulations require that each basic model must either be tested or rated using an AEDM. 10 CFR 431.17(a). Section 431.17 specifies the requirements for use of an AEDM, including requirements for substantiation (*i.e.,* the initial validation) and verification of an AEDM. 10 CFR 431.17(a)(2)–(4).

DOE is adopting several edits to the current regulatory language to revise the existing requirements that manufacturers must follow when determining the represented value of nominal full-load efficiency of a basic model. The revised provisions regarding the determination of the represented value of nominal full-load efficiency, certification provisions, and the validation and verification of an AEDM, consistent with DOE's overall approach for consolidating the locations of its certification and compliance provisions, will be placed in 10 CFR 429.64 and 429.70. In addition, the revised provisions regarding the determination of the represented value of nominal full-load efficiency, enforcement provisions, and the validation and verification of an AEDM will also apply to the newly-added electric motors now falling within the scope of the test procedure in those cases where a manufacturer of such motors would be required to use the DOE test procedure. These provisions are discussed in more detail in sections III.N.1 through III.N.4 of this document.

1. Nominal Full-Load Efficiency

DOE defines ''nominal full-load efficiency,'' with respect to an electric motor, as a representative value of efficiency selected from the ''nominal efficiency'' column of Table 12–10, NEMA MG 1–2009, that is not greater than the average full-load efficiency of a population of motors of the same design. (10 CFR 431.12) As proposed in the December 2021 NOPR, DOE is not adopting any changes to this definition other than updating the reference to the latest version of NEMA MG 1 as discussed in section III.C of this document. 86 FR 71710, 71754. DOE discusses how to determine the average full-load efficiency of a basic model in the following sections. *See* 10 CFR 429.64(e) as established by this final rule.

Manufacturers currently rely on the nominal full-load efficiency to represent the performance of electric motor basic models. In the December 2021 NOPR, DOE proposed to allow manufacturers to alternatively use the average full-load efficiency of a basic model of electric motor as the represented efficiency (instead of the nominal full-load efficiency) provided that the manufacturer uses the average full-load efficiency consistently on all marketing materials, and as the efficiency value reported on the nameplate. This proposed provision would apply starting on the compliance date for any new or amended standards for electric motors published after January 1, 2021. 86 FR 71754

Grundfos, a pump manufacturer, supported allowing average full-load efficiency to be an alternate to represented value as long as both nominal and average full-load efficiency do not need to be declared on the nameplate (*i.e.,* a manufacturer can post one or the other) (Grundfos, No. 29 at p. 9) NEMA opposed using average full-load efficiency as alternative represented values for electric motors because it would be inconsistent with harmonizing North American, IEC, and other global standards and regulatory practices. (NEMA, No. 26 at p. 27)

In the NOPR, DOE proposed this alternative as an option to allow manufacturers to rate less conservatively than potentially required by the use of a nominal full-load efficiency value. The current DOE standards for electric motors are based on nominal full load efficiency. 10 CFR 431.25. Further, as suggested by NEMA, the current IEC classification of motor efficiency (*i.e.,* the ''IE-code'') in IEC 60034–30–1 is also based on nominal efficiency limits. Therefore, in this final rule, DOE is not adopting the proposed approach to allow manufacturers to alternatively use the average full-load efficiency of a basic model of electric motor as the represented efficiency (instead of the nominal full-load efficiency). DOE is maintaining its current approach to remain in alignment with harmonized international standards.

2. Testing: Use of an Accredited Laboratory

Manufacturers who do not use a certification program and test basic models in an accredited laboratory must follow the criteria for selecting units for testing, including a minimum sample size of five (5) units in most cases, as specified at 10 CFR 431.17(b)(2). The sample of units must be large enough to account for reasonable manufacturing variability among individual units of the basic model or variability in the test methodology such that the test results for the overall sample will be reasonably representative of the average full-load efficiency of the whole population of production units of that basic model. DOE notes that the current regulations do not limit the sample size and manufacturers can increase their sample size to narrow the margin of error.

In the December 2021 NOPR, DOE proposed that manufacturers continue to follow the current provisions in 10 CFR 431.17 (including the formula at 10 CFR 431.17(b)(2)(i)) related to the determination of the represented value. Manufacturers would continue to follow this procedure until DOE amends its electric motor standards. However, DOE proposed to move these provisions in the newly proposed §§ 429.64(b) and 429.64(c). In addition, starting on the compliance date for any new or amended standards for any electric motors published after January 1, 2021, DOE proposed that manufacturers follow the amended provisions in accordance with the newly proposed §§ 429.64(d) through 429.64(f). 86 FR 71710, 71754.

NEMA disagreed with the proposed change of the mathematical symbol given in the second formula in the current regulation at 10 CFR 431.17(b)(2)(i), which DOE proposed to move to 10 CFR 429.64. Specifically, it disagreed with the proposed symbol change from ''greater than or equal to'' to ''equal to'' and argued that the original equation and ''greater than or equal to'' symbol should be restored. (NEMA No. 26, at p. 29)

DOE reviewed the formula in the December 2021 NOPR and identified a typographical error. As stated in the December 2021 NOPR, prior to the compliance date for any new or amended standards for electric motors published after January 1, 2021, DOE proposed that manufacturers continue to follow the current provisions in 10 CFR 431.17 related to the determination of the represented value. In addition, DOE proposed to move these provisions to the newly proposed §§ 429.64(b) and 429.64(c). 86 FR 71710, 71754. DOE's intent was to move the provisions from 10 CFR 431.17(b)(2)(i) to 429.64 without modification. In this final rule, based on the feedback from NEMA, DOE is revising the second formula in § 429.64(c)(2)(i) to match the second formula in the current regulation § 431.17(b)(2)(i) by replacing the ''equal to'' sign with a ''greater than or equal to'' sign.

In the December 2021 NOPR, DOE proposed that the average full-load efficiency of a basic model would be the arithmetic mean of the tested efficiencies of a sample of electric motors. The average full-load efficiency of a basic model is determined using the definition of ''average full-load efficiency''—*i.e.,* the arithmetic mean of the full-load efficiencies of a population of electric motors of duplicate design. 10 CFR 431.12. This requirement would need to be met starting on the compliance date for any new or amended standards for electric motors published after January 1, 2021, DOE proposed to add regulatory text to implement the definition of ''average full-load efficiency'' such that, when conducting testing, the average full-load efficiency of a basic model would be calculated as the arithmetic mean of the full-load efficiencies of a sample of electric motors selected in accordance with the sampling requirements at 10 CFR 431.17(b)(2). In addition, in the case of manufacturers making representations of energy efficiency starting on the compliance date of any new or amended standards for any electric motors that DOE may set, DOE proposed to remove the equations at 10 CFR 431.17(b)(2)(i)–(ii).[72] Finally, to ensure a high level of quality control and consistency of testing performance within the basic model, DOE proposed to add a requirement to verify that no motor tested would be able to sustain losses exceeding 15 percent of those permitted by the applicable energy conservation standard. 86 FR 71710, 71755.

ABB commented that if the currently permitted five percent additional loss allowance is eliminated, then the sample size required to predict the nominal efficiency with a high degree of probability would increase from five motors to over 100 motors and would take years to complete. (ABB, No. 18 at p. 2) CEMEP stated that the new statistical allowances would require multiple years to comply with and need a wholesale redesign of entire product portfolios. (CEMEP, No. 19 at p. 10) NEMA opposed the changes to the sampling plan at 10 CFR 429.64(e)(1) and commented that the additional test burden would be unmanageable, or that manufacturers would be required to redesign most or all of their existing basic models to a higher average efficiency level to maintain compliance. NEMA commented that the proposal in 10 CFR 429.64(e)(1) to remove the five percent loss allowance permitted in 10 CFR 431.17(b)(2) for the average of the samples relative to the represented efficiency forces a need for the samples chosen to estimate the mean value of efficiency of the basic model population with a low margin of error. NEMA commented that an increase in the number of required sample motors from the present value of 5 to an estimated value of approximately 120 to 140 would be required to estimate the average of the population within a margin of error of 0.05. Alternatively, NEMA commented that to maintain a sample size of 5 units, a redesign of existing basic models would be required to achieve an increase in average population efficiency that is estimated to be between 50 and 62.5 percent of a nominal efficiency band. NEMA believed forcing this redesign would be outside of the scope of a test procedure rulemaking and would need to be done through an energy conservation standards rulemaking where the economic justification and technological feasibility are assessed. (NEMA, No. 26 at pp. 2, 24–27) NEMA provided the results of several statistical simulations to support their comments in appendix A and B of their comments. (NEMA, No. 26 at pp. 31–44)

The Joint Advocates supported the proposed requirement that an electric motor's represented nominal efficiency be less than or equal to the average efficiency based on testing. Specifically, the Joint Advocates supported DOE's proposal that the nominal full-load efficiency of a basic model must be less or equal to the average full-load efficiency determined either through testing or AEDM. (Joint Advocates, No. 27 at p. 5) Grundfos agreed with DOE's proposal to specify how to determine the nominal full-load efficiency of a basic model when the average efficiency of that basic model is known. Grundfos further agreed with DOE's proposal to require that manufacturers must calculate the average full-load efficiency of a basic model as the arithmetic mean of the full-load efficiencies of a sample of electric motors starting on the compliance date for any new or amended electric motor standards. Grundfos further supported DOE's proposal to add a requirement that no electric motor tested in the sample has losses exceeding 15 percent of those permitted by the applicable energy conservation standard. (Grundfos, No. 29 at p. 9)

DOE reviewed NEMA's statistical analysis, which purported to show that an increase of up to approximately 120 to 140 units would be required to ensure that the average of a sample is greater than or equal to the average of the population within a margin of 5 percent. (NEMA, No. 26 at pp. 31–32) That analysis showed that a sample of 120–140 units would be required in order to estimate the 95th percentile value of the population, within a margin of 5 percent. It does not show that a sample of 120–140 units would be required to obtain an average value that is equal to the average of the population within a 5 percent tolerance. DOE is not requiring manufacturers to provide an average value that is equal to the average of the population within a 5 percent tolerance (see discussion related to DOE' typical sampling plans in the remainder of this section). Therefore, DOE disagrees that testing of over a hundred units would be required.

In addition, DOE reviewed the statistical analysis provided by NEMA

[72] The equation at § 431.17(b)(2)(i) currently allows manufacturers to select a value of nominal full-load efficiency that is greater than the average of the tested full-load efficiency of a sample of electric motors and corresponds to 5 percent losses less than the average losses of the sample. The equation at § 431.17(b)(2)(ii) verifies that no motor in the sample has losses exceeding 15 percent of the losses corresponding to the nominal full-load efficiency. *Note:* Motor losses (L) and efficiency (Eff) of motor of a given horsepower (hp) are related by the following equation: L = hp (1/Eff − 1).

to support its view that removing the 5 percent tolerance on a basic model currently rated at 95 percent would require redesigning the motors from an average efficiency of 95.076 (average of the population required to meet the current 5 percent tolerance) to 95.316 (average of the population required if the 5 percent tolerance is removed) in order to ensure, based on a 97.5 percent confidence level, that a randomly selected 5-sample set drawn from the population will have a sample mean greater than or equal to 95 percent. NEMA did not provide any data to support the actual shape of the distribution and its analysis is based on a hypothetical population distribution, with a known mean and standard deviation while, in reality, the mean of the population is unknown. Assuming the same hypothetical statistical distribution as presented by NEMA applies, DOE agrees that to ensure that any randomly selected 5-sample set drawn from the population will have a sample mean greater than or equal to 95 percent, the mean of the population would have to be greater than 95 percent. However, DOE is not requiring that all samples (or 97.5 percent of all samples) of a basic model rated at 95 percent full-load nominal efficiency have an average value of full-load efficiency that is less than or equal to 95 percent.[73] DOE emphasizes that not every, individual unit of a motor basic model must be at or above the standard; however, the represented nominal efficiency must not exceed the population mean. In view of the comments received, DOE believes stakeholders may be confusing the provisions used to determine the represented value of a basic model at 10 CFR 431.17 (b)(2) with the formulas used by DOE to determine if a basic model is in compliance in 10 CFR part 431, appendix A to subpart U. DOE imposes one set of sampling provisions for manufacturers to use when rating their products and a second separate set of sampling provisions for DOE to use when evaluating the compliance of those products. The sampling provisions for determining a represented value (*e.g.,* nominal efficiency) reflect the fact that an important function of represented values is to inform prospective purchasers how efficiently various products operate. In light of that purpose, DOE designed the regulation with respect to represented value so that purchasers are more likely than not to buy a unit that actually performs as efficiently as advertised. The enforcement statistical formulas are designed to determine if a basic model is compliant with the applicable energy conservation standard, and are weighted in favor of the manufacturer to minimize the likelihood of erroneous noncompliance determinations. The certification statistical formulas are designed to protect purchasers; the enforcement statistical formulas are designed to protect manufacturers. The enforcement statistical formulas for electric motors are in 10 CFR part 431, appendix A to subpart U. DOE did not propose, and is not adopting, any changes to these provisions. In other words, while DOE proposed changes in the formulas used to determine the represented value of a basic model, DOE did not propose to change how the compliance of a given basic model is determined. The compliance or non-compliance of a basic model would remain unchanged by the publication of this final rule. Therefore, DOE disagrees with NEMA that basic model redesigns would be required to ensure compliance.

With the current formulas used to determine the represented values of a basic model, a basic model could have a represented value of nominal efficiency that equals or exceeds the current energy conservation standard levels but fails the compliance test in accordance with the existing formulas at 10 CFR part 431, appendix A to subpart U. DOE cannot allow manufacturers to make valid representations of nominal full-load efficiency of a basic model for which the average efficiency of a manufacturer's production is less than the represented value. The risk of a product or equipment being falsely determined to be out of compliance (manufacturer's risk) is balanced against the risk of a product being inaccurately represented (consumer's risk) by establishing a reasonable sampling and testing regime. While the stakeholders' recommendation to rely on a 5 percent tolerance would reduce manufacturer risk, DOE is concerned that it would give rise to too high a risk that a manufacturer may state a nominal efficiency for a basic model that is greater than the actual population mean for that model, or that a manufacturer may state a nominal efficiency for a basic model that is equal to or greater than the current energy conservation standard level while the basic model fails the compliance test at 10 CFR part 431, appendix A to subpart U.

The average (or ''mean'') full-load efficiency of the population is unknown but can be estimated using confidence limits for the mean, which are an interval estimate for the mean. The design of the sampling plan is intended to determine an accurate assessment of product or equipment performance, within specified confidence limits, without imposing an undue testing or economic burden on manufacturers. Different samples from the same population will generate different values for the sample average. An interval estimate quantifies this uncertainty in the sample estimate by computing lower and upper confidence limits (''LCL'' and ''UCL'') of an interval (centered on the average of the sample) which will, with a given level of confidence, contain the population average. Instead of a single estimate for the average of the population (*i.e.,* the average of the sample), a confidence interval generates a lower and upper limit for the average of the population. The interval estimate indicates how much uncertainty there is in the estimate of the average of the population.[74] Confidence limits are expressed in terms of a confidence coefficient. For covered equipment and products, the confidence coefficient typically ranges from 90 to 99 percent.[75] The confidence coefficient (*e.g.,* 97.5 percent) means that if an infinite number of samples are collected, and the confidence interval computed, 97.5 percent of these intervals would contain the average of the population. In other words, although the average of the entire population is not known, there is a high probability (97.5 percent confidence level) that it is greater than or equal to the LCL and less than or equal to the UCL.

To ensure that the represented value of efficiency is no greater than the population average, the sampling plans for determination of the represented value typically consist of testing a representative sample to ensure that any represented value of energy efficiency is no greater than the lower of the average of the sample ($\bar{x}$), or the LCL divided by a constant ''K''. The degree of confidence level associated with the LCL and the value of K varies by product or equipment type and are selected based on an expected level of variability in product performance and

[73] Assuming a normal distribution, if an infinite number of 5-sample sets are drawn, 50 percent will have an average at or above the population average, and 50 percent will fall at or below the population average.

[74] *NIST/SEMATECH e-Handbook of Statistical Methods, https://www.itl.nist.gov/div898/handbook/eda/section3/eda352.htm.*

[75] 10 CFR part 429 outlines sampling plans for certification testing for product or equipment covered by EPCA.

measurement uncertainty.[76] 10 CFR part 429, subpart B. Requiring that the represented value be less than or equal to the LCL ensures that the represented value of efficiency is no greater than the population average. DOE divides the LCL by K to provide additional tolerance to account for variability in product performance and measurement uncertainty.[77] The comparison with the average of the sample further ensures that if the quotient of the LCL divided by K is greater than $\bar{x}$, the represented value is established using average of the sample. DOE relies on a one-sided confidence limit to provide the option for manufacturers to rate more conservatively.

For electric motors, with a given sample and sample average, the average of the population ($\bar{X}$) is unknown but can be estimated using the LCL and UCL interval ($LCL \leq \bar{x} \leq UCL$). Because the average of the population is greater than or equal to LCL, while the average full-load efficiency of the population is unknown, requiring that the represented value be less than or equal to the LCL would ensure that the represented value of efficiency (*i.e.,* the nominal full-load efficiency) is no greater than the population average, as required by the definition of nominal full-load efficiency. Instead, as previously discussed, DOE proposed to require that the represented value be less than or equal to the average of the sample. Because the average of the sample is greater than the LCL,[78] this proposal is less stringent than requiring that the represented value be less than or equal to the LCL, and provides additional tolerance to manufacturers while balancing the risk that an electric motor has a represented value that is higher than the population average. In addition, if a manufacturer believes that a given random 5-unit sample set does not lead to a full-load efficiency rating that is representative of the population, the manufacturer can increase the size of the sample.

For these reasons, while the average full-load efficiency of the population is unknown, DOE believes requiring that the nominal full-load efficiency be less than or equal to the average of the sample satisfies the requirements of ''nominal full-load efficiency'' as defined, while balancing the manufacturer's risk against the consumer's risk. Therefore, DOE is adopting the requirement that manufacturers determine the nominal full-load efficiency of a basic model, as a representative value of efficiency selected from the ''nominal efficiency'' column of Table 12–10, NEMA MG 1–2009, that is not greater than the average full-load efficiency of a basic model. This requirement would apply starting on the compliance date for any new or amended electric motor standards final rule that published after January 1, 2021, to all electric motors subject to energy conservation standards regardless of whether the final rule prescribes new or amended energy conservation standards for certain electric motors. DOE further specifies in this rule that the average full-load efficiency of a basic model is the arithmetic mean of tested efficiencies of a sample of electric motors. In addition, DOE is removing the equations at 10 CFR 431.17(b)(2)(i)–(ii). *Id.*

NEMA stated that manufacturers must use the most recent test procedure once implemented and thus the changes to 10 CFR 429.64(e)(1) would be implemented 180 days after the test procedure final rule and not whenever the energy conservation standards were finalized. (NEMA, No. 26 at p. 25) NEMA commented that any changes that would require currently certified electric motors to be retested and recertified once new test procedures come into effect, which as proposed is 180 days, would be untenable. (NEMA, No. 26 at p. 5)

As previously stated, in the December 2021 NOPR, prior to the compliance date for any new or amended standards for electric motors published after January 1, 2021, DOE proposed that manufacturers of electric motors currently subject to energy conservation standards would continue to follow the current provisions in 10 CFR 431.17 (now moving to 10 CFR 429.64) that relate to the determination of a motor's represented value. This final rule adopts the same timeline and requirements—specifically, the provisions in 10 CFR 429.64(e)(1) for electric motors currently subject to energy conservation standards would only become mandatory once new or amended energy conservation standards are established (for any category of electric motors subject to energy conservation standards, regardless of whether the final rule prescribes new or amended energy conservation standards for certain electric motors). As noted previously, while DOE proposed changes in the formulas used to determine the represented value of a basic model, DOE did not propose changing how the compliance of a given basic model would be determined. In addition, DOE notes that manufacturers of electric motors that are not currently subject to energy conservation standards would not be required to use the test procedure for Federal certification or labeling purposes, until such time as new or amended energy conservation standards are established for such electric motors. However, if manufacturers, distributors, retailers, and private labelers choose to make any representations respecting the energy consumption or cost of energy consumed by such motors, then such voluntary representations must be made in accordance with the test procedure and sampling requirements adopted at 10 CFR 429.64(e).

3. Testing: Use of a Nationally Recognized Certification Program

For manufacturers using a nationally recognized certification program as described in 10 CFR 431.17(a)(5), the selection and sampling requirements are typically specified in the certification program's operational documents but are not always described in detail. In the December 2021 NOPR, DOE proposed additional requirements to ensure that the certification program follows the provisions proposed in 10 CFR 429.64, as well as the AEDM validation procedures, and periodic AEDM verification procedures proposed in 10 CFR 429.70(i). DOE intended for these proposals to ensure consistency between basic model ratings obtained with and without the use of a certification program and would have no impact on how nationally certification programs operate. 86 FR 71710, 71755.

Advanced Energy supported the proposed requirements to ensure that the certification program follows the provisions proposed in 10 CFR 429.64. Advanced Energy stated that this requirement was consistent with its certification scheme (which follows the existing AEDM regulation in 10 CFR 431.17) and would not change the manner in which it currently conducts its testing. (Advanced Energy, No. 33 at p.18) Grundfos agreed with the proposal to add the provisions in 10 CFR 429.64 and 429.70(i) to the requirements that a nationally recognized certification program must satisfy. (Grundfos, No. 29 at p. 9) NEMA disagreed with the requirement due to its relationship with other provisions that would prevent a manufacturer from certifying through the use of its nationally accredited laboratory. (NEMA, No. 26 at p. 28)

[76] The confidence level associated with the LCL, typically ranges from 90 to 99 percent, while K, an adjustment factor, typically ranges from 0.9 to 0.99.

[77] For example, if DOE expects that the variability for measured performance is within a margin of 3 percent, DOE will use a K value of 0.97. *See* for example 79 FR 32019, 32037 (June 3, 2014).

[78] By definition, the confidence interval is such that $LCL \leq \bar{x} \leq UCL$, where $\bar{x}$ is the average of the sample.

The proposal to require that nationally recognized certification program follow the sampling provisions proposed in 10 CFR 429.64, as well as the AEDM validation procedures, and periodic AEDM verification procedures proposed in 10 CFR 429.70(i) is unrelated to the three certification requirement options discussed in section III.M.2. of this document. Therefore, DOE is adopting the proposed additional requirements to ensure that the certification program follows the provisions proposed in 10 CFR 429.64, as well as the AEDM validation procedures, and periodic AEDM verification procedures in 10 CFR 429.70(j).[79]

In addition, after any updates to DOE's electric motors regulations, DOE proposed that, within one year of publication of the final rule, all certification programs must either submit a letter to DOE certifying that no change to their program is needed, or submit a letter describing the measures implemented to ensure the criteria in the proposed 10 CFR 429.73(b) are met. If a certification program submits a letter describing updates to their program, DOE proposed that the current certification program would still be recognized until DOE evaluates any newly implemented measures and decides otherwise. 86 FR 71710, 71755.

In response, Advanced Energy stated that it follows the sampling and minimum test requirements as prescribed, and that it is beneficial to have consistency across all motor efficiency certification body schemes. (Advanced Energy, No. 33 at p. 18) DOE did not receive any additional comments on this issue and is adopting its proposal to require that, within one year of publication of the final rule, all certification programs must either submit a letter to DOE certifying that no change to their program is needed, or submit a letter describing the measures implemented to ensure the criteria in the proposed § 429.73(b) are met. If a certification program submits a letter describing updates to their program, the current certification program would still be recognized until DOE evaluates any newly implemented measures and decides otherwise.

4. Use of an AEDM

Section 431.17 also specifies the requirements for using an AEDM (10 CFR 431.17(a)(2)), including requirements for substantiation (*i.e.,* the initial validation) (10 CFR 431.17(a)(3), 10 CFR 431.17(b)(3)) and subsequent verification of an AEDM (10 CFR 431.17(a)(4)). Those requirements ensure the accuracy and reliability of the AEDM both prior to use and then through ongoing verification checks on the estimated efficiency.

In the December 2021 NOPR, DOE proposed to replace the term ''substantiation'' with the term ''validation'' to better align the relevant terminology with the AEDM provisions in 10 CFR 429.70. 86 FR 71710, 71755. DOE did not receive any comments on this topic and is amending its regulations to replace the term ''substantiation'' with the term ''validation.''

In the December 2021 NOPR, DOE also proposed to modify one of the requirements for AEDM validation. Currently, the provisions in 10 CFR 431.17(a)(3)(ii) require that the simulated full-load losses for each basic model selected for AEDM validation testing must be within plus or minus ten percent of the average full-load losses determined from the testing of that basic model.[80] DOE proposed to change that language to a one-sided 10 percent tolerance to allow manufacturers flexibility when choosing to rely on a more conservative AEDM. (*i.e.,* the simulated full-load losses for each basic model selected for AEDM validation testing, calculated by applying the AEDM, must be greater or equal to 90 percent of the average full-load losses determined from the testing of that basic model). This proposal would not require manufacturers to update their AEDMs and basic model ratings. *Id.*

In response to the December 2021 NOPR, Grundfos agreed with the proposed validation requirements for AEDMs. (Grundfos, No. 29 at p. 9) DOE did not receive any additional comments on this proposal. Consequently, it is adopting the proposed one-sided tolerance requirement for the reasons discussed as proposed.

In addition, DOE proposed to specify how to obtain the nominal full-load efficiency of a basic model using the simulated full-load efficiency of that basic model determined through the application of an AEDM: the nominal full-load efficiency of a basic model must be less than or equal to the simulated full-load efficiency of that basic model determined through the application of an AEDM. 86 FR 71710, 71754. DOE did not receive any comments on this issue. As a result, it is adopting its proposal to require that when using an AEDM, the nominal full-load efficiency of a basic model must be less than or equal to the simulated full-load efficiency of that basic model determined through the application of an AEDM.

Paragraph (b) of 10 CFR 431.17 provides further clarity regarding testing if a certification program is not used. Basic models used to validate an AEDM must be selected for testing in accordance with paragraph (b)(1), and units of each such basic model must be tested in accordance with paragraph (b)(2). 10 CFR 431.17(b)(3). Paragraph (b)(1) explains the criteria for selecting a minimum of 5 basic models for certification testing (in an accredited laboratory) to validate an AEDM. Paragraph (b)(2) provides the criteria for selecting units for testing, which includes a minimum sample size of 5 units in most cases.[81] For manufacturers using AEDMs, paragraph (b)(2) applies to those basic models selected for validating the AEDM. Paragraph (b)(3) also explains that the motors tested to validate an AEDM must either be in a certification program or must have been tested in an accredited laboratory. 10 CFR 431.17(b)(2)–(3).

In the December 2021 NOPR, DOE proposed to revise the current regulatory language to specify that, when manufacturers use an accredited laboratory or a nationally recognized testing program for testing the basic models used to validate the AEDM, the selection criteria and sampling requirements as described in paragraph (b)(2) apply, including the requirement to select a minimum of 5 basic models that must comply with the energy conservation standards at 10 CFR 431.25 (if any exist). In addition, when using an accredited laboratory or nationally recognized testing program for testing, DOE proposed that the average full-load

[79] The AEDM validation procedures for electric motors that DOE proposed for 10 CFR 429.70(i) in the December 2021 NOPR are being adopted at 10 CFR 429.70(j) in this rule. After the December 2021 NOPR, a separate rule published on July 22, 2022, added provisions at 10 CFR 429.70(i). 87 FR 45195. Accordingly, the AEDM validation procedures are renumbered in this final rule.

[80] The output of the AEDM is the average full-load efficiency of the basic model. The represented value of nominal full-load efficiency is obtained by applying the provisions discussed in section III.N.1 of this document. The average full-load losses predicted by the AEDM can be calculated as hp × (1/Eff − 1) where hp is the motor horsepower and Eff is the average full-load efficiency predicted by the AEDM.

[81] As discussed previously and in the remainder of this section, the provisions for selecting units within a basic model and minimum sample size described in paragraph 10 CFR 431.17(b)(2) apply to three different situations: when (1) testing at an accredited laboratory; (2) using an AEDM and selecting units for substantiating the AEDM; and (3) using an AEDM and selecting units for periodic verification testing.

efficiency of each basic model selected to validate the AEDM must be determined based on the provisions discussed in section III.N.2. Further, to reduce testing burden, DOE proposed to replace the requirement in paragraph (b)(1) that two of the basic models must be among the five basic models with the highest unit volumes of production by the manufacturer in ''the prior year'' with the phrase in ''the prior 5 years''. The extension from 1 year to 5 years would reduce testing burden in the case of a year-to-year variation in the basic models with the highest unit volumes of production and would not impact basic model ratings. 86 FR 71710, 71756.

In this final rule, DOE adopts the basic model selection requirements as proposed with the exception of one provision as discussed in this paragraph. In response to the December 2021 NOPR, NEMA commented that the proposed requirement regarding basic model selection for validation of an AEDM in the proposed §§ 429.70(a)(i)(2)(i)(D) and 429.70(a)(j)(2)(i)(D) (''Each basic model must have the lowest average full-load efficiency among the basic models within the same equipment class'') should be changed as follows to be consistent with the current provisions in § 431.17(b)(1)(i)(D): ''Each basic model must have the lowest nominal full-load efficiency among the basic models within the same equipment class.'' NEMA explained that relying on the ''lowest average full-load efficiency'' introduces the possibility of a basic model not being valid for purposes of validating an AEDM simply because there is another basic model with the same nominal full-load efficiency but with an average full-load efficiency that is slightly higher by a virtually unmeasurable amount and places an unreasonable burden on the manufacturer that is not justified by any benefit with respect to validating the accuracy of the AEDM. In this final rule, DOE maintains the current language in § 431.17(b)(1)(i)(D) and requires that each basic model must have the lowest nominal full-load efficiency among the basic models within the same equipment class in line with the DOE metric (*i.e.,* ''nominal full-load efficiency'').

Currently, the periodic verification of an AEDM can be achieved in one of three ways: through participation in a certification program; by additional, periodic testing in an accredited lab; or by verification by a professional engineer. When using periodic testing in an accredited laboratory, a sample of units must be tested in accordance with the DOE test procedure and 10 CFR 431.17(b)(2). 10 CFR 431.17(a)(4)(A). The current regulatory text does not specify how often the periodic testing must be conducted.

In the December 2021 NOPR, DOE proposed to add that manufacturers must perform a sufficient number of periodic verification tests to ensure the AEDM maintains its accuracy and reliability. Paragraph (b)(2) currently provides the criteria for selecting units for testing (in an accredited laboratory) when conducting periodic AEDM verification, including a minimum sample size of 5 units in most cases. DOE proposed to revise the 5-unit minimum requirement on the sample size and to replace it by requiring that manufacturers test at least one unit of each basic model. DOE believes that at least one unit comprises a sufficient sample size when conducting an AEDM verification and would reduce testing burden. 86 FR 71710, 71756.

Advanced Energy commented that the term ''periodic'' as used in reference to AEDM subsequent verification is very broad, and that DOE should request information from manufacturers on how often their AEDMs are updated. Advanced Energy stated that there are many reasons a manufacturer would update its AEDM, and noted that its subsequent verification is performed annually. Advanced Energy further agreed that one basic model is sufficient for subsequent verification testing, but that DOE should be clear on which basic model needs verifying, and that requiring one unit of every basic model would increase test burden to manufacturers. (Advanced Energy, No. 33 at pp. 19)

In this final rule, rather than specifying a verification testing frequency, DOE adopts the proposed AEDM verification provision which specifies that sufficient testing must be conducted to ensure the AEDM maintains its accuracy and reliability. DOE believes the manufacturer is responsible for determining what constitutes a sufficient number of periodic verification tests to ensure the AEDM maintains its accuracy and reliability.

Paragraph (b)(2) also currently includes the equations to use when conducting periodic AEDM verification. 10 CFR 431.17(b)(2)(i)–(ii). The equations in paragraph (b)(2) are used after the represented value of the basic model has already been determined (*e.g.,* by AEDM)[82] ''in a test of compliance with a represented average or nominal efficiency.'' The equations are applied to verify that the average full-load efficiency of the sample and the minimum full-load efficiency of the sample of the basic model, are within a prescribed margin of the represented value as provided by applying the AEDM (*i.e.,* a test of compliance with a represented average or nominal efficiency). In addition, the equations in paragraph (b)(2) also imply that the represented value of the basic model has already been determined (*e.g.,* by AEDM). As previously noted, DOE proposed to revise the current regulatory text to remove the equations currently located in 10 CFR 431.17(b)(2)(i)–(ii). Instead, for manufacturers conducting periodic AEDM verification using testing, DOE proposed that manufacturers would rely on the same criteria used for the AEDM validation at 10 CFR 429.70(i)(2)(iv) and compare the average of the measured full-load losses of the basic model[83] to the simulated full-load losses of the basic model as predicted by the AEDM.

NEMA commented in reference to the requirements in proposed §§ 429.70(a)(i)(3)(A) and 429.70(a)(j)(3)(a): ''the simulated full-load losses for each unit must be greater than or equal to 90 percent of the measured full-load losses (*i.e.,* 0.90 × average of the measured full-load losses ≤ simulated full-load losses).'' NEMA commented that the clarification in parenthesis was acceptable but the phrase ''for each unit'' that precedes it is confusing because there are not unique simulated full-load losses for each unit but, rather, for each basic model. NEMA added that for further clarity and consistency with the AEDM validation procedure in § 429.70(a)(i)(2)(iv), the words ''measured full-load losses'' should be changed to ''average of the measured full-load losses.'' (NEMA, No. 26, at pp. 28–29)

DOE agrees with NEMA. As written, the proposed regulatory text only accounted for a situation where a single unit per basic model was selected when conducting AEDM verification. In this final rule, DOE is amending the regulatory text to align with the preamble discussion and specify that if more than one unit per basic model is selected: (1) the requirement is for the simulated full-load losses for each basic model; and (2) ''measured full-load

[82] The AEDM output is the simulated full-load efficiency. The represented value of nominal full-load efficiency as predicted by the AEDM is obtained by applying the provisions discussed in section I.A.1 of this document.

[83] The sample could include a single unit, in which case, the average measured full-load losses of the basic model are the measured full-load losses of the unit.

losses'' is replaced by the ''average of the measured full-load losses.''

If a certification program to conduct the AEDM verification is used, the provisions at 10 CFR 431.17(a)(4)(i)(B) specify that a manufacturer must periodically select basic models to which it has applied the AEDM and have a nationally recognized certification program certify its nominal full-load efficiency. The provision does not specify the criteria to use when comparing the output of the AEDM of the tested and certified values of nominal full-load efficiency. In the December 2021 NOPR, DOE stated it was considering three options to further specify how the manufacturer must conduct the AEDM verification when using a certification program. DOE considered proposing: (1) that manufacturers rely on the same 10 percent tolerance used for the AEDM validation at 10 CFR 429.70(i)(2)(iv) and compare the losses corresponding to the tested and certified nominal full-load efficiency of the basic model to the nominal full-load efficiency of the basic model as predicted by the AEDM;[84] (2) that manufacturers rely on a higher tolerance (*e.g.,* a 15 percent tolerance rather than 10 percent) than used for the AEDM validation at 10 CFR 429.70(i)(2)(iv) and compare the losses corresponding to the tested and certified nominal full-load efficiency of the basic model to the nominal full-load efficiency of the basic model as predicted by the AEDM; or (3) to continue to not specify any requirements but require that certification programs provide a detailed description of the method used to verify the AEDM. 86 FR 71710, 71756.

Advanced Energy commented that of the three options to specify how a manufacturer must conduct AEDM verification when using a certification program, Advanced Energy supported Option (1), which is consistent with its current practice, and that Option (3) is the same as Option (1) in its case since it follows the recommended AEDM subsequent verification procedure provided in the current version of 10 CFR 431.17. (Advanced Energy, No. 33 at p. 19)

In this final rule, DOE specifies how the manufacturer must conduct the AEDM verification when using a certification program and requires that manufacturers must rely on the same 10 percent tolerance used for the AEDM validation at 10 CFR 429.70(j)(2)(iv)[85] and compare the losses corresponding to the simulated and certified nominal full-load efficiency of the basic model to the nominal full-load efficiency of the basic model as predicted by the AEDM.

In the December 2021 NOPR, DOE further proposed to remove the option to rely on a professional engineer to conduct AEDM verification because this is not an option that is used by manufacturers. 86 FR 71710, 71756. DOE did not receive any comments on this proposal and is removing it as proposed.

Finally, in the December 2021 NOPR, DOE explained that the proposed AEDM provisions would also apply to the additional electric motors proposed for inclusion in the scope of the test procedure, when a manufacturer of such motors would be required to use the DOE test procedure. DOE did not receive any comments specific to that issue. *Id.* In this final rule, DOE adopts the requirement that the AEDM provisions adopted for currently regulated electric motors will also apply to the additional electric motors included in the scope of the test procedure, when a manufacturer of such motors would be required to use the DOE test procedure.

O. Certification, Sampling Plans and AEDM Provisions for Dedicated-Purpose Pool Pump Motors

In the December 2021 NOPR, DOE proposed to include certification, sampling plan, and AEDM provisions for DPPP motors subject to the requirements in subpart Z of 10 CFR part 431. Because DPPP motors are a subset of electric motors, DOE proposed to apply the same certification, sampling provisions and AEDM provisions for consistency. In addition, DOE proposed to allow the use of ''nominal full-load efficiency'' as an alternative represented value for DPPP motors. DOE proposed to add these provisions in a new section 10 CFR 429.65[86] and 10 CFR 429.70(j), and to specifically reference DPPP motors in 10 CFR 429.73 and 10 CFR 429.74 as proposed. 86 FR 71710, 71757.

DOE did not receive comments specific to DPPP motors. In this final rule, DOE adopts the same certification, sampling provisions and AEDM provisions for DPPP motors as for electric motors as discussed in sections III.M and III.N of this document. DOE adopts these provisions in a §§ 429.65 and 429.70(k),[87] and specifically references DPPP motors in 10 CFR 429.73 and 429.74. In addition, DOE allows the use of ''nominal full-load efficiency'' as an alternative represented value for DPPP motors.

As discussed in the December 2021 NOPR, manufacturers would be required to test such motors once compliance is required with a labeling or energy conservation standard requirement should such a requirement be established. (42 U.S.C. 6315(b); 42 U.S.C. 6316(a); 42 U.S.C. 6295(s)). Any voluntary representations by manufacturers, distributors, retailers, or private labelers about the energy consumption or cost of energy for these motors must be based on the use of this test procedure and sampling requirements beginning 180 days following publication of this final rule. DOE's final rule does not require manufacturers who do not currently make voluntary representations to begin making public representations of efficiency. (42 U.S.C. 6314(d)(1)). 86 FR 71710, 71757.

P. Effective and Compliance Dates

The effective date for the adopted test procedure amendment will be 30 days after publication of this final rule in the **Federal Register**. EPCA prescribes that all representations of energy efficiency and energy use, including those made on marketing materials and product labels, must be made in accordance with an amended test procedure, beginning 180 days after publication of the final rule in the **Federal Register**. (42 U.S.C. 6314(d)(1)). EPCA provides an allowance for individual manufacturers to petition DOE for an extension of the 180-day period if the manufacturer may experience undue hardship in meeting the deadline. (42 U.S.C. 6314(d)(2). To receive such an extension, petitions must be filed with DOE no later than 60 days before the end of the 180-day

[84] The AEDM output is the average full-load efficiency. The represented value of nominal full-load efficiency as predicted by the AEDM is obtained by applying the provisions discussed in section III.N.1 of this document.

[85] The AEDM validation tolerance requirements for electric motors that DOE proposed for 10 CFR 429.70(i)(2(iv) in the December 2021 NOPR are being adopted at 10 CFR 429.70(j)(2)(iv) in this rule. After the December 2021 NOPR, a separate rule published on July 22, 2022, added provisions at 10 CFR 429(i). 87 FR 45195. Accordingly, the AEDM validation tolerance requirements are being renumbered in this final rule.

[86] In the December 2021 NOPR the proposed regulatory text pertaining to DPPP motor certification and sampling provisions is located in a newly proposed section 10 CFR 429.65 and not section 10 CFR 429.66 as incorrectly cited in the December 2021 NOPR, which included a typographical error. 86 FR 71710, 71757.

[87] The AEDM validation procedures for DPPP motors that DOE proposed for 10 CFR 429.70(j) in the December 2021 NOPR are being adopted at 10 CFR 429.70(k) in this rule. After the December 2021 NOPR, a separate rule published on July 22, 2022, added provisions at 10 CFR 429(i). 87 FR 45195. Accordingly, the electric motors and DPPP motors AEDM validation procedures provisions are being renumbered in this final rule.

period and must detail how the manufacturer will experience undue hardship. (*Id.*) To the extent the modified test procedure adopted in this final rule is required only for the evaluation and issuance of updated efficiency standards, compliance with the amended test procedure does not require use of such modified test procedure provisions until the compliance date of updated standards.

Franklin Electric stated that a 6-month period after publication of a final rule to comply with a submersible motor test procedure is too short, particularly when there is no defined certification body yet. (Franklin Electric, No. 22 at p. 5) As discussed in section III.A.8 of this document, DOE is no longer considering a submersible electric motor test method in this test procedure.

Specific to DOE's proposal to expand coverage to special and definite-purpose SNEMs, AHAM and AHRI commented that 180 days to comply with the proposed procedure if finalized is an unrealistic timeline. AHAM and AHRI commented that component motors that were once available for a product may no longer be available and OEMs will not have the information about market availability of new component motors until well after the motor has been tested and certified. (AHAM and AHRI, No. 36 at p. 7) AHAM and AHRI commented that OEMs may have to redesign and test equipment to accommodate for a different motor size, which takes years to complete. *Id.* As discussed previously, DOE notes that manufacturers of electric motors for which DOE is including within the scope of the test procedure, but that are not currently subject to an energy conservation standard, would not be required to use the test procedure, for Federal certification or labeling purposes, until such time as amended or new energy conservation standards are established for such electric motors. As such, only voluntary representations by manufacturers, distributors, retailers, or private labelers about the energy consumption or cost of energy for these motors must be based on the use of the test procedure beginning 180 days following publication of the final rule. Comments and costs associated with these voluntary representations are discussed in section III.Q of this document.

Q. Test Procedure Costs

1. Test Procedure Costs and Impacts

In this final rule, DOE revises the current scope of the test procedures to add additional electric motors and subsequent updates needed for supporting definitions and metric requirements as a result of this expanded scope; incorporates by reference the most recent versions of the referenced industry standards; incorporates by reference additional industry standards used to test newly covered electric motors; clarifies the scope and test instructions by adding definitions for specific terms; revises the current vertical motor testing instructions to reduce manufacturer test burden; revises the provisions pertaining to certification testing and determination of represented values; and adds provisions pertaining to certification testing and determination of represented values for DPPP motors.

Regarding several of the amendments to the provisions pertaining to certification testing and determination of represented values, DOE notes that the updates that are effective 180 days after the publication of this final rule, include moving and largely retaining the provisions related to AEDMs (see section III.N.4 of this document), as well as moving and largely retaining the procedures for recognition and withdrawal of recognition of accreditation bodies and certification programs (*see* sections III.L and III.N.3 of this document) from 10 CFR part 431 to 10 CFR part 429. DOE does not anticipate any added test burden from these changes. Regarding other aspects of this rule (*i.e.,* requiring to certify using three options as discussed in section III.M.2, revising the provisions pertaining to the determination of the represented value as discussed in sections III.N.1 and III.N.2 of this document) whose compliance date would occur once the compliance date is reached for any final rule that DOE may adopt to set for electric motors, DOE will discuss the associated costs in the energy conservation standards rulemaking. The same would apply to the new provisions pertaining to the certification testing and AEDM of dedicated-purpose pool pump motors as discussed in section III.O of this document, whose compliance date would be on or after the compliance date of a final rule adopting new or amended energy conservation standards for dedicated-purpose pool pump motors. DOE will discuss the associated costs in the energy conservation standards rulemaking.

Of the remaining amendments, DOE has determined that the following would impact testing costs: (1) the updates expanding scope to include other motor categories, and provisions pertaining to determination of represented values for DPPP motors; and (2) the update to vertical motor testing. These amendments are discussed in the following paragraphs.

a. Voluntary Representations

DOE is adding certain categories of electric motors to the scope of the test procedure. Specifically (1) air-over electric motors; (2) certain electric motors greater than 500 hp; (3) electric motors considered small; (3) inverter-only electric motors; and (4) certain synchronous motor technologies. In addition, DOE is incorporating by reference additional test methods. Finally, DOE is adding provisions pertaining to determination of represented values for DPPP motors.

Manufacturers of those additional electric motors that DOE is including within the expanded scope of the test procedure that this final rule is adopting would not be required to test those motors in accordance with the DOE test procedure until the compliance date of a final rule adopting new or amended energy conservation standards for such electric motors is reached. If manufacturers voluntarily make representations regarding the energy consumption or cost of energy of such electric motors, they would be required to test according to the DOE test procedure. (42 U.S.C. 6314(d)(1)). DOE has determined that the inclusion of additional motors within the scope of the test procedure and the update pertaining to determination of represented values for DPPP motors would result in added costs to motor manufacturers if manufacturers choose to make efficiency representations. These cost are estimated in the following paragraphs.

In the December 2021 NOPR, DOE determined that approximately 50 percent of the basic models that are covered under the new test procedure currently make voluntary representations based on a market review of product catalogs. 86 FR 71710, 71757. Regarding representations, NEMA disagreed with DOE's estimate that 50 percent of the current market of the proposed expanded scope EM and DPPP motors make voluntary representations, and instead stated that currently only industrial-rated motors tend to make representations while commercial-rated motors or SNEMs rarely do, and that these subgroups should be analyzed separately. (NEMA, No. 26 at p. 30) Grundfos stated that it already makes voluntary representations for their SNEMs, submersible, and inverter-only products. (Grundfos, No. 29 at p. 9) Trane commented that none of the air-over, inverter-only, or synchronous motors it purchases from suppliers currently have representations of efficiency. Trane stated that its only concern is system-level efficiency. (Trane, No. 31 at p. 7) DOE appreciates the comments. However, the analysis conducted in this section is based on a per-unit cost, not industry-wide cost, so this value does not directly impact DOE's per unit test cost analysis in this final rule. In the following paragraphs, DOE estimates the associated per-unit costs for making voluntary representations regarding the energy consumption or cost of energy of expanded scope electric motors.

DOE estimates that 10 percent of the motors that include voluntary representations from their manufacturers would be physically tested, consistent with the conclusions considered in the December 2021 NOPR that only a fraction of basic models are physically tested (the remainder have efficiency determined through an alternative efficiency determination method (''AEDM'')). 86 FR 71710, 71757. Further, this final rule would require at least five units be tested per basic model. 10 CFR 431.17(b)(2). However, considering DOE is harmonizing with current industry standards, DOE assumes that manufacturers have already tested at least one unit for all the expanded scope electric motor basic models. Therefore, DOE estimates that manufacturers may need to conduct up to four additional tests per expanded scope electric motor basic model.

DOE identified that the testing requirements can be summarized broadly with the following three groups: (1) motors tested according to CSA C747–09, (2) motors tested according to IEC 61800–9–2:2017, and (3) motors tested according to Section 34.4 of the NEMA Air-Over Motor Efficiency Test Method. Consistent with the December 2021 NOPR, DOE estimated that 90 percent of the physical tests for these electric motors would be conducted at in-house test facilities, and the remaining 10 percent of the physical tests would be conducted at third-party test facilities. 86 FR 71710, 71758. DOE assumed that the per-unit test costs differ between conducting testing at in-house test facilities versus testing at third-party test facilities. Table III.23 lists the estimated in-house and third-party single unit test cost incurred by the manufacturer for each industry standard.

TABLE III.23—ELECTRIC MOTOR PER UNIT TEST COST ESTIMATES

Industry standard	Tested at in-house facility (per unit test cost)	Tested at third-party facility (per unit test cost)
CSA C747–09	$587	$2,210
IEC 61800–9–2:2017	750	3,210
Section 34.4 of NEMA Air-over Motor Efficiency Test Method	631	2,210

To estimate in-house testing costs, DOE assumed testing a single electric motor unit to CSA C747–09 requires approximately nine hours of a mechanical engineer technician time and three hours from a mechanical engineer. DOE assumed testing a single electric motor-drive combination unit to IEC 61800–9–2:2017 requires approximately twelve hours of a mechanical engineer technician time and three and a half hours of time from a mechanical engineer. DOE assumed testing a single electric motor unit according to Section 34.4 of NEMA Air-Over Motor Efficiency Test Method requires ten hours of mechanical engineer technician time and three hours of time from a mechanical engineer. Based on data from the Bureau of Labor Statistics' (''BLS's'') Occupational Employment and Wage Statistics, the mean hourly wage for a mechanical engineer technician is $30.47 and the mean hourly wage for a mechanical engineer is $46.64.[88] Additionally, DOE used data from BLS's Employer Costs for Employee Compensation to estimate the percent that wages comprise the total compensation for an employee. DOE estimates that wages make up 70.5 percent of the total compensation for an employee.[89] Therefore, DOE estimated that the total hourly compensation (including all fringe benefits) of an employee is $43.22 for a mechanical engineering technician and $66.16 for a mechanical engineer.[90]

Using these labor rates and time estimates, DOE estimates that it would cost electric motor manufacturers approximately $587 to conduct a single test for motors tested according to CSA C747–09; approximately $750 to conduct a single test for motors tested according to IEC 61800–9–2:2017; and approximately $631 to conduct a single test for motors tested according to Section 34.4 of the NEMA Air-over Motor Efficiency Test Method, if these test were conducted by the electric motor manufacturers in-house.

To estimate third-party lab costs, DOE received quotes from test labs on the price of conducting each industry standard. DOE then averaged these prices to arrive at an estimate of what the manufacturers would have to spend to test their product using a third-party test lab. Using these quotes, DOE estimates that it would cost electric motor manufacturers approximately $2,000 to conduct a single test for motors tested according to CSA C747–09; approximately $3,000 to conduct a single test for motors tested according to IEC 61800–9–2:2017; and approximately $2,000 to conduct a single test for motors tested according to Section 34.4 of the NEMA Air-Over Motor Efficiency Test Method, if these tests were conducted by a third-party test facility. Depending on the size and weight of the electric motor being tested, manufacturers would also incur a cost to ship the product to the third-party lab, based on shipping costs associated with DOE's testing, DOE expects this cost to be approximately $210 per unit to and from the lab.

Regarding testing costs, AI Group stated that a typical motor test conducted in an Australian third-party lab will cost $3,000 to $5,000 depending on motor size and that in-house testing costs would be much lower. In providing these costs, AI Group did not specify how much lower these in-housing testing costs would be compared to third-party labs and it did

[88] DOE used the May 2021 Occupation Profiles of ''17–3027 Mechanical Engineering Technologists and Technicians'' to estimate the hourly wage rate of a mechanical technician (*See www.bls.gov/oes/current/oes173027.htm*) and ''17–2141 Mechanical Engineers'' to estimate the hourly wage rate of a mechanical engineer (*See www.bls.gov/oes/current/oes172141.htm*).

[89] DOE used the December 2021 ''Employer Costs for Employee Compensation'' to estimate that for ''Private Industry'' ''Wages and Salaries'' are 70.5 percent of total employee compensation (*See www.bls.gov/news.release/pdf/ecec.pdf*).

[90] Mechanical Engineering Technician: $30.47/0.705 = $43.22. Mechanical Engineer: $46.64/0.705 = $66.16.

not note any differences in costs based on the specific industry testing standard being conducted. (AI Group, No. 25 at p. 8) CEMEP stated that a small motor efficiency test (<10 hp) by a third-party lab would cost €4000 to €5000 euros per test, and that a comparable in-house test would be approximately a third of that cost—€1333 to €1666 per test. (CEMEP, No. 19 at p.11) Additionally, Grundfos noted a disagreement with DOE's estimated in-house and third-party test costs. It stated that DOE did not account for sample motor costs, shipping products to test labs, and third-party certification costs. It also noted a higher estimate of in-house test time and labor: 20 hours of a technician's time and 4 hours of an engineer's time per test. Grundfos did not specify the industry standard being used for that time estimate. (Grundfos, No. 29 at p. 10) For this final rule, DOE gathered its quotes from domestic third-party labs and acknowledges that third-party tests conducted in overseas labs may differ somewhat in cost. DOE also recognizes that in-house testing costs will vary across manufacturers. Since the values provided in the comments do not provide an industry standard that the motors are being tested to, DOE did not incorporate the values into its average estimated test cost. Per the remainder of Grundfos's comment, DOE has adjusted its analysis to include an estimate of shipping costs, expects that the sample motors will be recoverable, and notes that third-party certification costs do not affect voluntary representations and will be addressed in any future energy conservation standards.

Regarding cumulative regulatory burden, Lennox stated that DOE needs to consider the cumulative regulatory burden imposed on HVACR manufacturers that are having multiple energy conservation standards changing in the near future. Among these, they highlighted new standards for: Central Air Conditioners (''ACs''), Commercial ACs, Commercial Warm Air Furnaces and variable refrigerant flow systems. (Lennox, No. 24 at p. 9) JCI commented that the updated scope would exacerbate the cumulative test burden the HVAC industry is already facing with other DOE regulations. (JCI, No. 34 at p. 2). AHAM and AHRI emphasized that DOE needs to consider the additional burden in the context of the many updated standards affecting the HVAC industry and they described the new standards to which they will be subject from DOE, UL, EPA, and requirements under the American Innovation and Manufacturing Act, which will require the reduction of high-global warming potential (''GWP'') hydrofluorocarbons (''HFCs'') in stationary air conditioning (AC) equipment (in turn requiring the development of a second product line for all equipment using low-GWP refrigerants). (AHAM and AHRI, No. 36 at pp. 11–12). DOE recognizes the potential manufacturer burden of multiple simultaneous rulemakings and will evaluate the cumulative regulatory burden in future energy conservation standards rulemakings relating to electric motors as provided by its established processes.[91]

b. Updating Vertical Motor Testing Requirements

DOE is updating the testing requirements for vertical motors with hollow shafts to not require welding of a solid shaft to the drive end, and instead permit connection of electric motors to a dynamometer without restriction on the motor end and using a coupling of torsional rigidity greater than or equal to that of the motor shaft.

DOE has determined that its adopted amendments will not require changes to the designs of electric motors and will not impact the utility of such electric motors or impact the availability of electric motor options. DOE has also determined that the amendments will not impact the representations of electric motor energy efficiency/energy use based on the determination that manufacturers would be able to continue rely on data generated under the preceding test procedure. As such, retesting of electric motors will not be required solely as a result of DOE's adoption of this amendment.

Although DOE has determined that the amendments related to vertical motors will not add to manufacturer costs, under specific circumstances they may reduce testing costs. NEMA commented that the existing requirement to weld may prevent a motor from being used in its intended application (NEMA, No. 6 at p. 3). In such instances, the testing cost could include the cost of scrapping an otherwise useable motor. This scrap cost may be avoided if welding is not required by appendix B, in which case the test cost savings could equal the value of the motor.

To estimate these cost savings, DOE determined approximately how many tests of these motors are conducted annually. To do this, DOE reviewed product catalogs from 2006 and compared these to catalogs from 2018 to determine how many new vertical hollow shaft models have been produced in that time. DOE annualized this count to estimate how many new vertical hollow shaft motors are listed per year and would need to be certified as compliant with 10 CFR 431.25. Using the 2018 catalog, DOE found the average price of a vertical hollow shaft motor and assumed a markup of 100 percent to estimate the manufacturer's production cost. Next, DOE requires at least five units to be tested per basic model. 10 CFR 431.17(b)(2) Consistent with the final rule for test procedures for small electric motors and electric motors published January 4, 2021, DOE estimated that 10 percent of these new vertical hollow shaft motors are certified via physical testing, based on the observation that most manufacturers use an AEDM to certify an electric motor as required under 10 CFR 431.36. 86 FR 4, 17 (January 4, 2021) (applying a general 10 percent estimate regarding the number of electric motors that would be physically tested). Using this methodology, DOE estimates that annual cost savings to industry due to the amendments may approach $9,410 per year.

2. Harmonization With Industry Standards

DOE's established practice is to adopt relevant industry standards for a regulated product or equipment unless such methodology would be unduly burdensome to conduct or would not produce test results that reflect the energy efficiency, energy use, water use (as specified in EPCA) or estimated operating costs of that product during a representative average use cycle. 10 CFR 431.4; Section 8(c) of appendix A of 10 CFR part 430 subpart C. In cases where the industry standard does not meet EPCA's statutory criteria for test procedures, DOE will make modifications through the rulemaking process to these standards as the DOE test procedure. With regard to electric motors subject to standards, EPCA requires the test procedures to be the test procedures specified in NEMA Standards Publication MG1–1987 and IEEE Standard 112 Test Method B for motor efficiency, or the successor standards, unless DOE determines by rule, published in the **Federal Register** and supported by clear and convincing evidence, that to do so would not meet the statutory requirements for test procedures to produce results that are representative of an average use cycle and not be unduly burdensome to conduct. (42 U.S.C. 6314(a)(5)(A) and (B)). DOE established the prior test procedures for electric motors at appendix B based on the provisions of

[91] *See* 10 CFR part 430 subpart C appendix A section 13(g).

NEMA MG 1–2009, CSA C390–10, IEC 60034–2–1:2014, IEEE 112–2017, which are incorporated by reference and all of which contain methods for measuring the energy efficiency and losses of electric motors. These referenced standards specify test methods for polyphase induction electric motors above 1 horsepower that can operate directly connected to a power supply. DOE reviewed each of the industry standards and is updating its incorporation by reference to IEC 60034–12:2016, CSA C390–10, and NEMA MG 1–2016 to align with the latest revised and reaffirmed versions of these standards.

In addition, certain additional motors incorporated into the scope of the test procedure cannot be tested using the industry standards incorporated by reference for currently regulated electric motors because they require modifications to the test procedure to account for: requiring to be connected to an inverter to be able to operate (*i.e.,* inverter-only motors); and differences in electrical design (*i.e.,* single-phase induction electric motors included as SNEMs, and synchronous electric motors). For these additional motors newly included in scope, DOE incorporates by reference the following additional industry standards: IEEE 114–2010, CSA C747–09, IEC 60034–2–1:2014, and IEC 61800–9–2:2017. IEEE 114–2010, CSA C747–09, and IEC 60034–2–1:2014 specify methods for measuring the efficiency and losses of single-phase induction electric motors. IEC 61800–9–2:2017 specifies methods for measuring the efficiency and losses of induction and synchronous inverter-only electric motors.

The test procedures established for air-over electric motors and for SNEMs are included in NEMA MG 1–2016. *See* Section IV, Part 34: Air-Over Motor Efficiency Test Method and Section 12.30. Section 12.30 specifies the use of IEEE 112 and IEEE 114 for all single-phase and polyphase motors.[92] As further discussed in section III.D.2 of this document, DOE is requiring testing of SNEMs—other than inverter-only electric motors—according to IEEE 112–2017, (or CSA C390–10 or IEC 60034–2–1:2014, which are both equivalent to IEEE 112–2017; see discussion in section III.D.2) and IEEE 114–2010 (or CSA C747–09 or IEC 60034–2–1:2014, which are equivalent to IEEE 114–2010; see discussion in III.D.2). This amendment would satisfy the test procedure requirements under 42 U.S.C. 6314(a)(5).

The methods listed in Section 12.30 of NEMA MG 1–2016 for testing AC motors apply only to AC induction motors that can be operated directly connected to the power supply (direct-on-line) and do not apply to electric motors that are inverter-only or to synchronous electric motors that are not AC induction motors. Therefore, for these additional electric motors, DOE specifies the use of different industry test procedures, as previously noted.

DOE notes that, with regard to the industry standards currently incorporated into the DOE test procedure, DOE is only updating the versions referenced to the latest version of the industry standards.

R. Compliance Date

EPCA prescribes that, if DOE amends a test procedure, all representations of energy efficiency and energy use of an electric motor subject to the test procedure, including those made on marketing materials and product labels, must be made in accordance with that amended test procedure, beginning 180 days after publication of such a test procedure final rule in the **Federal Register**. (42 U.S.C. 6314(d)(1). To the extent DOE were to establish test procedures for electric motors not currently subject to an energy conservation standard, 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 or energy costs of his or her basic models beginning 180 days following publication of a final rule. DOE's final rule would not require manufacturers who do not currently make voluntary representations to then begin making public representations of efficiency. (42 U.S.C. 6314(d)(1)). Manufacturers would be required to test such motors at such time as compliance is required with a labeling or energy conservation standard requirement should such a requirement be established. (42 U.S.C. 6315(b); 42 U.S.C. 6316(a); 42 U.S.C. 6295(s)).

EPCA provides an allowance for individual manufacturers to petition DOE for an extension of the 180-day period if the manufacturer may experience undue hardship in meeting the deadline. (42 U.S.C. 6314(d)(2). To receive such an extension, petitions must be filed with DOE no later than 60 days before the end of the 180-day period and must detail how the manufacturer will experience undue hardship. (*Id.*)

IV. Procedural Issues and Regulatory Review

A. Review Under Executive Orders 12866 and 13563

Executive Order (''E.O.'') 12866, ''Regulatory Planning and Review,'' as supplemented and reaffirmed by E.O. 13563, ''Improving Regulation and Regulatory Review, 76 FR 3821 (Jan. 21, 2011), requires agencies, to the extent permitted by law, to (1) propose or adopt a regulation only upon a reasoned determination that its benefits justify its costs (recognizing that some benefits and costs are difficult to quantify); (2) tailor regulations to impose the least burden on society, consistent with obtaining regulatory objectives, taking into account, among other things, and to the extent practicable, the costs of cumulative regulations; (3) select, in choosing among alternative regulatory approaches, those approaches that maximize net benefits (including potential economic, environmental, public health and safety, and other advantages; distributive impacts; and equity); (4) to the extent feasible, specify performance objectives, rather than specifying the behavior or manner of compliance that regulated entities must adopt; and (5) identify and assess available alternatives to direct regulation, including providing economic incentives to encourage the desired behavior, such as user fees or marketable permits, or providing information upon which choices can be made by the public. DOE emphasizes as well that E.O. 13563 requires agencies to use the best available techniques to quantify anticipated present and future benefits and costs as accurately as possible. In its guidance, the Office of Information and Regulatory Affairs (''OIRA'') in the Office of Management and Budget (''OMB'') has emphasized that such techniques may include identifying changing future compliance costs that might result from technological innovation or anticipated behavioral changes. For the reasons stated in the preamble, this final regulatory action is consistent with these principles.

Section 6(a) of E.O. 12866 also requires agencies to submit ''significant regulatory actions'' to OIRA for review. OIRA has determined that this final regulatory action does not constitute a ''significant regulatory action'' under section 3(f) of E.O. 12866. Accordingly, this action was not submitted to OIRA for review under E.O. 12866.

ABB requested that DOE have OMB conduct a study of the economic impact of this rulemaking. They stated that based on the information provided it

[92] As previously mentioned, NEMA MG 1–2016 does not specify the publication year of the referenced test standards and instead specifies that the most recent version should be used.

appears that the small gain in efficiency the rule is intended to capture would result in inordinate expense and economic disruption to all affected motor manufacturers and OEMs in terms of product redesign. (ABB, No. 18 at p. 2) As previously stated, this final rule only establishes test procedures and does not establish energy conservation standards. Therefore, this rule would not necessitate any redesign of any of the equipment addressed by this final rule.

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, and a final regulatory flexibility analysis (FRFA) for any such rule that an agency adopts as a final rule, 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.energy.gov/gc/office-general-counsel.*

The following sections detail DOE's FRFA for this test procedure final rule.

1. Description of Reasons Why Action Is Being Considered

DOE is amending the existing DOE test procedures for electric motors. EPCA, pursuant to amendments made by the Energy Policy Act of 1992, Public Law 102–486 (Oct. 24, 1992), specifies that the test procedures for electric motors subject to standards are those specified in National Electrical Manufacturers Association (''NEMA'') Standards Publication MG1–1987 and Institute of Electrical and Electronics Engineers (''IEEE'') Standard 112 Test Method B, as in effect on October 24, 1992. (42 U.S.C. 6314(a)(5)(A)). DOE must amend its test procedures to conform to such amended test procedure requirements, unless DOE determines by rule, published in the **Federal Register** and supported by clear and convincing evidence, that to do so would not meet the statutory requirements related to the test procedure representativeness and burden. (42 U.S.C. 6314(a)(5)(B))

EPCA also requires that, at least once every 7 years, DOE evaluate test procedures for each type of covered equipment, including electric motors, to determine whether amended test procedures would more accurately or fully comply with the requirements for the test procedures to not be unduly burdensome to conduct and be reasonably designed to produce test results that reflect energy efficiency, energy use, and estimated operating costs during a representative average use cycle. (42 U.S.C. 6314(a)(1)).

DOE is publishing this final rule in satisfaction of the requirements specified in EPCA.

2. Objective of, and Legal Basis for, Rule

As noted previously, DOE is publishing this final rule in satisfaction of the requirements specified in EPCA that DOE amend the test procedure for electric motors whenever the relevant industry standards are amended, but at minimum every 7 years, to ensure that the DOE test procedure produces test results which reflect energy efficiency, energy use, and estimated operating costs of a type of industrial equipment (or class thereof) during a representative average use cycle. 42 U.S.C. 6314(a).

3. Description and Estimate of Small Entities Regulated

For manufacturers of electric motors, the Small Business Administration (''SBA'') has set a size threshold, which defines those entities classified as ''small businesses'' for the purposes of the statute. DOE used the SBA's small business size standards to determine whether any small entities would be subject to the requirements of the rule. *See* 13 CFR part 121. The size standards are listed by North American Industry Classification System (''NAICS'') code and industry description available at: *www.sba.gov/document/support--table-size-standards.* Electric motor manufacturing is classified under NAICS code 335312, ''motor and generator manufacturing.'' The SBA sets a threshold of 1,250 employees or less for an entity to be considered as a small business for this category.

In this final rule, DOE revises the current scope of the test procedures to add additional electric motors and subsequent updates needed for supporting definitions and metric requirements as a result of this expanded scope; incorporates by reference the most recent versions of the referenced industry standards; incorporates by reference additional industry standards used to test newly covered electric motors; clarifies the scope and test instructions by adding definitions for specific terms; revises the current vertical motor testing instructions to reduce manufacturer test burden; revises the provisions pertaining to certification testing and determination of represented values; and adds provisions pertaining to certification testing and determination of represented values for DPPP motors.

As previously stated in section III.Q.1 of this document, DOE estimates that some electric motor manufacturers would experience a cost savings from the test procedure amendment regarding the update to the testing requirements for vertical motors with hollow shafts. Additionally, this test procedure expands the scope of covered electric motors and establishes certification, sampling plan, and AEDM provisions for DPPP motors.

While manufacturers making these expanded scope electric motors and DPPP motors would not be required to test according to the DOE test procedure until energy efficiency standards were established, if manufacturers voluntarily make representations regarding the energy consumption or cost of energy of such electric motors, they would be required to test according to the DOE test procedure. DOE identified up to 12 potential small businesses manufacturing these expanded scope electric motors or DPPP motors. DOE estimates that all other test procedure amendments would not result in any electric motor manufacturer, large or small, to incur any additional costs due to the test procedure amendments in this final rule.

4. Description and Estimate of Compliance Requirements

DOE estimated the per unit testing cost for these expanded scope electric motors and DPPP motors in section III.Q.1. of this document. These estimated per unit testing costs are presented in Table IV.1.

TABLE IV.1—ELECTRIC MOTOR PER UNIT TEST COST ESTIMATES

Industry standard	Tested at in-house facility	Tested at third-party facility
	(per unit test cost)	(per unit test cost)
CSA C747–09	$587	$2,210
IEC 61800–9–2:2017	750	3,210
Section 34.4 of NEMA Air-over Motor Efficiency Test Method	631	2,210

DOE is unable to estimate the number of electric motor models that small business manufacturers would decide to make voluntary representations about the efficiency of their electric motors. Therefore, DOE is unable to estimate the total cost each small business would incur to test their electric motors in accordance with the DOE test procedure.

Due to the uncertainty of the potential costs to small businesses, DOE is not able to conclude that the impacts of the test procedure amendments included in this final rule would not have a ''significant economic impact on a substantial number of small entities.''

5. Duplication, Overlap, and Conflict With Other Rules and Regulations

DOE is not aware of any rules or regulations that duplicate, overlap, or conflict with the rule being considered today.

6. Significant Alternatives to the Rule

As previously stated in this section, DOE is required to review existing DOE test procedures for all covered equipment every 7 years. Additionally, DOE shall amend test procedures with respect to any covered equipment, if the Secretary determines that amended test procedures would more accurately produce test results which measure energy efficiency, energy use, or estimated annual operating cost of a covered equipment during a representative average use cycle or period of use. (42 U.S.C. 6314(a)(1)) DOE has determined that the test procedure would more accurately produce test results to measure the energy efficiency of electric motors.

DOE has determined that there are no better alternatives than the amended test procedures in terms of meeting the agency's objectives to more accurately measure energy efficiency and reducing burden on manufacturers. Therefore, DOE is amending the existing DOE test procedure for electric motors in this final rule.

Additional compliance flexibilities may be available through other means. EPCA provides that a manufacturer whose annual gross revenue from all of its operations does not exceed $8 million may apply for an exemption from all or part of an energy conservation standard for a period not longer than 24 months after the effective date of a final rule establishing the standard. (42 U.S.C. 6295(t)) Additionally, section 504 of the Department of Energy Organization Act, 42 U.S.C. 7194, provides authority for the Secretary to adjust a rule issued under EPCA in order to prevent ''special hardship, inequity, or unfair distribution of burdens'' that may be imposed on that manufacturer as a result of such rule. Manufacturers should refer to 10 CFR part 430, subpart E, and 10 CFR part 1003 for additional details.

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. To certify compliance, manufacturers must first obtain test data for their products according to the DOE test procedures, including any amendments adopted for those test procedures. DOE has established regulations for the certification and recordkeeping requirements for all covered consumer products and commercial equipment, including electric motors. (*See generally* 10 CFR part 429.) The collection-of-information requirement for the certification and recordkeeping is subject to review and approval by OMB under the Paperwork Reduction Act (''PRA''). DOE's current reporting requirements have been approved by OMB under OMB control number 1910–1400. Public reporting burden for the certification is estimated to average 35 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, certifying compliance, 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.

1. Description of the Requirements

In this final rule, DOE is requiring that within one year of publication of any final rule updating or amending DOE's electric motors regulations, all nationally recognized certification programs must reassess the evaluation criteria necessary for a certification program to be classified by DOE as nationally recognized and either submit a letter to DOE certifying that no change to their program is needed, or submit a letter describing the measures implemented to ensure the evaluation criteria in amended 10 CFR 429.73(b) are met. DOE is revising the collection of information approval under OMB Control Number 1910–1400 to account for the paperwork burden associated with submitting this letter, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

2. Method of Collection

DOE is requiring that nationally recognized certification programs must submit a letter within one year after any final rule is published updating or amending DOE's electric motor regulations.

3. Data

There are three nationally recognized certification programs for electric motors. DOE estimated that drafting and submitting a letter to DOE certifying that no change to their program is needed or drafting and submitting a letter describing the measures implemented to ensure the criteria in amended 10 CFR 429.73(b) are met would require approximately 10 hours for each nationally recognized certification program. Therefore, DOE estimated that the three nationally recognized certification programs would spend approximately 30 hours to draft and submit these letters to DOE. DOE's February 2021 ''Supporting Statement for Certification Reports, Compliance Statements, Application for a Test Procedure Waiver, and Recording keeping for Consumer Products and Commercial Equipment Subject to Energy or Water Conservation Standards'' estimated a fully loaded (burdened) average wage rate of $67 per hour for manufacturer reporting and recordkeeping.[93] (86 FR 9916). DOE used this wage rate to estimate the burden on the certification programs. Therefore, DOE estimates that the total burden to the industry is approximately $2,010.[94]

OMB Control Number: 1910–1400.

Form Number: DOE F 220.7.

Type of Review: Regular submission.

Affected Public: Nationally recognized certification programs.

Estimated Number of Respondents: 3.

Estimated Time per Response: 10 hours.

Estimated Total Annual Burden Hours: 30 hours.

Estimated Total Annual Cost to the Manufacturers: $2,010 in recordkeeping/reporting costs.

4. Conclusion

DOE has determined that the cost of these amendments would not impose a material burden on nationally recognized certification programs. It is the responsibility of nationally recognized certification programs to have a complete understanding of applicable regulations for electric motors given their role as a certification body, and accordingly, DOE has concluded that the anticipated cost of $670 per program to submit a letter upon finalization of any updated or amended electric motors regulations is a reasonable burden for such a program.

D. Review Under the National Environmental Policy Act of 1969

In this final rule, DOE establishes 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, DOE has determined that adopting test procedures for measuring energy efficiency of consumer products and industrial equipment is consistent with activities identified in 10 CFR part 1021, appendix A to subpart D, A5 and A6. Accordingly, neither an environmental assessment nor an environmental impact statement is required.

AHAM and AHRI stated that the compliance deadlines proposed in the NOPR will produce significant environmental impact and warrant review under NEPA. They stated that manufacturers that make voluntary representations about motor efficiency will be required to certify 180 days after the final rule, and there will not be capacity at third-party test labs to do this certification in time, so manufacturers will be forced to remove this efficiency information from marketing materials. They stated that this removal of efficiency information will cause purchasers to gravitate towards cheaper, and likely less efficient, products, which will lead to increased energy consumption and the environmental impacts associated with such. (AHAM and AHRI, No. 36 at pp. 14–15). In this final rule, DOE is adopting the industry standards similar to what was proposed in the NOPR. In addition, as discussed in section III.M.1 of this document, DOE does not adopt the proposal to replace the requirement to test at an accredited laboratory by testing in an independent testing program. Instead, DOE retains the use of accredited laboratory as currently described at 10 CFR 431.17(5).

E. Review Under Executive Order 13132

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

F. Review Under Executive Order 12988

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

G. Review Under the Unfunded Mandates Reform Act of 1995

Title II of the Unfunded Mandates Reform Act of 1995 (''UMRA'') requires each Federal agency to assess the effects of Federal regulatory actions on State, local, and Tribal governments and the private sector. Public Law 104–4, sec. 201 (codified at 2 U.S.C. 1531). For a regulatory action resulting in a rule that may cause the expenditure by State, local, and Tribal governments, in the aggregate, or by the private sector of $100 million or more in any one year (adjusted annually for inflation), section 202 of UMRA requires a Federal agency to publish a written statement that estimates the resulting costs, benefits, and other effects on the national economy. (2 U.S.C. 1532(a), (b)) The

[93] *www.reginfo.gov/public/do/PRAViewDocument?ref_nbr=202102-1910-002.*

[94] 3 certification programs × 10 hours × $67 = $2,010.

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.energy.gov/gc/office-general-counsel.* DOE examined this final rule according to UMRA and its statement of policy and determined that the rule contains neither an intergovernmental mandate, nor a mandate that may result in the expenditure of $100 million or more in any year, so these requirements do not apply.

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

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

I. Review Under Executive Order 12630

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

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

Section 515 of the Treasury and General Government Appropriations Act, 2001 (44 U.S.C. 3516 note) provides for agencies to review most disseminations of information to the public under guidelines established by each agency pursuant to general guidelines issued by OMB. OMB's guidelines were published at 67 FR 8452 (Feb. 22, 2002), and DOE's guidelines were published at 67 FR 62446 (Oct. 7, 2002). Pursuant to OMB Memorandum M–19–15, Improving Implementation of the Information Quality Act (April 24, 2019), DOE published updated guidelines which are available at *www.energy.gov/sites/prod/files/2019/12/f70/DOE%20Final%20Updated%20IQA%20Guidelines%20Dec%202019.pdf.* DOE has reviewed this final rule under the OMB and DOE guidelines and has concluded that it is consistent with applicable policies in those guidelines.

K. Review Under Executive Order 13211

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

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

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

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

The modifications to the test procedure for electric motors adopted in this final rule incorporates testing methods contained in certain sections of the following commercial standards: CSA C390–10; IEC 60034–12:2016; IEC 60079–7:2015; IEC 61800–9–2:2017; NEMA MG 1–2016; and NFPA 20–2022. DOE has evaluated these standards and is unable to conclude whether it fully complies with the requirements of section 32(b) of the FEAA (*i.e.,* whether it was developed in a manner that fully provides for public participation, comment, and review.) DOE has consulted with both the Attorney General and the Chairman of the FTC about the impact on competition of using the methods contained in these standards and has received no comments objecting to their use.

M. Congressional Notification

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

N. Description of Materials Incorporated by Reference

The following standards were previously approved for incorporation by reference in the section where they appear and no changes are required: IEC 60034–1 (select provisions in section 4), IEC 60034–1:2010, IEC 60034–2–1:2014, IEC 60050–411, IEC 60051–1:2016, IEEE 112–2017, and NEMA MG1–1967.

In this final rule, DOE incorporates by reference the test standards published by CSA, IEC, IEEE, NEMA and NFPA.

CSA C390–10 specifies test methods, marking requirements, and energy efficiency levels for three-phase induction motors.

CSA C747–09 specifies test methods for single-phase electric motors and polyphase electric motors below 1 hp.

IEC 60034–12:2016 specifies the parameters for eight designs (IEC Design N, Design NE, Design NY, Design NEY, IEC Design H, Design HE, Design HY, Design HEY) of starting performance of single-speed three-phase 50 Hz or 60 Hz cage induction motors.

IEC 60072–1 (clauses 2, 3, 4.1, 6.1, 7, and 10, and Tables 1, 2 and 4) specifies the IEC-metric equivalent frame size.

IEC 60079–7:2015 is referenced within IEC 60034–12:2016 and specifies the requirements for the design, construction, testing and marking of electrical equipment and Ex Components with type of protection increased safety ''e'' intended for use in explosive gas atmospheres.

IEC 61800–9–2:2017 specifies test methods for inverter-fed electric motors that include an inverter.

IEEE 114–2010 specifies test methods for single-phase electric motors.

NEMA MG 1–2016 provides test methods to determine motor efficiency and losses, including for air-over electric motors, and establishes several industry definitions.

NFPA 20–2022 provides specifications for fire-pump motors.

Copies of these standards can be obtained from the organizations directly at the following addresses:

- Canadian Standards Association, Sales Department, 5060 Spectrum Way, Suite 100, Mississauga, Ontario, L4W 5N6, Canada, 1–800–463–6727, or by visiting *www.shopcsa.ca/onlinestore/welcome.asp.*
- International Electrotechnical Commission, 3 rue de Varembé, 1st Floor, P.O. Box 131, CH–1211 Geneva 20–Switzerland, +41 22 919 02 11, or by visiting *https://webstore.iec.ch/home.*
- Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855–1331, (732) 981–0060, or by visiting *www.ieee.org.*
- NEMA, 1300 North 17th Street, Suite 900, Arlington, Virginia 22209, +1 (703) 841 3200, or by visiting *www.nema.org.*
- National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169, +1 800 344 3555, or by visiting *www.nfpa.org.*

V. Approval of the Office of the Secretary

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

List of Subjects

10 CFR Part 429

Administrative practice and procedure, Confidential business information, Energy conservation, Household appliances, Imports, Intergovernmental relations, Reporting and recordkeeping requirements, Small businesses.

10 CFR Part 431

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

Signing Authority

This document of the Department of Energy was signed on October 3, 2022, by Francisco Alejandro Moreno, Acting Assistant Secretary for Energy Efficiency and Renewable Energy, pursuant to delegated authority from the Secretary of Energy. That document with the original signature and date is maintained by DOE. For administrative purposes only, and in compliance with requirements of the Office of the Federal Register, the undersigned DOE Federal Register Liaison Officer has been authorized to sign and submit the document in electronic format for publication, as an official document of the Department of Energy. This administrative process in no way alters the legal effect of this document upon publication in the **Federal Register**.

Signed in Washington, DC, on October 4, 2022.

Treena V. Garrett,

Federal Register Liaison Officer, U.S. Department of Energy.

For the reasons stated in the preamble, DOE amends parts 429 and 431 of chapter II of title 10, Code of Federal Regulations as set forth below:

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

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

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

■ 2. Revise § 429.1 to read as follows:

§ 429.1 Purpose and scope.

This part sets forth the procedures for certification, determination and enforcement of compliance of covered products and covered equipment with the applicable energy conservation standards set forth in parts 430 and 431 of this subchapter.

■ 3. Amend § 429.2 by revising paragraph (a) and adding in alphabetical order to paragraph (b) a definition for ''Independent'' to read as follows:

§ 429.2 Definitions.

(a) The definitions found in 10 CFR parts 430 and 431 apply for purposes of this part.

(b) * * *

Independent means, in the context of a nationally recognized certification program, or accreditation program for electric motors, an entity that is not controlled by, or under common control with, electric motor manufacturers, importers, private labelers, or vendors, and that has no affiliation, financial ties, or contractual agreements, apparently or otherwise, with such entities that would:

(i) Hinder the ability of the program to evaluate fully or report the measured or calculated energy efficiency of any electric motor, or

(ii) Create any potential or actual conflict of interest that would undermine the validity of said evaluation. For purposes of this definition, financial ties or contractual agreements between an electric motor manufacturer, importer, private labeler or vendor and a nationally recognized certification program, or accreditation program exclusively for certification or accreditation services does not negate an otherwise independent relationship.

* * * * *

■ 4. Add § 429.3 to read as follows:

§ 429.3 Sources for information and guidance.

(a) *General.* The standards listed in this paragraph are referred to in §§ 429.73 and 429.74 and are not incorporated by reference. These sources are provided here for information and guidance only.

(b) *ISO/IEC.* International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, CP 56, CH–1211 Geneva 20, Switzerland/ International Electrotechnical Commission, 3, rue de Varembé, P.O. Box 131, CH–1211 Geneva 20, Switzerland.

(1) International Organization for Standardization (ISO)/International Electrotechnical Commission (IEC), (''ISO/IEC'') 17025, ''General requirements for the competence of calibration and testing laboratories,'' November 2017.

(2) [Reserved]

(c) *NVLAP.* National Voluntary Laboratory Accreditation Program, National Institute of Standards and Technology, 100 Bureau Drive, M/S 2140, Gaithersburg, MD 20899–2140, 301–975–4016, or go to *www.nist.gov/nvlap/.* Also see *http://www.nist.gov/nvlap/nvlap-handbooks.cfm.*

(1) National Institute of Standards and Technology (NIST) Handbook 150, ''NVLAP Procedures and General Requirements,'' 2000 edition, August 2020.

(2) National Institute of Standards and Technology (NIST) Handbook 150–10, ''Efficiency of Electric Motors,'' 2020 edition, April 2020.

■ 5. Revise § 429.11 to read as follows:

§ 429.11 General sampling requirements for selecting units to be tested.

(a) When testing of covered products or covered equipment is required to comply with section 323(c) of the Act, or to comply with rules prescribed under sections 324, 325, 342, 344, 345 or 346 of the Act, a sample comprised of production units (or units representative of production units) of the basic model being tested must be selected at random and tested and must meet the criteria found in §§ 429.14 through 429.65. Components of similar design may be substituted without additional testing if the substitution does not affect energy or water consumption. Any represented values of measures of energy efficiency, water efficiency, energy consumption, or water consumption for all individual models represented by a given basic model must be the same, except for central air conditioners and central air conditioning heat pumps, as specified in § 429.16; and

(b) The minimum number of units tested shall be no less than two, except where:

(1) A different minimum limit is specified in §§ 429.14 through 429.65; or

(2) Only one unit of the basic model is produced, in which case, that unit must be tested and the test results must demonstrate that the basic model performs at or better than the applicable standard(s). If one or more units of the basic model are manufactured subsequently, compliance with the default sampling and representations provisions is required.

■ 6. Add § 429.64 to read as follows:

§ 429.64 Electric motors.

(a) *Applicability.* When a party determines the energy efficiency of an electric motor in order to comply with an obligation imposed on it by or pursuant to Part C of Title III of EPCA, 42 U.S.C. 6311–6316, this section applies. This section does not apply to enforcement testing conducted pursuant to § 431.383 of this subchapter. This section applies to electric motors that are subject to requirements in subpart B of part 431 of this subchapter and does not apply to dedicated-purpose pool pump motors subject to requirements in subpart Z of part 431.

(1) Prior to the date described in paragraph (a)(2) of this section, manufacturers of electric motors subject to energy conservation standards in subpart B of part 431 must make representations of energy efficiency, including representations for certification of compliance, in accordance with paragraphs (b) and (c) of this section.

(2) On and after the compliance date for any new or amended standards for electric motors published after January 1, 2021, manufacturers of electric motors subject to energy conservation standards in subpart B of part 431 of this subchapter must make representations of energy efficiency, including representations for certification of compliance, in accordance with paragraphs (d) through (f) of this section.

(3) On or after April 17, 2023, manufacturers of electric motors subject to the test procedures in appendix B of subpart B of part 431 but are subject to the energy conservation standards in subpart B of part 431 of this subchapter, must, if they chose to voluntarily make representations of energy efficiency, follow the provisions in paragraph (e) of this section.

(b) *Compliance certification*—(1) *General requirements.* The represented value of nominal full-load efficiency of each basic model of electric motor must be determined either by testing in accordance with § 431.16 of this subchapter, or by application of an alternative efficiency determination method (AEDM) that meets the requirements of paragraph (b)(2) of this section.

(2) *Alternative efficiency determination method.* In lieu of testing, the represented value of nominal full-load efficiency for a basic model of electric motor must be determined through the application of an AEDM pursuant to the requirements of § 429.70(j) and the provisions of this paragraph (b) and paragraph (c) of this section, where:

(i) The average full-load efficiency of any basic model used to validate an AEDM must be calculated under paragraph (c) of this section.

(ii) The represented value is the nominal full-load efficiency of a basic model of electric motor and is to be used in marketing materials and all public representations, as the certified value of efficiency, and on the nameplate. (*See* § 431.31(a) of this subchapter.) Determine the nominal full-load efficiency by selecting a value from the ''Nominal Full-Load Efficiency'' table in appendix B to subpart B of this part that is no greater than the simulated full-load efficiency predicted by the AEDM for the basic model.

(3) *Use of a certification program or accredited laboratory.* (i) A manufacturer may have a certification program, that DOE has classified as nationally recognized under § 429.73, certify the nominal full-load efficiency of a basic model of electric motor, and issue a certificate of conformity for the motor.

(ii) For each basic model for which a certification program is not used as described in paragraph (b)(3)(i) of this section, any testing of the motor pursuant to paragraph (b)(1) or (2) of this section to determine its energy efficiency must be carried out in an accredited laboratory that meets the requirements of § 431.18 of this subchapter;

(c) *Additional testing requirements applicable when a certification program is not used*—(1) *Selection of units for testing.* For each basic model selected for testing, a sample of units shall be selected at random and tested. Components of similar design may be substituted without requiring additional testing if the represented measures of energy consumption continue to satisfy the applicable sampling provision.

(2) *Sampling requirements.* The sample shall be comprised of production units of the basic model, or units that are representative of such production units. The sample size shall be not fewer than five units, except that when fewer than five units of a basic model would be produced over a reasonable period of time (approximately 180 days), then each unit shall be tested. In a test of compliance with a represented average or nominal efficiency:

(i) The average full-load efficiency of the sample, which is defined by:

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

where x_i is the measured full-load efficiency of unit *i* and n is the number of units tested, shall satisfy the condition:

$$\bar{x} \geq \frac{100}{1 + 1.05(\frac{100}{RE} - 1)}$$

where RE is the represented nominal full-load efficiency, and

(ii) The lowest full-load efficiency in the sample x_{min}, which is defined by:

$x_{min} = \min(x_i)$

shall satisfy the condition:

$$x_{min} \geq \frac{100}{1 + 1.15(\frac{100}{RE} - 1)}$$

(d) *Compliance certification.* A manufacturer may not certify the compliance of an electric motor pursuant to § 429.12 unless:

(1) Testing of the electric motor basic model was conducted using an accredited laboratory that meets the requirements of paragraph (f) of this section;

(2) Testing was conducted using a laboratory other than an accredited laboratory that meets the requirements of paragraph (f) of this section, or the

nominal full-load efficiency of the electric motor basic model was determined through the application of an AEDM pursuant to the requirements of § 429.70(j), and a third-party certification organization that is nationally recognized in the United States under § 429.73 has certified the nominal full-load efficiency of the electric motor basic model through issuance of a certificate of conformity for the basic model.

(e) *Determination of represented value.* A manufacturer must determine the represented value of nominal full-load efficiency (inclusive of the inverter for inverter-only electric motors) for each basic model of electric motor either by testing in conjunction with the applicable sampling provisions or by applying an AEDM as set forth in this section and in § 429.70(j).

(1) *Testing*—(i) *Units to be tested.* If the represented value for a given basic model is determined through testing, the requirements of § 429.11 apply except that, for electric motors, the minimum sample size is five units. If fewer units than the minimum sample size are produced, each unit produced must be tested and the test results must demonstrate that the basic model performs at or better than the applicable standard(s). If one or more units of the basic model are manufactured subsequently, compliance with the default sampling and representations provisions is required.

(ii) *Average Full-load Efficiency:* Determine the average full-load efficiency for the basic model $\bar{x}$, for the units in the sample as follows:

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

Where x_i is the measured full-load efficiency of unit i and n is the number of units tested.

(iii) *Represented value.* The represented value is the nominal full-load efficiency of a basic model of electric motor and is to be used in marketing materials and all public representations, as the certified value of efficiency, and on the nameplate. (*See* § 431.31(a) of this subchapter.) Determine the nominal full-load efficiency by selecting an efficiency from the ‘‘Nominal Full-load Efficiency’’ table in appendix B that is no greater than the average full-load efficiency of the basic model as calculated in § 429.64(e)(1)(ii).

(iv) *Minimum full-load efficiency:* To ensure a high level of quality control and consistency of performance within the basic model, the lowest full-load efficiency in the sample X_{min}, must satisfy the condition:

$$x_{min} \geq \frac{100}{1 + 1.15(\frac{100}{Std} - 1)}$$

where *Std* is the value of the applicable energy conservation standard. If the lowest measured full-load efficiency of a unit in the tested sample does not satisfy the condition in this section, then the basic model cannot be certified as compliant with the applicable standard.

(2) *Alternative efficiency determination methods.* In lieu of testing, the represented value of nominal full-load efficiency for a basic model of electric motor must be determined through the application of an AEDM pursuant to the requirements of § 429.70(j) and the provisions of this section, where:

(i) The average full-load efficiency of any basic model used to validate an AEDM must be calculated under paragraph (e)(1)(ii) of this section; and

(ii) The represented value is the nominal full-load efficiency of a basic model of electric motor and is to be used in marketing materials and all public representations, as the certified value of efficiency, and on the nameplate. (See § 431.31(a) of this subchapter) Determine the nominal full-load efficiency by selecting a value from the ‘‘Nominal Full-Load Efficiency’’ table in appendix B to subpart B of this part, that is no greater than the simulated full-load efficiency predicted by the AEDM for the basic model.

(f) *Accredited laboratory.* (1) Testing pursuant to paragraphs (b)(3)(ii) and (d)(1) of this section must be conducted in an accredited laboratory for which the accreditation body was:

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

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

(iii) An organization classified by the Department, pursuant to § 429.74, as an accreditation body.

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

■ 7. Add § 429.65 to read as follows:

§ 429.65 Dedicated-purpose pool pump motors.

(a) *Applicability.* This section applies to dedicated purpose motors that are subject to requirements in subpart Z of part 431 of this subchapter. Starting on the compliance date for any standards for dedicated-purpose pool pump motors published after January 1, 2021, manufacturers of dedicated-purpose pool pump motors subject to such standards must make representations of energy efficiency, including representations for certification of compliance, in accordance with this section. Prior to the compliance date for any standards for dedicated-purpose pool pump motors published after January 1, 2021, and on or after April 17, 2023, manufacturers of dedicated-purpose pool pump motors subject to test procedures in subpart Z of part 431 of this subchapter choosing to make representations of energy efficiency must follow the provisions in paragraph (c) of this section.

(b) *Compliance certification.* A manufacturer may not certify the compliance of a dedicated-purpose pool pump motor pursuant to 10 CFR 429.12 unless:

(1) Testing of the dedicated-purpose pool pump motor basic model was conducted using an accredited laboratory that meets the requirements of paragraph (d) of this section;

(2) Testing was conducted using a laboratory other than an accredited laboratory that meets the requirements of paragraph (d) of this section, or the full-load efficiency of the dedicated-purpose pool pump motor basic model was determined through the application of an AEDM pursuant to the requirements of § 429.70(k), and a third-party certification organization that is nationally recognized in the United States under § 429.73 has certified the full-load efficiency of the dedicated-

purpose pool pump motor basic model through issuance of a certificate of conformity for the basic model.

(c) *Determination of represented value.* A manufacturer must determine the represented value of full-load efficiency (inclusive of the drive, if the dedicated-purpose pool pump motor basic model is placed into commerce with a drive, or is unable to operate without the presence of a drive) for each basic model of dedicated-purpose pool pump motor either by testing in conjunction with the applicable sampling provisions or by applying an AEDM as set forth in this section and in § 429.70(k).

(1) *Testing*—(i) *Units to be tested.* If the represented value for a given basic model is determined through testing, the requirements of § 429.11 apply except that, for dedicated-purpose pool pump motors, the minimum sample size is five units. If fewer units than the minimum sample size are produced, each unit produced must be tested and the test results must demonstrate that the basic model performs at or better than the applicable standard(s). If one or more units of the basic model are manufactured subsequently, compliance with the default sampling and representations provisions is required.

(ii) *Full-load efficiency.* Any value of full-load efficiency must be lower than or equal to the average of the sample $\bar{x}$, calculated as follows:

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

Where x_i is the measured full-load efficiency of unit i and n is the number of units tested in the sample.

(iii) *Represented value.* The represented value is the full-load efficiency of a basic model of dedicated-purpose pool pump motor and is to be used in marketing materials and all public representations, as the certified value of efficiency, and on the nameplate. (*See* § 431.486 of this subchapter). Alternatively, a manufacturer may make representations using the nominal full-load efficiency of a basic model of dedicated-purpose pool pump motor provided that the manufacturer uses the nominal full-load efficiency consistently on all marketing materials, and as the value on the nameplate. Determine the nominal full-load efficiency by selecting an efficiency from the ''Nominal Full-load Efficiency'' table in appendix B to subpart B of this part, that is no greater than the full-load efficiency of the basic model as calculated in § 429.65(c)(1)(ii).

(iv) *Minimum full-load efficiency:* To ensure quality control and consistency of performance within the basic model, the lowest full-load efficiency in the sample X_{min}, must satisfy the condition:

$$x_{min} \geq \frac{100}{1 + 1.15\left(\frac{100}{Std} - 1\right)}$$

where *Std* is the value of any applicable energy conservation standard. If the lowest measured full-load efficiency of a motor in the tested sample does not satisfy the condition in this section, then the basic model cannot be certified as compliant with the applicable standard.

(v) *Dedicated-purpose pool pump motor total horsepower.* The represented value of the total horsepower of a basic model of dedicated-purpose pool pump motor must be the mean of the dedicated-purpose pool pump motor total horsepower for each tested unit in the sample.

(2) *Alternative efficiency determination methods.* In lieu of testing, the represented value of full-load efficiency for a basic model of dedicated-purpose pool pump motor must be determined through the application of an AEDM pursuant to the requirements of § 429.70(k) and the provisions of this section, where:

(i) The full-load efficiency of any basic model used to validate an AEDM must be calculated under paragraph (c)(1)(ii) of this section; and

(ii) The represented value is the full-load efficiency of a basic model of dedicated-purpose pool pump motor and is to be used in marketing materials and all public representations, as the certified value of efficiency, and on the nameplate. (*See* § 431.485 of this subchapter). Alternatively, a manufacturer may make representations using the nominal full-load efficiency of a basic model of dedicated-purpose pool pump motor provided that the manufacturer uses the nominal full-load efficiency consistently on all marketing materials, and as the value on the nameplate. Determine the nominal full-load efficiency by selecting an efficiency from the ''Nominal Full-load Efficiency'' table in appendix B to subpart B of this part, that is no greater than the full-load efficiency of the basic model as calculated in § 429.65(c)(1)(ii).

(d) *Accredited laboratory.* (1) Testing pursuant to paragraph (b) of this section must be conducted in an accredited laboratory for which the accreditation body was:

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

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

(iii) An organization classified by the Department, pursuant to § 429.74, as an accreditation body.

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

■ 8. Amend § 429.70 by revising paragraph (a) and adding paragraphs (j) and (k) to read as follows:

§ 429.70 Alternative methods for determining energy efficiency and energy use.

(a) *General.* A manufacturer of covered products or covered equipment explicitly authorized to use an AEDM in §§ 429.14 through 429.65 may not distribute any basic model of such product or equipment in commerce unless the manufacturer has determined the energy consumption or energy efficiency of the basic model, either from testing the basic model in conjunction with DOE's certification sampling plans and statistics or from applying an alternative method for determining energy efficiency or energy use (*i.e.,* AEDM) to the basic model, in accordance with the requirements of this section. In instances where a manufacturer has tested a basic model to validate the AEDM, the represented value of energy consumption or efficiency of that basic model must be determined and certified according to results from actual testing in conjunction with 10 CFR part 429, subpart B certification sampling plans and statistics. In addition, a manufacturer may not knowingly use an AEDM to overrate the efficiency of a basic model.

* * * * *

(j) *Alternative efficiency determination method (AEDM) for electric motors subject to requirements in subpart B of part 431 of this subchapter*—(1) *Criteria an AEDM must satisfy.* A manufacturer is not permitted to apply an AEDM to a basic model of electric motor to determine its efficiency pursuant to this section unless:

(i) The AEDM is derived from a mathematical model that estimates the energy efficiency characteristics and losses of the basic model as measured by the applicable DOE test procedure and accurately represents the mechanical and electrical characteristics of that basic model; and

(ii) The AEDM is based on engineering or statistical analysis, computer simulation or modeling, or other analytic evaluation of actual performance data.

(iii) The manufacturer has validated the AEDM in accordance with paragraph (i)(2) of this section with basic models that meet the current Federal energy conservation standards (if any).

(2) *Validation of an AEDM.* Before using an AEDM, the manufacturer must validate the AEDM's accuracy and reliability by comparing the simulated full-load losses to tested average full-load losses as follows.

(i) *Select basic models.* A manufacturer must select at least five basic models compliant with the energy conservation standards at § 431.25 of this subchapter (if any), in accordance with the criteria paragraphs (i)(2)(i)(A) through (D) of this section. In any instance where it is impossible for a manufacturer to select basic models for testing in accordance with all of these criteria, prioritize the criteria in the order in which they are listed. Within the limits imposed by the criteria, select basic models randomly. In addition, a basic model with a sample size of fewer than five units may not be selected to validate an AEDM.

(A) Two of the basic models must be among the five basic models with the highest unit volumes of production by the manufacturer in the prior 5 years;

(B) No two basic models may have the same horsepower rating;

(C) No two basic models may have the same frame number series; and

(D) Each basic model must have the lowest nominal full-load efficiency among the basic models within the same equipment class.

(ii) *Apply the AEDM to the selected basic models.* Using the AEDM, calculate the simulated full-load losses for each of the selected basic models as follows: hp × (1/simulated full-load efficiency − 1), where hp is the horsepower of the basic model.

(iii) *Test at least five units of each of the selected basic models in accordance with § 431.16 of this subchapter.* Use the measured full-load losses for each of the tested units to determine the average of the measured full-load losses for each of the selected basic models.

(iv) *Compare.* The simulated full-load losses for each basic model (as determined under paragraph (i)(2)(ii) of this section) must be greater than or equal to 90 percent of the average of the measured full-load losses (as determined under paragraph (i)(2)(iii) of this section) (*i.e.,* 0.90 × average of the measured full-load losses ≤ simulated full-load losses).

(3) *Verification of an AEDM.* (i) Each manufacturer must periodically select basic models representative of those to which it has applied an AEDM. The manufacturer must select a sufficient number of basic models to ensure the AEDM maintains its accuracy and reliability. For each basic model selected for verification:

(A) Subject at least one unit for each basic model to test in accordance with § 431.16 of this subchapter by an accredited laboratory that meets the requirements of § 429.65(f). If one unit per basic model is selected, the simulated full-load losses for each basic model must be greater than or equal to 90 percent of the measured full-load losses (*i.e.,* 0.90 × the measured full-load losses ≤ simulated full-load losses). If more than one unit per basic model is selected, the simulated full-load losses for each basic model must be greater than or equal to 90 percent of the average of the measured full-load losses (*i.e.,* 0.90 × average of the measured full-load losses ≤ simulated full-load losses); or

(B) Have a certification body recognized under § 429.73 certify the results of the AEDM as accurately representing the basic model's average full-load efficiency. The simulated full-load efficiency for each basic model must be greater than or equal to 90 percent of the certified full-load losses (*i.e.,* 0.90 × certified full-load losses ≤ simulated full-load losses).

(ii) Each manufacturer that has used an AEDM under this section must have available for inspection by the Department of Energy records showing:

(A) The method or methods used to develop the AEDM;

(B) The mathematical model, the engineering or statistical analysis, computer simulation or modeling, and other analytic evaluation of performance data on which the AEDM is based;

(C) Complete test data, product information, and related information that the manufacturer has generated or acquired pursuant to paragraphs (i)(2) and (3) of this section; and

(D) The calculations used to determine the simulated full-load efficiency of each basic model to which the AEDM was applied.

(iii) If requested by the Department, the manufacturer must:

(A) Conduct simulations to predict the performance of particular basic models of electric motors specified by the Department;

(B) Provide analyses of previous simulations conducted by the manufacturer; and/or

(C) Conduct testing of basic models selected by the Department.

(k) *Alternative efficiency determination method (AEDM) for dedicated-purpose pool pump motors subject to requirements in subpart Z of part 431 of this subchapter*—(1) *Criteria an AEDM must satisfy.* A manufacturer is not permitted to apply an AEDM to a basic model of dedicated-purpose pool pump motors, to determine its efficiency pursuant to this section unless:

(i) The AEDM is derived from a mathematical model that estimates the energy efficiency characteristics and losses of the basic model as measured by the applicable DOE test procedure and accurately represents the mechanical and electrical characteristics of that basic model;

(ii) The AEDM is based on engineering or statistical analysis, computer simulation or modeling, or other analytic evaluation of actual performance data; and

(iii) The manufacturer has validated the AEDM in accordance with paragraph (i)(2) of this section with basic models that meet the current Federal energy conservation standards (if any).

(2) *Validation of an AEDM.* Before using an AEDM, the manufacturer must validate the AEDM's accuracy and reliability by comparing the simulated full-load losses to tested full-load losses as follows:

(i) *Select basic models.* A manufacturer must select at least five basic models compliant with any relevant energy conservation standards at § 431.485 of this subchapter (if any), in accordance with the criteria paragraphs (j)(2)(i)(A) through (D) of this section. In any instance where it is impossible for a manufacturer to select basic models for testing in accordance with all of these criteria, prioritize the criteria in the order in which they are listed. Within the limits imposed by the criteria, select basic models randomly. In addition, a basic model with a sample size of fewer than five units may not be selected to validate an AEDM.

(A) Two of the basic models must be among the five basic models with the highest unit volumes of production by the manufacturer in the prior 5 years.

(B) No two basic models may have the same total horsepower rating;

(C) No two basic models may have the same speed configuration; and

(D) Each basic model must have the lowest full-load efficiency among the basic models within the same equipment class.

(ii) *Apply the AEDM* to the selected basic models. Using the AEDM, calculate the simulated full-load losses for each of the selected basic models as follows: THP × (1/simulated full-load efficiency − 1), where THP is the total horsepower of the basic model.

(iii) *Test at least five units of each of the selected basic models in accordance with § 431.483 of this subchapter.* Use the measured full-load losses for each of the tested units to determine the average of the measured full-load losses for each of the selected basic models.

(iv) *Compare.* The simulated full-load losses for each basic model (paragraph (i)(2)(ii) of this section) must be greater than or equal to 90 percent of the average of the measured full-load losses (paragraph (i)(2)(iii) of this section) (*i.e.,* 0.90 × average of the measured full-load losses ≤ simulated full-load losses).

(3) *Verification of an AEDM.* (i) Each manufacturer must periodically select basic models representative of those to which it has applied an AEDM. The manufacturer must select a sufficient number of basic models to ensure the AEDM maintains its accuracy and reliability. For each basic model selected for verification:

(A) Subject at least one unit to testing in accordance with § 431.483 of this subchapter by an accredited laboratory that meets the requirements of § 429.65(d). If one unit per basic model is selected, the simulated full-load losses for each basic model must be greater than or equal to 90 percent of the measured full-load losses (*i.e.,* 0.90 × the measured full-load losses ≤ simulated full-load losses). If more than one unit per basic model is selected, the simulated full-load losses for each basic model must be greater than or equal to 90 percent of the average measured full-load losses (*i.e.,* 0.90 × average of the measured full-load losses ≤ simulated full-load losses); or

(B) Have a certification body recognized under § 429.73 certify the results of the AEDM accurately represent the basic model's full-load efficiency. The simulated full-load efficiency for each basic model must be greater than or equal to 90 percent of the certified full-load losses (*i.e.,* 0.90 × certified full-load losses ≤ simulated full-load losses).

(ii) Each manufacturer that has used an AEDM under this section must have available for inspection by the Department of Energy records showing:

(A) The method or methods used to develop the AEDM;

(B) The mathematical model, the engineering or statistical analysis, computer simulation or modeling, and other analytic evaluation of performance data on which the AEDM is based;

(C) Complete test data, product information, and related information that the manufacturer has generated or acquired pursuant to paragraphs (i)(2) and (3) of this section; and

(D) The calculations used to determine the simulated full-load efficiency of each basic model to which the AEDM was applied.

(iii) If requested by the Department, the manufacturer must:

(A) Conduct simulations to predict the performance of particular basic models of dedicated-purpose pool pump motors specified by the Department;

(B) Provide analyses of previous simulations conducted by the manufacturer;

(C) Conduct testing of basic models selected by the Department; or

(D) A combination of the foregoing.

■ 9. Add § 429.73 to subpart B to read as follows:

§ 429.73 Department of Energy recognition of nationally recognized certification programs for electric motors, including dedicated-purpose pool pump motors.

(a) *Petition.* For a certification program to be classified by the Department of Energy as being nationally recognized in the United States for the purposes of §§ 429.64 and 429.65, the organization operating the program must submit a petition to the Department requesting such classification, in accordance with paragraph (c) of this section and § 429.75. The petition must demonstrate that the program meets the criteria in paragraph (b) of this section.

(b) *Evaluation criteria.* For a certification program to be classified by the Department as nationally recognized, it must meet the following criteria:

(1) It must have satisfactory standards and procedures for conducting and administering a certification system, including periodic follow up activities to assure that basic models of electric motors continue to conform to the efficiency levels for which they were certified, and for granting a certificate of conformity;

(2) For certification of electric motors, including dedicated-purpose pool pump motors, it must be independent (as defined at § 429.2) of electric motor (including dedicated-purpose pool pump motor) manufacturers, importers, distributors, private labelers or vendors for which it is providing certification;

(3) It must be qualified to operate a certification system in a highly competent manner; and

(4) In the case of electric motors subject to requirements in subpart B of part 431 of this subchapter, the certification program must have expertise in the content and application of the test procedures at § 431.16 of this subchapter and must apply the provisions at §§ 429.64 and 429.70(j); or

(5) In the case of dedicated-purpose pool pump motors subject to requirements in subpart Z of part 431 of this subchapter, the certification program must have expertise in the content and application of the test procedures at § 431.484 of this subchapter and must apply the provisions at §§ 429.65 and 429.70(k).

(c) *Petition format.* Each petition requesting classification as a nationally recognized certification program must contain a narrative statement as to why the program meets the criteria listed in paragraph (b) of this section, must be signed on behalf of the organization operating the program by an authorized representative, and must be accompanied by documentation that supports the narrative statement. The following provides additional guidance as to the specific criteria:

(1) *Standards and procedures.* A copy of the standards and procedures for operating a certification system and for granting a certificate of conformity should accompany the petition.

(2) *Independent status.* The petitioning organization must describe how it is independent (as defined at § 429.2) from electric motor, including dedicated-purpose pool pump motor manufacturers, importers, distributors, private labelers, vendors, and trade associations.

(3) *Qualifications to operate a certification system.* Experience in operating a certification system should be described and substantiated by supporting documents within the petition. Of particular relevance would

be documentary evidence that establishes experience in the application of guidelines contained in the ISO/IEC Guide 65, ''General requirements for bodies operating product certification systems'' (referenced for guidance only, *see* § 429.3), ISO/IEC Guide 27, ''Guidelines for corrective action to be taken by a certification body in the event of either misapplication of its mark of conformity to a product, or products which bear the mark of the certification body being found to subject persons or property to risk'' (referenced for guidance only, *see* § 429.3), and ISO/IEC Guide 28, ''General rules for a model third-party certification system for products'' (referenced for guidance only, *see* § 429.3), as well as experience in overseeing compliance with the guidelines contained in the ISO/IEC Guide 25, ''General requirements for the competence of calibration and testing laboratories'' (referenced for guidance only, *see* § 429.3).

(4) *Expertise in test procedures*—(i) *General.* This part of the petition should include items such as, but not limited to, a description of prior projects and qualifications of staff members. Of particular relevance would be documentary evidence that establishes experience in applying guidelines contained in the ISO/IEC Guide 25, ''General Requirements for the Competence of Calibration and Testing Laboratories'' (referenced for guidance only, *see* § 429.3), and with energy efficiency testing of the equipment to be certified.

(ii) *Electric motors subject to requirements in subpart B of part 431 of this subchapter.* The petition should set forth the program's experience with the test procedures detailed in § 431.16 of this subchapter and the provisions in §§ 429.64 and 429.70(j).

(iii) *Dedicated-purpose pool pump motors subject to requirements in subpart Z of part 431 of this subchapter.* The petition should set forth the program's experience with the test procedures detailed in § 431.484 of this subchapter and the provisions in §§ 429.65 and 429.70(k).

(d) *Disposition.* The Department will evaluate the petition in accordance with § 429.75, and will determine whether the applicant meets the criteria in paragraph (b) of this section for classification as a nationally recognized certification program.

(e) *Periodic evaluation.* Within one year after publication of any final rule regarding electric motors, a nationally recognized certification program must evaluate whether they meet the criteria in paragraph (b) of this section and must either submit a letter to DOE certifying that no change to its program is needed to continue to meet the criteria in paragraph (b) or submit a letter describing the measures implemented to ensure the criteria in paragraph (b) are met. A certification program will continue to be classified by the Department of Energy as being nationally recognized in the United States until DOE concludes otherwise.

■ 10. Add § 429.74 to subpart B to read as follows:

§ 429.74 Department of Energy recognition of accreditation bodies for electric motors, including dedicated-purpose pool pump motors.

(a) *Petition.* To be classified by the Department of Energy as an accreditation body, an organization must submit a petition to the Department requesting such classification, in accordance with paragraph (c) of this section and § 429.75. The petition must demonstrate that the organization meets the criteria in paragraph (b) of this section.

(b) *Evaluation criteria.* To be classified as an accreditation body by the Department, the organization must meet the following criteria:

(1) It must have satisfactory standards and procedures for conducting and administering an accreditation system and for granting accreditation. This must include provisions for periodic audits to verify that the laboratories receiving its accreditation continue to conform to the criteria by which they were initially accredited, and for withdrawal of accreditation where such conformance does not occur, including failure to provide accurate test results.

(2) It must be independent (as defined at § 429.2) of electric motor manufacturers, importers, distributors, private labelers or vendors for which it is providing accreditation.

(3) It must be qualified to perform the accrediting function in a highly competent manner.

(4)(i) In the case of electric motors subject to requirements in subpart B of part 431 of this subchapter, the organization must be an expert in the content and application of the test procedures and methodologies at § 431.16 of this subchapter and § 429.64.

(ii) In the case of dedicated-purpose pool pump motors subject to requirements in subpart Z of part 431 of this subchapter, the organization must be an expert in the content and application of the test procedures and methodologies at § 431.484 of this subchapter and § 429.65.

(c) *Petition format.* Each petition requesting classification as an accreditation body must contain a narrative statement as to why the program meets the criteria set forth in paragraph (b) of this section, must be signed on behalf of the organization operating the program by an authorized representative, and must be accompanied by documentation that supports the narrative statement. The following provides additional guidance:

(1) *Standards and procedures.* A copy of the organization's standards and procedures for operating an accreditation system and for granting accreditation should accompany the petition.

(2) *Independent status.* The petitioning organization must describe how it is independent (as defined at § 429.2) from electric motor manufacturers, importers, distributors, private labelers, vendors, and trade associations.

(3) *Qualifications to do accrediting.* Experience in accrediting should be discussed and substantiated by supporting documents. Of particular relevance would be documentary evidence that establishes experience in the application of guidelines contained in the ISO/IEC Guide 58, ''Calibration and testing laboratory accreditation systems—General requirements for operation and recognition'' (referenced for guidance only, *see* § 429.3), as well as experience in overseeing compliance with the guidelines contained in the ISO/IEC Guide 25, ''General Requirements for the Competence of Calibration and Testing Laboratories'' (referenced for guidance only, *see* § 429.3).

(4) *Expertise in test procedures.* The petition should set forth the organization's experience with the test procedures and methodologies test procedures and methodologies at § 431.16 of this subchapter and § 429.64. This part of the petition should include items such as, but not limited to, a description of prior projects and qualifications of staff members. Of particular relevance would be documentary evidence that establishes experience in applying the guidelines contained in the ISO/IEC Guide 25, ''General Requirements for the Competence of Calibration and Testing Laboratories,'' (referenced for guidance only, *see* § 429.3) to energy efficiency testing for electric motors.

(d) *Disposition.* The Department will evaluate the petition in accordance with § 429.75, and will determine whether the applicant meets the criteria in paragraph (b) of this section for classification as an accrediting body.

■ 11. Add § 429.75 to subpart B to read as follows:

§ 429.75 Procedures for recognition and withdrawal of recognition of accreditation bodies or certification programs.

(a) *Filing of petition.* Any petition submitted to the Department pursuant to § 429.73(a) or § 429.74(a), shall be entitled ''Petition for Recognition'' (''Petition'') and must be submitted to the Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Office, Appliance and Equipment Standards Program, EE–5B, 1000 Independence Avenue SW, Washington, DC 20585–0121, or via email (preferred submittal method) to *AS_Motor_Petitions@ee.doe.gov.* In accordance with the provisions set forth in 10 CFR 1004.11, any request for confidential treatment of any information contained in such a Petition or in supporting documentation must be accompanied by a copy of the Petition or supporting documentation from which the information claimed to be confidential has been deleted.

(b) *Public notice and solicitation of comments.* DOE shall publish in the **Federal Register** the Petition from which confidential information, as determined by DOE, has been deleted in accordance with 10 CFR 1004.11 and shall solicit comments, data and information on whether the Petition should be granted. The Department shall also make available for inspection and copying the Petition's supporting documentation from which confidential information, as determined by DOE, has been deleted in accordance with 10 CFR 1004.11. Any person submitting written comments to DOE with respect to a Petition shall also send a copy of such comments to the petitioner.

(c) *Responsive statement by the petitioner.* A petitioner may, within 10 working days of receipt of a copy of any comments submitted in accordance with paragraph (b) of this section, respond to such comments in a written statement submitted to the Assistant Secretary for Energy Efficiency and Renewable Energy. A petitioner may address more than one set of comments in a single responsive statement.

(d) *Public announcement of interim determination and solicitation of comments.* The Assistant Secretary for Energy Efficiency and Renewable Energy shall issue an interim determination on the Petition as soon as is practicable following receipt and review of the Petition and other applicable documents, including, but not limited to, comments and responses to comments. The petitioner shall be notified in writing of the interim determination. DOE shall also publish in the **Federal Register** the interim determination and shall solicit comments, data, and information with respect to that interim determination. Written comments and responsive statements may be submitted as provided in paragraphs (b) and (c) of this section.

(e) *Public announcement of final determination.* The Assistant Secretary for Energy Efficiency and Renewable Energy shall as soon as practicable, following receipt and review of comments and responsive statements on the interim determination, publish in the **Federal Register** notification of final determination on the Petition.

(f) *Additional information.* The Department may, at any time during the recognition process, request additional relevant information or conduct an investigation concerning the Petition. The Department's determination on a Petition may be based solely on the Petition and supporting documents, or may also be based on such additional information as the Department deems appropriate.

(g) *Withdrawal of recognition*—(1) *Withdrawal by the Department.* If DOE believes that an accreditation body or certification program that has been recognized under § 429.73 or § 429.74, respectively, is failing to meet the criteria of paragraph (b) of the section under which it is recognized, or if the certification program fails to meet the provisions at § 429.73(e), the Department will issue a Notice of Withdrawal (''Notice'') to inform such entity and request that it take appropriate corrective action(s) specified in the Notice. The Department will give the entity an opportunity to respond. In no case shall the time allowed for corrective action exceed 180 days from the date of the notice (inclusive of the 30 days allowed for disputing the bases for DOE's notification of withdrawal). If the entity wishes to dispute any bases identified in the Notice, the entity must respond to DOE within 30 days of receipt of the Notice. If after receiving such response, or no response, the Department believes satisfactory correction has not been made, the Department will withdraw its recognition from that entity.

(2) *Voluntary withdrawal.* An accreditation body or certification program may withdraw itself from recognition by the Department by advising the Department in writing of such withdrawal. It must also advise those that use it (for an accreditation body, the testing laboratories, and for a certification organization, the manufacturers) of such withdrawal.

(3) *Notice of withdrawal of recognition.* The Department will publish in the **Federal Register** notification of any withdrawal of recognition that occurs pursuant to this paragraph.

■ 12. Add appendix B to subpart B of part 429 to read as follows:

Appendix B to Subpart B of Part 429—Nominal Full-Load Efficiency Table for Electric Motors

99.0	96.5	88.5	68	36.5
98.9	96.2	87.5	66	34.5
98.8	95.8	86.5	64	
98.7	95.4	85.5	62	
98.6	95	84	59.5	
98.5	94.5	82.5	57.5	
98.4	94.1	81.5	55	
98.2	93.6	80	52.5	
98	93	78.5	50.5	
97.8	92.4	77	48	
97.6	91.7	75.5	46	
97.4	91	74	43.5	
97.1	90.2	72	41	
96.8	89.5	70	38.5	

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

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

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

■ 14. Section 431.12 is amended by:
■ a. Revising the definitions of ''Air-over electric motor'', ''Basic model'', ''Definite purpose electric motor'', ''Definite purpose motor'', ''Electric motor with encapsulated windings'', ''Electric motor with moisture resistant windings'', and ''Electric motor with sealed windings'';
■ b. Adding in alphabetical order a definition for ''Equipment class'';
■ c. Revising the definitions of ''General purpose electric motor'', ''General purpose electric motor (subtype I)'', ''General purpose electric motor (subtype II)'', and ''IEC Design H motor'';
■ d. Adding in alphabetical order definitions for ''IEC Design HE'', ''IEC Design HEY'', and ''IEC Design HY'';
■ e. Revising the definition of ''IEC Design N motor'';
■ f. Adding in alphabetical order definitions for ''IEC Design NE'', ''IEC Design NEY'', and ''IEC Design NY'';
■ g. Adding in alphabetical order a definition for ''Inverter'';
■ h. Revising the definitions of ''Inverter-capable electric motor'', ''Inverter-only electric motor'', ''Liquid-cooled electric motor'', ''NEMA Design A motor'', ''NEMA Design B motor'', ''NEMA Design C motor'', and ''Nominal full-load efficiency''; and
■ i. Adding in alphabetical order definitions for ''Rated frequency'', ''Rated load'', and ''Rated voltage.''

The revisions and additions read as follows:

§ 431.12 Definitions.

* * * * *

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

* * * * *

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

* * * * *

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

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

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

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

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

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

* * * * *

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

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

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

* * * * *

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

* * * * *

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Note 1 to definition of ''*General purpose electric motor (subtype I)*'': References to ''MG1'' above refer to NEMA Standards Publication MG 1–2016 (incorporated by reference in § 431.15). References to ''IEC'' above refer to IEC 60034–1, 60034–12:2016, 60050–411, and 60072–1 (incorporated by reference in § 431.15), as applicable.

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

(1) Is built in accordance with NEMA U-frame dimensions as described in NEMA MG 1–1967 (incorporated by reference, *see* § 431.15) or in accordance with the IEC metric equivalents,

including a frame size that is between two consecutive NEMA frame sizes or their IEC metric equivalents;

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

(3) Is a close-coupled pump motor;

(4) Is a footless motor;

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

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

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

Note 2 to definition of ''General purpose electric motor (subtype II)'': With the exception of the NEMA Motor Standards MG1–1967 (incorporated by reference in § 431.15), references to ''MG1'' above refer to NEMA MG 1–2016 (incorporated by reference in § 431.15). References to ''IEC'' above refer to IEC 60034–1, 60034–12, 60050–411, and 60072–1 (incorporated by reference in § 431.15), as applicable.

* * * * *

IEC Design H motor means an electric motor that:

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

(2) Contains a cage rotor;

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

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

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

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

IEC Design HE means an electric motor that:

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

(2) Contains a cage rotor;

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

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

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

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

IEC Design HEY means an electric motor that:

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

(2) Contains a cage rotor;

(3) Is capable of star-delta starting;

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

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

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

IEC Design HY means an electric motor that:

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

(2) Contains a cage rotor;

(3) Is capable of star-delta starting;

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

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

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

IEC Design HY means an electric motor that:

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

(2) Contains a cage rotor;

(3) Is capable of star-delta starting;

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

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

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

IEC Design N motor means an electric motor that:

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

(2) Contains a cage rotor;

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

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

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

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

IEC Design NE means an electric motor that:

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

(2) Contains a cage rotor;

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

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

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

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

IEC Design NEY means an electric motor that:

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

(2) Contains a cage rotor;

(3) Is capable of star-delta starting;

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

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

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

IEC Design NY means an electric motor that:

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

(2) Contains a cage rotor;

(3) Is capable of star-delta starting;

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

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

(6) Conforms to Section 5.4, Section 6.2 and Section 6.3 of the IEC 60034–12:2016 (incorporated by reference, *see* § 431.15) specifications for starting torque, locked rotor apparent power, and starting requirements, respectively.

* * * * *

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

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

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

* * * * *

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

* * * * *

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

(1) Is designed to withstand full-voltage starting and developing locked-

rotor torque as shown in NEMA MG 1–2016, paragraph 12.38.1 (incorporated by reference, *see* § 431.15);

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

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

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

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

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

(1) Designed to withstand full-voltage starting;

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

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

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

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

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

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

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

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

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

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

* * * * *

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

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

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

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

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

* * * * *

§ 431.14 [Removed and Reserved]

■ 15. Remove and reserve § 431.14.

■ 16. Section 431.15 is amended by:

■ a. Revising paragraphs (a) and (b);

■ b. Removing the text '', + 41 22 919 02 11, or go to *http://webstore.iec.ch*'' and adding in its place the text ''; + 41 22 919 02 11; *webstore.iec.ch*'' in paragraph (c) introductory text;

■ c. Revising paragraphs (c)(3), (4), and (7);

■ d. Adding paragraphs (c)(8) and (9); and

■ e. Revising paragraphs (d) through (f).

The revisions and additions read as follows:

§ 431.15 Materials incorporated by reference.

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

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

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

(2) CSA C747–09 (reaffirmed 2019) (''CSA C747–09''), *Energy efficiency test methods for small motors,* including Update No. 1 (August 2016), October 2009; IBR approved for appendix B to this subpart.

(c) * * *

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

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

* * * * *

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

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

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

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

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

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

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

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

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

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

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

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

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

(2) [Reserved]

§ 431.17 [Removed and Reserved]

■ 17. Remove and reserve § 431.17.

■ 18. Section 431.18 is amended by revising paragraph (b) to read as follows:

§ 431.18 Testing laboratories.

* * * * *

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

§§ 431.19 through 431.21 [Removed]

■ 19. Remove §§ 431.19 through 431.21.

■ 20. Section 431.25 is amended by:

■ a. Revising paragraph (g)(9);

■ b. Revising paragraph (h) introductory text and the table 5 heading; and

■ c. Revising paragraph (i) introductory text and the table 6 heading.

The revisions read as follows:

§ 431.25 Energy conservation standards and compliance dates.

* * * * *

(g) * * *

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

* * * * *

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

Table 5 to Paragraph (h)—Nominal Full-Load Efficiencies of NEMA Design A, NEMA Design B and IEC Design N, NE, NEY or NY Motors (Excluding Fire Pump Electric Motors) at 60 Hz

* * * * *

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

Table 6 to Paragraph (i)—Nominal Full-Load Efficiencies of NEMA Design C and IEC Design H, HE, HEY or HY Motors at 60 Hz

* * * * *

■ 20. Appendix B to subpart B of part 431 is revised to read as follows:

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

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

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

0. Incorporation by Reference

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

0.1. CSA C390–10

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

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

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

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

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

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

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

0.2. CSA C747–09

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

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

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

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

0.3. IEC 60034–1:2010

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

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

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

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

0.4. IEC 60034–2–1:2014

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

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

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

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

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

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

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

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

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

0.5. IEC 60051–1:2016

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

(b) [Reserved].

0.6. IEC 61800–9–2:2017

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

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

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

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

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

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

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

0.7. IEEE 112–2017

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

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

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

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

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

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

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

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

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

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

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

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

0.8. IEEE 114–2010

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

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

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

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

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

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

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

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

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

0.9. NEMA MG 1–2016

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

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

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

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

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

1. Scope and Definitions

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

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

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

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

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

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

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

(d) Is rated for 600 volts or less;

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

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

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

Synchronous Electric Motor means an electric motor that:

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

(b) Is a synchronous electric motor;

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

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

(e) Is rated 600 volts or less;

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

2. Test Procedures

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

Efficiency and losses must be determined in accordance with NEMA MG 1–2016, Paragraph 12.58.1, ''Determination of Motor

Efficiency and Losses,'' or one of the following testing methods:

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

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

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

2.2. Test Procedures for Air-Over Electric Motors

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

3. Procedures for the Testing of Certain Electric Motor Categories

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

3.1. Brake Electric Motors:

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

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

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

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

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

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

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

3.5. Electric Motors with a Separately-Powered Blower:

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

3.6. Immersible Electric Motors:

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

3.7. Partial Electric Motors:

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

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

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

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