DEPARTMENT OF ENERGY

10 CFR Parts 429 and 431

[EERE–2020–BT–TP–0032]

RIN 1904–AE53

Energy Conservation Program: Test Procedure for Commercial and Industrial Pumps

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

ACTION: Final rule.

SUMMARY: This final rule amends the test procedure for commercial and industrial pumps (''pumps'') to incorporate by reference relevant portions of the latest version of the industry testing standard, expands the scope of clean water pumps covered by this test procedure, revises calculation methods for pumps sold with motors and controls to better represent field energy use, adds and updates certain definitions, and allows the use of alternative efficiency determination methods for the rating and certification of pumps.

DATES: The effective date of this rule is April 24, 2023. The amendments will be mandatory for product testing starting September 20, 2023.

The incorporation by reference of certain materials listed in the rule is approved by the Director of the Federal Register on April 24, 2023. The incorporation by reference of certain other materials listed in this rule was approved by the Director of the Federal Register on January 25, 2016.

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

A link to the docket web page can be found at *www.regulations.gov/docket/EERE-2020-BT-TP-0032.* 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.*

FOR FURTHER INFORMATION CONTACT:

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SUPPLEMENTARY INFORMATION: DOE incorporates by reference the following industry standards into part 431:

HI 40.6–2021, ''Methods For Rotodynamic Pump Efficiency Testing'';
ANSI/HI 9.6.1–2017, ''Rotodynamic Pumps Guideline for NPSH Margin'';
ANSI/HI 9.6.6–2016, ''Rotodynamic Pumps for Pump Piping'';
ANSI/HI 9.8–2018, ''Rotodynamic Pumps for Pump Intake Design'';
ANSI/HI 14.1–14.2–2019, ''Rotodynamic Pumps for Nomenclature and Definitions'';
HI Engineering Data Book—Second Edition;

Copies of HI 40.6–2021, ANSI/HI 9.6.1–2017, ANSI/HI 9.6.6–2016, ANSI/HI 9.8–2018, ANSI/HI 14.1–14.2–2019, and the HI Engineering Data Book—Second Edition, can be obtained from the Hydraulics Institute (HI), 300 Interpace Parkway, 3rd Bldg. A Floor, Parsippany, NJ 07054, (973) 267–9700, or online at: *www.Pumps.org.*

ANSI/ASME MFC–5M–1985 (Reaffirmed 2006), ''Measurement of Liquid Flow in Closed Conduits Using Transit-Time Ultrasonic Flowmeters'' (''ANSI/ASME MFC–5M–1985'');
ASME MFC–3M–2004 (Reaffirmed 2017), ''Measurement of Fluid Flow in Pipes Using Orifice, Nozzle, and Venturi'' (''ASME MFC–3M–2004'');
ASME MFC–8M–2001 (Reaffirmed 2011), ''Fluid Flow in Closed Conduits: Connections for Pressure Signal Transmissions Between Primary and Secondary Devices'';
ASME MFC–12M–2006 (Reaffirmed 2014), ''Measurement of Fluid Flow in Closed Conduits Using Multiport Averaging Pitot Primary Elements'' (''ASME MFC–12M–2006'');
ASME MFC–16–2014, ''Measurement of Liquid Flow in Closed Conduits with Electromagnetic Flowmeters'';
ASME MFC–22–2007 (Reaffirmed 2014), ''Measurement of Liquid by Turbine Flowmeters'' (''ASME MFC–22–2007'');

Copies of ANSI/ASME MFC–5M–1985, ASME MFC–3M–2004, ASME MFC–8M–2001, ASME MFC–12M–2006, ASME MFC–16–2014, and ASME MFC–22–2007 can be obtained from the American Society of Mechanical Engineers (ASME), Two Park Avenue, New York, NY 10016–5990, (800) 843–2763, or online at: *www.asme.org.*

ANSI/AWWA E103–2015, ''Horizontal and Vertical Line-Shaft Pumps'' (''AWWA E103–2015'');

Copies of AWWA E103–2015 can be obtained from the American Water Works Association (AWWA), 6666 W Quincy Avenue, Denver, CO 80235, (303) 794–7711, or online at: *www.awwa.org.*

CSA C390–10, ''Test methods, marking requirements, and energy efficiency levels for three-phase induction motors'';

Copies of CSA C390–10 can be obtained from the Canadian Standards Association (CSA), 178 Rexdale Blvd., Toronto, ON, Canada M9W 1R3, (800) 463–6727, or online at *www.csagroup.org.*

IEEE 112–2017, ''IEEE Standard Test Procedure for Polyphase Induction Motors and Generators'';
IEEE 114–2010, ''IEEE Standard Test Procedure for Single-Phase Induction Motors'';

Copies of IEEE 112–2017 and IEEE 114–2010 can be obtained from the Institute of Electrical and Electronics Engineers (IEEE), 445 Hoes Lane, Piscataway, NJ 08854–4141, (732) 981–0060, or online at *standards.ieee.org.*

ISO 1438:2017(E), ''Hydrometry—Open channel flow measurement using thin-plate weirs'' (''ISO 1438:2017'');
ISO 2186:2007(E), ''Fluid flow in closed conduits—Connections for pressure signal transmissions between primary and secondary elements'' (''ISO 2186:2007'');
ISO 2715:2017(E), ''Liquid hydrocarbons—Volumetric measurement by turbine flowmeter'' (''ISO 2715:2017'');
ISO 3354:2008(E), ''Measurement of clean water flow in closed conduits—Velocity-area method using current-meters in full conduits and under regular flow conditions'' (''ISO 3354:2008'');
ISO 3966:2020(E), ''Measurement of fluid flow in closed conduits—Velocity area method using Pitot static tubes'' (''ISO 3996:2020'');
ISO 5167–1:2003(E), ''Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full—Part 1: General

principles and requirements'' (''ISO 5167–1:2003'');

ISO 5198:1987(E), ''Centrifugal, mixed flow and axial pumps—Code for hydraulic performance tests—Precision class'' (''ISO 5198:1987'');

ISO 6416:2017(E), ''Hydrometry—Measurement of discharge by the ultrasonic transit time (time of flight) method'' (''ISO 6416:2017'');

ISO 20456:2017(E), ''Measurement of fluid flow in closed conduits—Guidance for the use of electromagnetic flowmeters for conductive liquids'' (''ISO 20456:2017'');

Copies of ISO 1438:2017, ISO 2186:2007, ISO 2715:2017, ISO 3354:2008, ISO 3966:2020, ISO 5167–1:2003, ISO 5198:1987, ISO 6416:2017, and ISO 20456:2017 can be obtained from the International Organization for Standardization (ISO), Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, +41 22 749 01 11, or online at: *www.iso.org.*

For a further discussion of these standards, see section IV.N of this document.

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I. Authority and Background

Commercial and industrial pumps (collectively, ''pumps'') 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 pumps are currently prescribed at title 10 of the Code of Federal Regulations (''CFR''), § 431.464, and 10 CFR part 431 subpart Y appendix A (''appendix A''). The following sections discuss DOE's authority to establish test procedures for pumps and relevant background information regarding DOE's consideration of test procedures for this equipment.

A. Authority

The Energy Policy and Conservation Act, Public Law 94–163, 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 of EPCA,[2] established the Energy Conservation Program for Certain Industrial Equipment, which sets forth a variety of provisions designed to improve energy efficiency. This equipment includes pumps, 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

[1] All references to EPCA in this document refer to the statute as amended through the Energy Act of 2020, Public Law 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.

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 also requires that, at least once every 7 years, DOE evaluate test procedures for each type of covered equipment, including pumps, 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. (42 U.S.C. 6314(a)(1)(A)(ii))

DOE is publishing this final rule in satisfaction of the 7-year review requirement specified in EPCA. (42 U.S.C. 6314(b)(1))

B. Background

DOE established its test procedure for pumps in a final rule published on January 25, 2016. 81 FR 4086 (''January 2016 Final Rule'').[3] The January 2016 Final Rule established definitions for the terms ''pump,''[4] ''driver,''[5] and ''controls,''[6] and identified several categories and configurations of pumps. The pumps test procedure currently incorporates by reference the Hydraulic Institute (''HI'') Standard 40.6–2014, ''Methods for Rotodynamic Pump Efficiency Testing'' (''HI 40.6–2014''), along with several modifications to that testing method related to measuring the hydraulic power, shaft power, and electric input power of pumps, inclusive of electric motors and any continuous or non-continuous controls.[7]

On September 28, 2020, DOE published an early assessment review request for information (''RFI'') to determine whether to proceed with a rulemaking to amend the test procedure for pumps. 85 FR 60734 (''September 2020 Early Assessment RFI''). DOE subsequently published an RFI on April 16, 2021 seeking further data and information pertaining to the test procedure for pumps. 86 FR 20075 (''April 2021 RFI''). On April 11, 2022, DOE published a test procedure notice of proposed rulemaking presenting DOE's proposals to amend the pumps test procedure. 87 FR 21268 (''April 2022 NOPR''). DOE held a public meeting related to the April 2022 NOPR on April 26, 2022 (''NOPR public meeting'').

DOE received comments in response to the April 2022 NOPR from the interested parties listed in Table I.1.

TABLE I.1—LIST OF COMMENTERS WITH WRITTEN SUBMISSIONS IN RESPONSE TO THE APRIL 2022 NOPR

Commenter(s)	Reference in this final rule	Comment No. in the docket	Commenter type
Appliance Standards Awareness Project, American Council for an Energy-Efficient Economy, Natural Resources Defense Council.	Efficiency Advocates	30	Efficiency Organizations.
ebm-pabst, Inc	ebm-pabst	n/a	Motor Manufacturer.
Grundfos Americas Corporation	Grundfos	31	Manufacturer.
Hydraulic Institute	HI	33	Trade Association.
Northwest Energy Efficiency Alliance	NEEA	34	Efficiency Organization.
Pacific Gas and Electric Company, San Diego Gas and Electric, and Southern California Edison; collectively, the California Investor-Owned Utilities.	CA IOUs	32	Utilities.
People's Republic of China	China	29	Country.

A parenthetical reference at the end of a comment quotation or paraphrase provides the location of the item in the public record.[8] To the extent that interested parties have provided written comments that are substantively consistent with any oral comments provided during the NOPR public meeting, DOE cites the written comments throughout this final rule. Any oral comments provided during the webinar that are not substantively addressed by written comments are summarized and cited separately throughout this final rule.

II. Synopsis of the Final Rule

In this final rule, DOE amends §§ 431.462, 431.463, 431.464, and appendix A as follows:

[3] On March 23, 2016, DOE published a correction to the January 2016 Final Rule to correct the placement of the product-specific enforcement provisions related to pumps under 10 CFR 429.134(i). 81 FR 15426.

[4] A ''pump'' means equipment designed to move liquids (which may include entrained gases, free solids, and totally dissolved solids) by physical or mechanical action and includes a bare pump and, if included by the manufacturer at the time of sale, mechanical equipment, driver, and controls. (10 CFR 431.462)

[5] A ''driver'' provides mechanical input to drive a bare pump directly or through the use of mechanical equipment. Electric motors, internal combustion engines, and gas/steam turbines are examples of drivers. (10 CFR 431.462)

[6] A ''control'' is used to operate a driver. (10 CFR 431.462)

[7] A ''continuous control'' is a control that adjusts the speed of the pump driver continuously over the driver operating speed range in response to incremental changes in the required pump flow, head, or power output. A ''non-continuous control'' is a control that adjusts the speed of a driver to one of a discrete number of non-continuous preset operating speeds and does not respond to incremental reductions in the required pump flow, head, or power output. 10 CFR 431.462.

[8] The parenthetical reference provides a reference for information located in the docket of DOE's rulemaking to develop test procedures for pumps. (Docket No. EERE–2020–BT–TP–0032, which is maintained at *www.regulations.gov*). The references are arranged as follows: (commenter name, comment docket ID number, page of that document).

(1) Expand the scope of the test procedure to include additional clean water pumps, specifically radially-split, multi-stage, horizontal (''RSH'') pumps; radially-split, multi-stage, horizontal in-line diffuser casing (''RSHIL'') pumps; radially-split, multi-stage, horizontal, end-suction diffuser casing (''RSHES'') pumps; small vertical in-line (''SVIL'') pumps; vertical turbine (''VT'') pumps; pumps sold with 6-pole induction motors or motors with design speeds greater than or equal to 960 rpm and less than 1,440 rpm; and end-suction pumps not covered by the current test procedure;

(2) Clarify the applicability of the design temperature range and modify the range parameters;

(3) Add and modify certain definitions in 10 CFR 431.462 to accommodate the expansion of the test procedure's scope and to clarify existing definitions;

(4) Incorporate by reference HI 40.6–2021 into 10 CFR 431.463 and remove language in the DOE test procedure that is redundant with HI 40.6–2021;

(5) Clarify certain test provisions for pumps with BEP at run-out;

(6) Update part-load loss factor equation coefficients in the calculation method for pumps sold with induction motors and controls;

(7) Provide a calculation method for pumps sold with inverter-only motors;

(8) Update the test procedure for submersible pumps to address DOE's coverage of submersible motors;

(9) Add provisions for testing and rating RSH, SVIL, VT pumps, and pumps sold with a 6-pole induction motors or with design speeds greater than or equal to 960 rpm and less than 1,440 rpm; and

(10) Allow use of alternative efficiency determination methods (''AEDMs'').

The adopted amendments are summarized in Table II.1 compared to the current 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

DOE test procedure prior to amendment	Amended test procedure	Attribution
Does not include in the scope of the test procedure RSHIL, RSHES, SVIL, or VT pumps; pumps distributed in commerce with nominal speeds of 1,200 rpm; or all end-suction pumps.	Includes in the scope of the test procedure RSHIL, RSHES, SVIL, and VT pumps; pumps distributed in commerce with nominal speeds of 1,200 rpm; and all end-suction pumps.	Improved representativeness.
Includes a scope limitation of a design temperature range from 14 to 248 °F.	Specifies a scope limitation of a pump whose design temperature range falls wholly or partially into the range from 15 to 250 °F.	Improved clarity and enforceability.
Includes definitions for pump categories within the current scope of the test procedure.	Includes definitions for additional pump categories and clarifications to the definitions for some existing pump categories.	Required for scope expansion; improved enforceability.
Incorporates by reference HI 40.6–2014 for determining the constant load pump energy index (“PEI_{CL}”) and the variable load pump energy index (“PEI_{VL}”) value of pumps.	Incorporates by reference HI 40.6–2021 for determining the PEI_{CL} and the PEI_{VL} value of pumps.	Updates to applicable industry test standard.
Provides example pump categories for certain pump definitions by referencing ANSI/HI 1.1–1.2–2014 and ANSI/HI 2.1–2.2–2014.	Removes example pump categories from all relevant definitions.	Simplification of the test procedure.
References ANSI/HI 2.1–2.2–2014 to define ''intermediate bowl'' within the definition for bowl diameter.	Incorporates a definition for ''intermediate bowl'' in the definition for bowl diameter, removing the reference to ANSI/HI 2.1–2.2–2014.	Simplification of the test procedure.
Does not include test provisions for multistage pumps other than RSV and ST.	Includes specifications for stages for testing for RSHIL, RSHES, and VT pumps.	Required for scope expansion.
Includes provisions for pumps with BEP at run-out	Clarifies provisions for pumps with BEP at run-out	Improved repeatability and reproducibility.
References a section of HI 40.6–2014 related to calibration of measurement equipment.	Clarifies the applicable test provisions in HI 40.6–2021 for calibration of measurement equipment.	Improved repeatability and reproducibility.
Includes a calculation method for pumps sold with induction motors and controls.	Includes revised part-load loss factor equation coefficients for motors 50 hp and above.	Improved representativeness.
Does not provide a calculation method for pumps sold with inverter-only motors.	Provides a calculation method for pumps sold with inverter-only motors.	Reduced burden.
Includes test provisions specific to submersible pumps based on default motor efficiency.	Includes test provisions specific to submersible pumps based on DOE's coverage of submersible motors.	Allows for seamless update if or when DOE finalizes submersible motor coverage.
Does not include test provisions specific to SVILs	Includes test provisions specific to SVILs	Required for scope expansion.
Does not include provisions for testing pumps distributed in commerce with 6-pole motors or motors with design speeds greater than or equal to 960 rpm and less than 1,440 rpm.	Includes provisions for testing pumps sold with 6-pole motors or motors with design speeds greater than or equal to 960 rpm and less than 1,440 rpm.	Improved representativeness.
Does not allow use of AEDMs	Allows use of AEDMs	Reduced burden.

DOE has determined that the amendments described in section III of this final rule would not alter the measured efficiency [9] of commercial and industrial pumps that are currently included in the scope of DOE's energy conservation standards for pumps. Therefore, DOE does not expect that retesting or recertification would be necessary for currently certified pumps as a result of DOE's adoption of the amendments to the test procedures. Additionally, DOE has determined that the amendments would not increase the cost of testing for these pumps.

For pumps that are not currently within the scope of the test procedure but are subject to the expansion of scope adopted by this final rule, use of the DOE test procedure as amended by this final rule is not required until the compliance date of any energy conservation standards that DOE may ultimately establish for such pumps as part of a separate rulemaking assessing the technological feasibility and economic justification for such 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. (42 U.S.C. 6314(d))

Discussion of DOE's actions are addressed in detail in section III of this final rule.

III. Discussion

A. Scope of Applicability

The current DOE test procedure for pumps applies to five categories of ''clean water pumps'' with specific defined characteristics and excludes certain defined categories [10] of pumps. 10 CFR 431.464(a)(1).

DOE defines ''clean water pump'' as a pump that is designed for use in pumping water with a maximum non-absorbent free solid content of 0.016 pounds per cubic foot, and with a maximum dissolved solid content of 3.1 pounds per cubic foot, provided that the total gas content of the water does not exceed the saturation volume and disregarding any additives necessary to prevent the water from freezing at a minimum of 14 °F. 10 CFR 431.462.

The five categories of clean water pumps to which the current test procedure applies are: end-suction close-coupled (''ESCC''); end-suction frame mounted/own bearings (''ESFM''); in-line (''IL''); radially-split, multi-stage, vertical, in-line diffuser casing (''RSV''); and submersible turbine (''ST''). 10 CFR 431.464(a)(1)(i). The defined characteristics specify limits on flow rate, maximum head, design temperature range, motor type, bowl diameter, and speed.[11] 10 CFR 431.464(a)(1)(ii). In the context of the energy conservation standards, pumps are further delineated into equipment classes based on nominal speed of rotation and operating mode (*i.e.,* constant load or variable load). 10 CFR 431.465.

In the April 2022 NOPR, DOE proposed expanding the test procedure scope to include BB, RSH, RSHIL, RSHES, SVIL, and VT pumps, as well as pumps sold with 6-pole induction motors or motors with design speeds between 960 rpm and 1,440 rpm; ST pumps with bowl diameters greater than 6 inches; and end-suction pumps not covered by the current test procedure. 87 FR 21268, 21272.

The CA IOUs, Efficiency Advocates, and NEEA supported DOE's proposal to expand the test procedure scope to include additional pumps. (NEEA, No. 34 at p. 2; Efficiency Advocates, No. 30 at pp. 1–3; CA IOUs, No. 32 at p. 1) NEEA commented that sales reported to its commercial and industrial pumps efficiency program indicated these pumps should be included in the scope of the test procedure and that this would avoid pumps outside the scope from competing with regulated pumps without the costs of complying with the efficiency standards and labeling requirements. (NEEA, No. 34 at p. 2)

HI stated that the proposed scope expansion could be tested to HI 40.6–2021 but commented that DOE should consider the benefits of including larger pumps, since these pumps are often sold in much smaller volumes and the capital and manufacturing impacts will be disproportionate compared to energy savings for the current scope. (HI, No. 33 at p. 1) HI also stated that these larger pumps may require different testing infrastructure and instrumentation and that this would require substantial capital investment for testing. *Id.*

DOE addresses HI's comments in the following sections relative to specific pump categories. The following sections also provide additional information and responses to stakeholder comments specific to the pumps that DOE considered for inclusion in the test procedure scope.

1. Pumps Not Designed for Clean Water Applications

The scope of the current DOE test procedure, as described previously, does not include either chemical process or wastewater pumps. *See* 10 CFR 431.464(a)(1)(i). Chemical process pumps are designed to pump fluids other than water, and wastewater pumps are designed for water with a higher level of free solids than clean water pumps. In the April 2022 NOPR, in response to comments received on the April 2021 RFI, DOE explained that although certain non-clean water pumps may be used in clean water applications, DOE expects the number of non-clean water pumps used in the clean water applications to be relatively small. 87 FR 21268, 21275. DOE noted that the relevant industry standards do not provide requirements for testing pumps designed for non-clean water applications. *Id.* To test non-clean water pumps, DOE would need to reference or develop an alternate test procedure. *Id.* While this test procedure might enable comparison between non-clean water pumps, it is unlikely that a clean water and non-clean water test procedure would provide comparable results. *Id.*

[9] DOE is updating the induction motor coefficients (see section III.F.2 of this document) which will change the calculated rating for pumps sold with induction motors. However, DOE expects the updated calculations will provide a PEI equal to or less than that determined using the current induction motor coefficients. Since the pump would be considered more efficient, manufacturers would not have to recertify their basic models, although they could voluntarily choose to do so. As such, DOE has determined that the updated induction motor coefficients will not increase manufacturer burden.

[10] The excluded categories of pumps are fire pumps; self-priming pumps; prime-assist pumps; magnet driven pumps; pumps designed to be used in a nuclear facility subject to 10 CFR part 50, ''Domestic Licensing of Production and Utilization Facilities''; and pumps meeting the design and construction requirements set forth in Military Specifications: MIL–P–17639F, ''Pumps, Centrifugal, Miscellaneous Service, Naval Shipboard Use'' (as amended); MIL–P–17881D, ''Pumps, Centrifugal, Boiler Feed, (Multi-Stage)'' (as amended); MIL–P–17840C, ''Pumps, Centrifugal, Close-Coupled, Navy Standard (For Surface Ship Application)'' (as amended); MIL–P–18682D, ''Pump, Centrifugal, Main Condenser Circulating, Naval Shipboard'' (as amended); and MIL–P–18472G, ''Pumps, Centrifugal, Condensate, Feed Booster, Waste Heat Boiler, And Distilling Plant'' (as amended). 10 CFR 431.464(a)(1)(iii).

[11] More specifically, these characteristics include: (A) flow rate of 25 gallons per minute or greater at best efficiency point (''BEP'') and full impeller diameter; (B) maximum head of 459 feet at BEP and full impeller diameter and the number of stages required for testing; (C) design temperature range from 14 to 248 °F; (D) designed to operate with either (1) a 2- or 4-pole induction motor, or (2) a non-induction motor with a speed of rotation operating range that includes speeds of rotation between 2,880 and 4,320 revolutions per minute (''rpm'') and/or 1,440 and 2,160 rpm, and in either case, the driver and impeller must rotate at the same speed; (E) For ST pumps, a 6-inch or smaller bowl diameter; and (F) For ESCC and ESFM pumps, a specific speed less than or equal to 5,000 when calculated using U.S. customary units. 10 CFR 431.464(a)(1)(ii).

Additionally, DOE noted that non-clean water pumps, specifically wastewater pumps, must meet specific performance requirements to ensure the health of the U.S. population. 87 FR 21268, 21275. DOE would need to carefully evaluate how the performance of non-clean water pumps could be impacted by energy conservation standards and ensure that public health and safety would not be negatively affected. *Id.* As such, additional investigation would be needed to understand the market, energy savings potential, test procedure implications, and performance requirements of non-clean water pumps (*i.e.,* chemical process and wastewater). *Id.* DOE noted that because ''C-value'' is specified in the energy conservation standard (*see* 10 CFR 431.465(b)(4)) and C-value is required for determining PEI_{CL} and $PEI_{VL,}$ there would be limited use of the test procedure without corresponding standards. *Id.* Therefore, in the April 2022 NOPR, DOE tentatively determined to continue to limit the applicability of the test procedure to clean water pumps. *Id.*

In response to the April 2022 NOPR, NEEA requested that DOE add ASME B73 [12] compliant pumps in the clean water definition. (NEEA, No. 34 at p. 2–4) NEEA explained that pumps that meet the requirements of ANSI/ASME Standard B73.1–2012 or ANSI/ASME B73.2–2002 are often used in pumping clean water. *Id.* NEEA further stated that these pumps are often advertised as serving clean water functions and have been certified for that end use—some for drinking water components. Since these pumps overlap and compete directly with covered pumps in clean water applications, NEEA argued that they potentially create a compliance loophole. *Id.* NEEA suggested that DOE no longer consider ASME B73 certified pumps to be excluded from the clean water definition and clarified that they did not believe DOE would need to change the current or proposed scope of pumps to do so. (NEEA, No. 34 at p. 4) NEEA stated that ending the exclusion was sufficient, and that in doing so DOE would only be including those ASME B73 certified pumps that advertise as clean water pumps and compete directly with clean water pumps. *Id.*

In response to NEEA, any pump designed for non-clean water applications would also be capable of pumping clean water. However, DOE notes that the definition of clean water pump specifies that the pump is *designed for use* in pumping [clean water] (emphasis added). *See* 10 CFR 431.462. DOE further notes that the ASME B73 pumps have additional design requirements for maximum shaft deflections, bearing frame lubrication, sealing, and vibration limits because they are designed for use in chemical process applications.

Because of the additional design requirements applicable to ASME B73 pumps, it is unlikely that a manufacturer of clean water pumps would certify to ASME B73 as a way to avoid DOE energy conservation standards. DOE market research indicates that the prices of ASME B73 pumps are typically substantially higher than the clean water pumps that are included in this rulemaking, presumably due to these additional design requirements. Therefore, DOE does not expect end users to specifically purchase ASME B73 pumps for use as replacements for clean water pumps currently covered by DOE energy conservation standards. Finally, DOE is not aware of ASME B73 pumps being distributed in commerce as substitutes for clean water pumps to any significant degree. Given these considerations, DOE is not amending the definition of clean water pump to specifically include pumps certified under the ASME B73 designation in this rulemaking.

The Efficiency Advocates encouraged DOE to investigate ways to accelerate adoption of variable speed drives (''VSDs'') in nonclean water applications, stating that pumps in chemical and wastewater sectors are estimated to use more than 27 and 17 TWh/yr of electricity respectively. (Efficiency Advocates, No. 30 at p. 4) They cited a 2020 study by NEEA showing that VSDs provided average energy savings of 23 percent and 43 percent for constant- and variable-load clean water pumping applications, respectively. *Id.* The Efficiency Advocates concluded from this study that there are significant potential savings from using VSDs, noting that wastewater flow can vary significantly over time and may benefit especially. *Id.* Efficiency Advocates encouraged DOE to develop the test procedure for VSDs in non-clean water applications in order to facilitate greater market adoption of VSDs in wastewater and chemical process pumps and capture the potential energy-savings benefits.

In response to the Efficiency Advocates, DOE reiterates its discussion in the April 2022 NOPR that DOE expects the number of non-clean water pumps used in the clean water applications to be relatively small; that the scope of HI 40.6–2014, which is currently incorporated by reference into the DOE test procedure, includes clean water pumps only, and that it is unlikely that a clean water and non-clean water test procedure would provide comparable results. 87 FR 21268, 21275. DOE emphasizes that waste water pumps, in particular, are required to pump slurries/solids. DOE is incorporating by reference HI 40.6–2021, which is only applicable to clean water pumps. If DOE were to include waste water and other clean water pumps in its scope of coverage, it would need to evaluate the applicability and repeatability of industry test procedures for these pumps. DOE has not had an opportunity to appropriately evaluate these test procedures or conduct its own testing on non-clean water pumps during this test procedure rulemaking; however, DOE may consider evaluating these pumps in a future rulemaking.

In summary, the scope of the test procedure as amended by this final rule continues to exclude both chemical process and wastewater pumps.

Regarding VSDs, DOE notes that its current test procedure accommodates pumps with variable speed operation by providing calculations for determining variable load PEI (''PEI_{VL}''). (*See* Appendix A to subpart Y of part 431.) However, as discussed, DOE is continuing to exclude wastewater pumps from the scope of the test procedure.

2. Small Vertical Inline Pumps

As discussed, the scope of the current DOE test procedure is limited to five categories of pumps designed for clean water applications. 10 CFR 431.464(a)(1)(i). One of these categories is IL pumps, which are limited to a shaft input power greater than or equal to 1 hp and less than or equal to 200 hp at best efficiency point (''BEP'') [13] and full impeller diameter, and in which liquid is discharged in a plane perpendicular to the impeller shaft. 10 CFR 431.462. In 2016, a Circulator Pump Working Group [14] recommended a test procedure

[12] Pumps certified under the ASME B73 designation include: B73.1 (''Specification for Horizontal End-suction Centrifugal Pumps for Chemical Process''), B73.2 (''Specification for Vertical In-Line Centrifugal Pumps for Chemical Process''), B73.3 (''Specification for Sealless Horizontal End-suction Centrifugal Pumps for Chemical Process''), and B73.5 (''Thermoplastic/thermoset Polymer Material Horizontal End-suction Centrifugal Pumps Chemical Process''). All B73 pumps are designed for use as chemical process pumps, which have specific design requirements related to reliability and performance such as maximum shaft deflections, bearing frame lubrication, sealing requirements, and vibration limits.

[13] BEP is the pump hydraulic power operating point (consisting of both flow and head conditions) that results in the maximum efficiency.

[14] On February 3, 2016, DOE published its intention to establish a working group under the

Continued

and energy conservation standard for circulator pumps, which DOE is addressing in a separate rulemaking, and also made recommendations for SVIL pumps. SVIL pumps have characteristics identical to those for in-line pumps except SVIL pumps have shaft input power of less than 1 hp. The Circulator Pump Working Group recommended that (1) SVIL pumps be evaluated using the PEI_{CL} or PEI_{VL} metric, and (2) SVIL pumps should be tested using the DOE commercial and industrial pump test procedure, with any needed modifications determined by DOE. (Docket No. EERE–2016–BT–STD–0004, No. 58 Recommendation #1B at pp. 1–2).

In the April 2022 NOPR, consistent with the Circulator Pump Working Group recommendation, DOE proposed to include SVIL pumps in the pump test procedure scope as an extension of IL pumps. 87 FR 21268, 21275–21276. DOE tentatively determined that SVIL pumps can be tested using the current DOE pumps test procedure with certain additional modifications. The metric and test procedure for SVIL pumps are discussed in sections III.D and III.G of this notice. Moreover, DOE stated in the April 2022 NOPR that it expects that including SVIL pumps in the pumps test procedure would reduce confusion over which inline pumps are and are not subject to energy conservation standards. *Id.* DOE requested comment on its proposal to expand the scope of the test procedure to cover SVIL pumps.

HI, NEEA, the CA IOUs, and the Efficiency Advocates agreed with including SVIL pumps in the scope of the test procedure, and Grundfos agreed that SVILs should be an extension of IL pumps. (HI, No. 33 at p. 2; NEEA, No. 34 at p. 4; CA IOUs, No. 32 at p. 2; Efficiency Advocates, No. 30 at pp. 2–3; Grundfos, No. 31 at p. 1) Grundfos also commented that it sells a small number of SVIL pumps without a motor, but it does not believe that SVILs sold without motors should be excluded from the regulation. (Grundfos, No. 31 at p. 4)

Due to the overlap between SVILs and circulators, NEEA and the CA IOUs expressed support for the development of standards to ensure that efficiencies of both are comparable. (NEEA, No. 34 at p. 4; CA IOUs, No. 32 at p. 2) NEEA stated their finding that 12 percent of IL pumps (excluding circulator pumps) are less than 1 hp, and that SVILs are therefore an important and overlapping segment of the market. (NEEA, No. 34 at p. 4) NEEA stated that it believes broadening the scope to include SVILs will help to avoid market confusion or gaps in coverage. *Id.*

For the reasons discussed in the preceding paragraphs and in the April 2022 NOPR, DOE is finalizing its proposal to include SVILs in the scope of the test procedure. DOE finalizes a definition for SVIL pumps in section III.B.4 of this document. In response to Grundfos' comment, DOE's finalized test procedure, as discussed in section III.G, incudes methods to test SVILs both with and without motors. DOE will address the development of standards separately in the ongoing pumps energy conservation standards rulemaking.

3. Other Clean Water Pump Categories

In the April 2022 NOPR, DOE proposed to expand the current test procedure's scope to include additional clean water pumps. 87 FR 21268, 21276–21279. The following sections discuss DOE's consideration of additional pump categories in the scope of the test procedure.

a. Between-Bearing Pumps

Section 1.2.9.2 of ANSI–HI 14.1–14.2–2019 describes between-bearing pumps as pumps that are one- or two-stage, axially-split, mounted to a baseplate, driven by a motor via a flexible coupling, and with bearings on both ends of the rotating assembly.

Based on a review of the market, BB pumps are generally larger than the pumps currently subject to the DOE test procedure. Many BB pumps exceed the head and horsepower limits in the current DOE test procedure. Additionally, BB pumps are not typically designed for clean water applications. Despite these generalities, DOE has identified certain clean water BB pumps under 200 hp and 459 feet of head that could be viewed as potentially interchangeable with pumps that are currently included in the scope of the current DOE test procedure.

To address the potential for pumps that provide unregulated alternatives to the pumps currently subject to the DOE test procedure, DOE proposed to include BB pumps within the scope of the DOE test procedure in the April 2022 NOPR. 87 FR 21268, 21277. However, DOE did not propose to expand scope beyond clean water pumps, and did not propose to expand the head or horsepower limitations currently listed in 10 CFR 431.464(1)(ii). *Id.* DOE noted that while many BB pumps exceed the test procedure's head or horsepower limitations, an expansion of the current head and horsepower restrictions has the potential to increase test burden by requiring larger laboratory equipment to test pumps according to the DOE test procedure and most of the larger BB pumps were not designed for clean water. *Id.*

In response to the April 2022 NOPR, the CA IOUs, the Efficiency Advocates, and Grundfos supported DOE's proposal to expand the test procedure scope to include BB pumps. (CA IOUs, No. 32 at p. 3; Efficiency Advocates, No. 30 at pp. 2–3; Grundfos, No. 31 at p. 1) The CA IOUs commented that BB pumps are high-cost, low-sale pumps and that they anticipate BB pumps will be larger, with motor horsepower of 100 or over. (CA IOUs, No. 32 at p. 3) The CA IOUs also cited industry literature indicating that efficiency can be improved by balancing the impeller forces in BB pumps. *Id.*

HI disagreed that BB1 [15] pumps are commercially acceptable replacements for currently regulated pumps due to design and cost considerations. (HI, No. 33 at p. 2) HI stated that the price for a BB1 pump compared to a currently regulated pump would be two times or more. *Id.* Despite supporting DOE's proposal to include BB pumps in the test procedure scope, Grundfos stated that it expects testing these pumps will increase test burden because of their large size, larger motor sizes required for test, and the potential for additional test fixtures. (Grundfos, No. 31 at p. 1)

Based on stake holder comments, feedback from manufacturer interviews, and additional reviews of product literature, DOE has determined that BB pumps do not serve as replacements for pumps currently covered by the DOE test procedure. For a given load point, a BB pump will be larger, heavier, and more expensive than an equivalent end suction pump. Therefore, it is making it very unlikely that customers would choose to replace a regulated end suction pump with an unregulated BB pump. Additionally, DOE has determined that manufacturers of BB pumps would likely need to build new test stands to test their BB products using the DOE test procedure. DOE notes that because most BB pumps are outside of the DOE test procedure scope, due to their flow and head exceeding the maximum flow and head set by DOE. Therefore, if DOE were to include BB pumps in this test procedure, BB pump manufacturers would need to make substantial capital investments to test and certify a very small number of

Appliance Standards and Rulemaking Federal Advisory Committee (''ASRAC'') to negotiate a test procedure and energy conservation standards for circulator pumps. 81 FR 5658. Throughout this document, this working group is referred to as the ''Circulator Pump Working Group''.

[15] BB1 pumps are a pump class defined by HI 14.1–14.2–2019 that are 1 and 2 stage, axially-split pumps with the impeller(s) mounted between bearings at either end. BB1 pumps are a specific sub-category of BB pumps.

pumps. This would result in a test cost per basic model that is as much as 100 times higher than DOE's estimate presented in the April 2022 NOPR. 87 FR 21268, 21309. Test costs are discussed in more detail in section III.K.1. Since customers are not expected to use BB pumps as replacements for end suction pumps and test burden for BB pump manufacturers would be very high relative to the number of pumps tested, DOE has determined that the potential benefits of including BB pumps within the scope of this test procedure are outweighed by the burdens associated with testing and certifying such products. As such, in this final rule DOE is not including BB pumps within the scope of this test procedure.

b. Vertical Turbine Pumps

As discussed in the April 2022 NOPR, DOE tentatively determined that ST pumps and VT pumps have similar end uses. 87 FR 21268, 21277. Additionally, DOE tentatively determined that ST and VT pumps have similar bowl and impeller assemblies, and that VT pumps may even share an identical assembly with an ST pump produced by the same manufacturer. *Id.* To address the potential for pumps that provide unregulated alternatives to the pumps currently subject to the DOE test procedure, DOE proposed in the April 2022 NOPR to include VT pumps, with no limit on bowl diameter for inclusion in the DOE test procedure. *Id.*

In response to DOE's proposal in the April 2022 NOPR, the Efficiency Advocates expressed support for DOE's scope expansion to cover VT pumps. (Efficiency Advocates, No. 30 at pp. 2–3) The CA IOUs commended DOE for including VT pumps and asserted that regulating equipment used for accessing groundwater in irrigation applications is important because at least 30 percent of the wells in Texas and California use VT pumps. (CA IOUs, No. 32 at p. 2)

HI stated that expanding the test procedure scope to include VT pumps would add a substantial burden for manufacturers who will have to test low-speed and large-diameter pumps. (HI, No. 33 at p. 3) HI continued by stating that these large-diameter VT pumps may be assembled and tested on site, and that manufacturers may or may not have the capacity to test VT pumps in their test facilities. *Id.*

DOE is finalizing its proposal to include VT pumps in the pumps test procedure scope. However, DOE is not adopting its proposal to include these pumps without a limit on bowl diameter, and is instead limiting the scope of VT pumps to bowl diameters less than or equal to six inches, consistent with the existing test procedure and energy conservation standards size limitation for ST pumps. HI indicated that expanding bowl diameter to greater than 6 inches for VT and ST pumps may have a significant impact on manufacturer test burden. DOE expects test time and cost for VT pumps with bowl diameters less than or equal to 6 inches is equivalent to that for ST pumps with bowl diameters less than or equal to 6 inches because of the similar physical characteristics and hydraulic properties for these pump classes. DOE's determination to exclude VT and ST pumps with bowl diameters greater than 6 inches is discussed in more detail in section III.A.4.a. of this document.

Based on its review of pump literature and pump schematics, DOE has determined that the current DOE test procedure based on HI 40.6–2021 is applicable to VT pumps and that therefore VT pumps can be easily added to the scope of the DOE test procedure. In addition, including provisions for VT pumps in the DOE test procedure will give consumers the ability to easily compare the efficiency of different VT and ST pump models serving similar applications. Lastly, creating a uniform test procedure and rating method for VT pumps will enable DOE to consider establishing energy conservation standards for these pumps. The definition for VT pumps is discussed in section III.B.6 of this document. DOE addresses the question of test burden in section III.K.1.a. of this document.

c. Radially-Split Multi-Stage Horizontal Pumps

The current DOE test procedure includes RSV pumps, but does not include RSH pumps, which are also multistage pumps used primarily in heating, cooling, and pressure boosting applications.

DOE has surveyed pump and end-product materials and literature available online and has concluded that RSV and RSH pumps are marketed for similar applications, and that RSH pumps could be substituted for RSV pumps and may provide a regulatory loophole to RSV pumps. Additionally, DOE determined that RSH pumps can be tested using the current DOE test procedure. In the April 2022 NOPR, DOE proposed to include RSH pumps with both in-line (''RSHIL'') and end-suction (''RSHES'') flow configurations in its test procedure scope. 87 FR 21268, 21278.

In response to the proposal to include RSH pumps in the test procedure scope, Grundfos stated that it agrees with adding RSHES pumps to the scope but requested additional information regarding which products meet the definitions and whether they should be considered under a single pump category. (Grundfos, No. 31 at p. 2) The Efficiency Advocates supported DOE expanding its test procedure scope to include RSHIL and RSHES configurations. (Efficiency Advocates, No. 30 at pp. 2–3) HI commented that the addition of RSH pumps will add manufacturer test burden. (HI, No. 33 at p. 3)

DOE has determined that the current DOE test procedure based on HI 40.6–2021 is applicable to RSH pumps, and that therefore RSH pumps can be easily added to the scope of the DOE test procedure. In addition, including provisions for RSH pumps in the DOE test procedure will give consumers the ability to easily compare the efficiency of different RSH and RSV pump models. Lastly, creating a uniform test procedure and rating method for RSH pumps will enable DOE to consider establishing energy conservation standards for these pumps. DOE is finalizing its proposal to include RSH pumps, specifically RSHIL and RSHES pumps, in the scope of the DOE test procedure. Definitions for RSH, RSHES, and RSHIL are discussed in section III.B.7 of this document. DOE addresses the question of test burden in section III.K.1.a. of this document.

d. End-Suction Pumps Similar to ESFM and ESCC Pumps

DOE defines a ''close-coupled pump'' as a pump having a motor shaft that also serves as the impeller shaft, and defines a ''mechanically-coupled pump'' as a pump that has its own impeller shaft and bearings separate from the motor shaft. 10 CFR 431.462. As discussed in the April 2021 RFI, DOE is aware that certain pumps may have their own shaft, but with no bearings to support that shaft. 86 FR 20075, 20078. Additionally, while the close-coupled pump definition describes a pump in which the motor shaft also serves as the pump shaft, the definition does not provide detail on how the motor and pump shaft may be connected. DOE has observed that some manufacturers describe close-coupled pumps as using an adapter to mount the impeller directly to the motor shaft. The coupling type is the only differentiator between ESCC pumps, which are ''close-coupled pumps,'' and ESFM pumps, which are ''mechanically-coupled pumps.'' In the January 2016 Final Rule, DOE noted that it intended for ESFM and ESCC pumps to be mutually exclusive to ensure that pumps that are close-coupled to the motor and have a single impeller and motor shaft would be part of the ESCC equipment category, while all other end-suction pumps that are mechanically-coupled to the motor and for which the bare pump and motor have separate shafts would be part of the ESFM equipment category. 81 FR 4086, 4096. Despite this intention, DOE is aware that these definitions may have excluded some end-suction pumps from the test procedure scope.

In the April 2022 NOPR, based on comment responses from the April 2021 RFI and DOE's review of ESCC and ESFM pumps, DOE tentatively determined that there is a group of end-suction pumps that do not currently fall into either the ESFM or ESCC definition, but which may be competitors to the currently regulated pumps. 87 FR 21268, 21278. Therefore, in the April 2022 NOPR, DOE proposed to ensure that all clean water end-suction pumps are covered by the test procedure by revising the definitions of ESFM and ESCC pumps. *Id.* DOE tentatively determined that no test procedure revisions would be needed to accommodate these additional end-suction pumps. *Id.*

In response to DOE's proposal in the April 2022 NOPR, Grundfos and the Efficiency Advocates expressed support for revising the ESFM and ESCC definitions to include additional end-suction pumps. (Grundfos, No. 31 at p. 2; Efficiency Advocates, No. 30 at pp. 2–3)

For the reasons discussed in the April 2022 NOPR and in the preceding paragraphs, DOE is including all end-suction pumps within the coverage of this test procedure by modifying the definitions of ESFM and ESCC pumps.

e. Line Shaft and Cantilever Pumps

ANSI/HI Standard 14.1–14.2–2019, ''American National Standard for Rotodynamic Pumps for Nomenclature and Definitions'' (ANSI/HI 14.1–14.2–2019'') includes design criteria for different pump configurations, and section 14.1.3.3.1.3 describes vertically separate discharge sump pumps, a category of pump that includes line shaft (''VS4'') pumps and cantilever (''VS5'') pumps. Both VS4 and VS5 pumps are vertically-suspended pumps with a single casing and with a discharge column that is separate from the shaft column. The pump equipment categories defined by DOE do not explicitly reference VS4 or VS5 pumps, and some pumps may be covered by both the DOE definition of an ESFM pump and the HI definition of a VS4 or VS5 pump. 86 FR 20075, 20079.

DOE addressed comments on the April 2021 RFI regarding these pumps in the April 2022 NOPR. 87 FR 21268, 21278. DOE discussed that some line shaft pumps may already be within the test procedure scope but are defined as ESFM pumps. *Id.* Additionally, DOE noted that cantilever pumps are primarily designed for non-clean water applications, including liquids and slurries containing large solids. *Id.* DOE did not propose to include line shaft or cantilever pumps in the test procedure scope in the April 2022 NOPR. 87 FR 21268, 21279.

In response to the April 2022 NOPR, the Efficiency Advocates further encouraged DOE to consider coverage for both cantilever and line shaft pumps, stating that some of these pumps have similar designs to ESFM and ESCC pumps and some are marketed for pumping clean water. (Efficiency Advocates, No. 30 at pp. 3–4)

DOE notes that most or all clean water line shaft and cantilever pumps are already covered by the ES definition. DOE does not believe there is a significant amount of clean water cantilever and line shaft pumps, as these pumps are primarily designed for non-clean water applications including liquids and slurries that contain large solids. As discussed, DOE is not expanding the scope to include non-clear water pumps.

4. Scope Limitations

In the April 2022 NOPR, DOE also proposed to remove bowl diameter limitations for certain pumps, include an additional nominal speed of 1200 rpm, and decrease horsepower requirements for IL pumps. 87 FR 21268, 21279. DOE also proposed to clarify pump design temperature range. *Id.* The following sections summarize each of these topics.

a. Submersible Turbine Pumps With Bowl Diameter Greater Than 6 Inches

As discussed previously, the scope of the current DOE test procedure includes ST pumps with a bowl diameter of 6 inches or smaller. 10 CFR 431.464(a)(1)(i)(E) and (a)(1)(ii)(E).

DOE proposed in the April 2022 NOPR to include VT pumps within the scope of the DOE test procedure. 87 FR 21268, 21279. DOE did not propose a bowl diameter limitation for VT pumps in the April 2022 NOPR. VT pumps are similar in design to ST pumps and commenters had indicated that the two pump categories can be used in overlapping applications. *Id.* Therefore, to maintain consistency across VT and ST pump categories, DOE also proposed to remove the 6-inch bowl diameter limitation for ST pumps. *Id.*

In response to the April 2022 NOPR, the CA IOUs and the Efficiency Advocates supported including ST pumps with a bowl diameter greater than six inches. (CA IOUs, No. 32 at p. 3; Efficiency Advocates, No. 30 at p. 3) The CA IOUs also provided supplemental data to support the inclusion of ST pumps with bowl diameters greater than six inches. (CA IOUs, No. 32 at p. 3–5, 7) They found that 21 percent of California wells, and 36 percent of Texas wells had an estimated nominal bowl size between eight and twelve inches. *Id.* at 5.

China recommended that DOE retain the 6-inch maximum bowl diameter restriction for ST pumps to avoid the high cost of testing larger ST pumps. (China, No. 29 at p. 4)

Grundfos stated that all of its products with bowl diameters greater than 6 inches would be excluded from the regulation due to the head limitation (*i.e.,* less than or equal to 459 feet); however, it commented that increasing the maximum bowl diameter would have minimal impact on energy use and suggested that DOE instead evaluate how ST pumps with larger bowl diameters may be evaluated in a future rulemaking. (Grundfos, No. 31 at p. 2)

HI encouraged DOE to define how bowl size would be determined for a ST pump when the bowl diameter varies among stages. (HI, No. 33 at p. 4) HI also stated that since DOE has proposed to expand the size of ST pumps and include all sizes of VT pumps, DOE should clarify that its scope is limited to a specific speed of 5,000 in U.S. customary units for these pumps. (HI, No. 33 at p. 1) Additionally, HI recommended that DOE update the text in 431.464 (a)(1)(iii)(E) as follows: For ST, VT, ESCC and ESFM pumps, a specific speed less than or equal to 5,000 when calculated using U.S. customary units. *Id.*

In response to HI's comment on determining bowl size when bowl diameter varies between stages, DOE clarifies that where bowl diameter varies among stages, the minimum bowl diameter of a ST or VT pump would be considered the appropriate measurement.

Based on additional evaluation and the feedback it received from stakeholders, DOE has determined that manufacturers of VT and ST pumps with bowl diameters larger then 6 inches would likely need to build new test stands to test these products using the DOE test procedure. DOE notes that because many VT and ST pumps with bowl diameters larger then 6 inches are outside of the DOE test procedure scope because their head exceeds the maximum set by DOE. Therefore, if DOE were to include these pumps in its test procedure, pump manufacturers would need to make substantial capital investments to test and certify a very small number of in-scope pumps. This would result in a test cost per basic model that is as much as 100 times higher than the estimates DOE presented in the April 2022 NOPR. 87 FR 21268, 21309. Test costs are discussed in more details in section III.K.1 of this document. Since test burden for VT and ST pump manufacturers would be very high relative to the number of pumps tested, DOE has determined that the potential benefits of including VT and ST pumps with bowl diameters larger than 6 inches within the scope of this test procedure are outweighed by the burdens associated with testing and certifying such products. Therefore, DOE is maintaining the 6-inch bowl diameter limitation for ST pumps and specifying a maximum bowl diameter of 6 inches for VT pumps in this final rule.

b. Pumps Designed To Be Operated at 1,200 RPM

As discussed, DOE limits the scope of pumps under the current test procedure to those designed to operate with a 2- or 4-pole induction motor, or a non-induction motor with an operating range that includes speeds of rotation between 2,880 and 4,320 rpm and/or 1,440 and 2,160 rpm. 10 CFR 431.464(a)(1)(ii)(D). In either case, the driver and impeller must rotate at the same speed. 10 CFR 431.464(a)(1)(ii)(D). The current DOE test procedure does not include pumps designed to operate with 6-pole induction motors, or with non-induction motors that have a speed-of-rotation operating range exclusively outside the ranges defined.

Based on a review of pump performance curves available online, DOE found that unregulated pumps tested with a nominal speed of 1,200 rpm are often part of the same pump families as those pumps that currently fall within the scope of the DOE test procedure.[16] 87 FR 21268, 21279. To ensure equitable treatment among these pumps, DOE proposed in the April 2022 NOPR to extend the scope of this test procedure to cover pumps designed to operate with 6-pole induction motors, and pumps designed to operate with non-induction motors with an operating range that includes speeds of rotation between 960 rpm and 1,440 rpm.[17] *Id.* DOE proposed test provisions to accommodate these pumps in the April 2022 NOPR and requested comment on its proposal. *Id.*

In response to the April 2022 NOPR, the CA IOUs and the Efficiency Advocates supported DOE including 6-pole motors. (CA IOUs, No. 32 at p. 3; Efficiency Advocates, No. 30 at p. 3) The CA IOUs stated that 6-pole clean water pumps often have operating ranges that compete with 4-pole pumps. (CA IOUs, No. 32 at p. 3) Grundfos agreed that 6-pole pumps should be considered but questioned whether doing so would achieve the energy savings that DOE anticipates, and observed that 6-pole pumps have much smaller sales numbers compared to less expensive 4-pole pumps for a similar duty point. (Grundfos, No. 31 at p. 5).

After review of stakeholder feedback, and for the reasons discussed above, DOE is extending the scope of this test procedure to cover pumps designed to operate with 6-pole induction motors. DOE may evaluate potential energy savings for these pumps in a future energy conservation standard.

In terms of operating range, Grundfos urged DOE to ensure that the operating ranges for 6-pole and 4-pole pumps designed to operate with non-induction motors are independent from each other. Grundfos additionally recommended setting the maximum operating range for 6-pole pumps designed to operate with non-induction motors at 1,439 rpm since the lower end of the operating range is 1,440 rpm for 4-pole pumps designed to operate with non-induction motors. (Grundfos, No. 31 at p. 2, 5) Similarly, HI recommended that DOE change the maximum operating speed for 6-pole pumps designed to operate with non-induction motors from 1,440 rpm to 1,439 rpm to provide a clear delineation between the operating range for 4-pole pumps designed to operate with non-induction motors (*i.e.,* 1,440 rpm to 2,160 rpm). (HI, No. 33 at p. 5)

DOE agrees that the operating ranges for 2-, 4-, and 6-pole pumps designed to operate with a non-induction motor should be separate from each other and not overlap. In consideration of stakeholder feedback, DOE is modifying the maximum operating speed for a 6-pole pump designed to operate with a non-induction motor from 960 rpm to 1,400 rpm as proposed in the April 2022 NOPR to greater than or equal to 960 rpm and less than 1,440 rpm. In summary, in this final rule, DOE is including clean water pumps designed to operate with a 6-pole induction motor or a non-induction motor with a speed of rotation operating range greater than or equal to 960 rpm and less than 1,440 rpm.

Grundfos also commented that adding the 6-pole speed highlights a point of unnecessary testing burden around the defined ''operating ranges'' with respect to variable speed equipment. (Grundfos, No. 31 at p. 2) According to Grundfos, a variable speed product with a motor designed for 4,000 rpm can technically operate at speeds across all three defined ''ranges,'' and current regulations require testing at all three nominal speeds. *Id.* However, Grundfos stated that a product with a 4,000 rpm design speed will likely perform only in a single operating range defined by DOE. *Id.* Grundfos asserted that consumers are more likely to purchase a less expensive pump with a smaller horsepower range than run a 4,000 rpm pump at 1,800 rpm. *Id.* Therefore, Grundfos recommended the DOE consider updating its language to state that variable load equipment should be tested at the nominal speed nearest the speed identified on the pump nameplate. *Id.*

DOE notes that section I.C.1 in appendix A specifies how to determine the nominal speed of rotation for testing. For instance, for pumps sold with 4-pole induction motors, the nominal speed of rotation shall be 1,800 rpm. (*See* section I.C.1.2) For 4-pole pumps designed for use with non-induction motors where the operating range of the pump and motor includes speeds of rotation between 1,440 rpm and 2,160 rpm, the nominal speed for test would be 1,800 rpm. (*See* section I.C.1.5) Whether the pump is sold with variable speed capability is immaterial, as the determination of nominal test speed is based solely on where the pump is designed to operate. DOE notes that, to determine the range of speeds that a pump is designed to operate within, DOE would refer to published data, marketing literature, and other publicly available information. This would include the pump nameplate. If the range of speeds a pump is designed to operate within crosses two or more categories, manufacturers must test and certify at each relevant nominal speed.

c. Pump Horsepower and Design Speed

As previously discussed, the current test procedure includes only ESFM, ESCC, IL, RSV, and ST pumps, each of which is limited by its respective definition to those with shaft input power greater than or equal to 1 hp and less than or equal to 200 hp at BEP and

[16] See *www.regulations.gov/document/EERE-2020-BT-TP-0032-0024.* (Docket No. EERE–2020–BT–TP–0032–0024.)

[17] 960 and 1440 rpm are ±20 percent of 1,200 rpm. The acceptable non-induction motor ranges for 1800 and 3600 rpm pumps are also ±20 percent of the nominal value.

full impeller diameter. 10 CFR 431.464(a)(1)(i); 10 CFR 431.462.

In the April 2022 NOPR, DOE discussed comments that some pumps sold with electronically commutated motors (''ECMs'') and intended to run at higher speeds, such as 4,320 rpm, must be normalized to rate at 3,600 rpm. 87 FR 21268, 21279–21280. This adjustment causes the power of the motor to fall below 1 hp, meaning the pump is therefore out of scope. *Id.* As stated previously, the pump definitions reference horsepower limitations based on shaft input power at BEP and full impeller diameter. 10 CFR 431.462. DOE defines ''BEP'' as the pump hydraulic power operating point (consisting of both flow and head conditions) that results in maximum efficiency, and defines ''full impeller diameter'' as the maximum impeller diameter with which a given pump basic model is distributed in commerce. 10 CFR 431.462. DOE's test procedure for pumps at appendix A also includes test provisions for determining both BEP and pump input power (also known as shaft input power), as well as provisions for normalizing all measured data to the specified nominal speed of rotation. As such, while the definitions themselves do not specify that shaft input power is determined at nominal speed, DOE understands that the pump definitions could be interpreted to exclude pumps with shaft input power greater than or equal to 1 HP at BEP at their design speed, but less than 1 HP when tested and corrected to nominal speed. In addition, DOE understands that the value of maximum efficiency varies little with speed, and is often assumed to be constant, and as such the definition of BEP alone would not be sufficient to assume that it must be determined at a certain speed different from that in the test procedure.

However, DOE also notes that it is expanding the current test procedure scope to include SVIL pumps, which will address this issue. Specifically, SVIL pumps are fractional horsepower pumps, so even when corrected to nominal speed, the pumps in question would be included in scope. DOE understands that use of high frequency (*i.e.,* 4,000 rpm) ECMs is likely more prevalent on SVILs than on other pumps in this horsepower range, particularly as a result of their applications and competition with the circulator market. This means that including SVILs in this test procedure includes most, if not all, pumps where motor power decreases below 1 hp when rated at BEP. For these reasons, DOE did not propose to change the specified horsepower limitations within the pump category definitions in the April 2022 NOPR. 87 FR 21268, 21280.

DOE requested comment on its tentative determination that including SVILs in the test procedure scope will largely eliminate the issue of higher speed 1 hp pumps falling out of scope when they rate at a nominal speed of 3,600 rpm. 87 FR 21268, 21273. Grundfos and HI both agreed with DOE's determination. (Grundfos, No. 31 at p. 3; HI, No. 33 at p. 3)

For the reasons discussed in the preceding paragraphs and in the April 2022 NOPR, DOE is maintaining the 1 hp limitations in the ESFM, ESFC, IL, RSV, and ST pump definitions, and is including the 1 hp limitation in its definitions for RSH, and VT pumps.

d. Pumps Over 200 HP

As previously discussed, the current test procedure includes only ESFM, ESCC, IL, RSV, and ST pumps. Each of these classes is limited by its respective definition to those pumps with shaft input power greater than or equal to 1 hp and less than or equal to 200 hp at BEP and full impeller diameter. 10 CFR 431.464(a)(1)(i); 10 CFR 431.462.

In response to the April 2022 NOPR, the Efficiency Advocates encouraged DOE to expand the test procedure scope to include pumps greater than 200 hp, and stated that motors between 201 and 500 hp are the most consumptive motor size group in industrial electricity consumption. (Efficiency Advocates, No. 32 at p. 3) The Efficiency Advocates further commented that the current calculation methods and DOE's proposal to allow alternative efficiency determination methods (AEDMs) in lieu of physical testing would help mitigate test burden associated with these larger pumps. *Id.*

DOE notes in response that pumps with shaft input powers over 200 hp generally require larger, more expensive, test stands and testing facilities. Additionally, these pumps are often ''engineered-to-order'', resulting in many different basic models. These two factors would lead to significantly higher per- model test costs than for pumps with shaft input powers below 200 hp. AEDMs and the calculation methods in the DOE test procedure for pumps may alleviate some testing burden, but neither completely negate the need for physical testing of bare pumps which drives the higher testing burden above 200 hp. At this time, DOE has determined that expanding the pumps test procedure to include pumps with shaft powers greater than 200 hp would be too burdensome to pump manufacturers. DOE may re-evaluate this decision in a future rulemaking.

e. Horsepower and Number of Stages for Testing

In the April 2022 NOPR, DOE discussed how to handle certification of equipment when some models are regulated, and others are not. 87 FR 21268, 21280. DOE provided an example of an RSV basic model sold with a 1 hp motor tested at 3 stages, which is in scope, and an RSV model that is 2-stage with a 0.75 hp motor. *Id.* Since the latter pump uses a 0.75 hp motor, it is partially out of scope. *Id.*

In the April 2022 NOPR, DOE stated it understands that the same model of RSV pump may be sold with two stages, three stages, or some other number of stages. 87 FR 21268, 21280. DOE's RSV pump definition includes those pumps that have a shaft input power greater than or equal to 1 hp and less than or equal to 200 hp at BEP and full impeller diameter and at the number of stages required for testing. 10 CFR 431.462. DOE's testing provisions for RSV pumps in section C.2 of appendix A specify that the number of stages required for testing is three, or, if the basic model is only available with fewer than three stages, the basic model is tested with the maximum number of stages with which it is distributed in commerce in the United States. Therefore, in the previous example, the RSV pump model sold with 2 or 3 stages would be included in the scope of the test procedure (and standards) if it had a shaft input power greater than or equal to 1 hp when tested at 3 stages, and the resulting PEI would apply to all stages with which the pump model is sold. 87 FR 21268, 21280. DOE did not propose to modify this language in the April 2022 NOPR. *Id.*

In response to the April 2022 NOPR, Grundfos stated that it disagrees with DOE's interpretation of the regulation. (Grundfos, No. 31 at p. 11) Grundfos explained that the definition for a basic model states that a manufacturer cannot group equipment using DOE-regulated motors with equipment using motors under 1 hp, and therefore, the manufacturer would have two basic models, one with pumps at 1 to 200 hp and a second for pumps under 1 hp. *Id.* Grundfos added that the second basic model would not be in scope since RSV pumps with motors under 1 hp are not included in the test procedure scope. *Id.* Additionally, Grundfos commented that the same equipment sold as a bare pump would be considered a single basic model regardless of the number of stages and shaft power. *Id.*

DOE notes that the basic model definition in 10 CFR 431.462 states that all variations in the number of stages of bare RSV and ST pumps must be considered a single basic model. The definition also states that for pumps sold with different motors, the motors must be in the same motor efficiency band to be considered a single basic model, referencing Table 3 in appendix A. However, Table 3 does not provide motor efficiencies for fractional horsepower motors. Additionally, section I.C.2 of appendix A specifies the number of stages for testing RSV and ST pumps. DOE acknowledges that this leaves multi-stage pumps sold with fractional horsepower motors out of scope of this test procedure, whereas equivalent pumps that include the specified number of stages for testing are included within scope of this test procedure. This distinction applies only for pumps sold with motors and does not affect bare pumps, in which DOE's original interpretation still stands.

f. Design Temperature Range

The current scope for the pumps test procedure is limited to pumps with a design temperature range between and including 14 to 248 °F. This range was derived from the original negotiation term sheet for pumps, which recommended limiting the scope to pumps with a design range from −10 °C to 120 °C. (Docket No. EERE–2013–BT–NOC–0039–0092). For the purposes of its regulations, DOE translated this range to Fahrenheit. DOE has received inquires as to whether a pump marketed for temperatures up to 250 °F is outside of the current test procedure's scope. In the April 2022 NOPR, DOE stated it reviewed marketing materials for a number of pumps and found that common upper limits of temperature are 212, 225, 248, 250, and 300 °F. 87 FR 21268, 21280. Some marketing materials stated that standard seals may have one high temperature limit while optional seals provide a higher limit (typically 250 or 300 °F). *Id.* DOE noted it understood that the original intent of the scope limitation was to exclude pumps designed exclusively for low or high temperatures from the test procedure. *Id.* However, if a manufacturer is offering a pump model across all temperature ranges to minimize SKUs, rather than offering separate low temperature and high temperature models, such a pump model should be subject to the regulations. *Id.* DOE explained that only pumps designed and marketed for temperatures exclusively outside the range of DOE's scope would be excluded from the test procedure and energy conservation standards. *Id.*

DOE also discussed that rounding to a temperature limit of 250 °F when translating from °C to °F would be preferable to using the exact value of 248 °F since manufacturers commonly use rounded temperature values in their marketing materials. *Id.* Similarly, DOE discussed that it would be preferable to round the lower temperature limit from 14 °F to 15 °F. *Id.*

In the April 2022 NOPR, DOE proposed to clarify its design temperature limits to include equipment that is designed for operation at temperatures that fall into any part of the range from 15 to 250 °F. 87 FR 21268, 21280. DOE requested comment on this clarification and on DOE's recommendation to shift the design temperature range from 14 °F to 248 °F to 15 °F to 250 °F. *Id.*

In response, Grundfos agreed with DOE's intention to clarify the temperature ranges. (Grundfos, No. 31 at p. 3) HI stated that it does not expect the temperature adjustment to have a significant impact (HI, No. 33 at p. 3)

For the reasons discussed previously, DOE is finalizing its proposed clarifications to the design temperature range which includes pumps with a design temperature inclusive of any part of the range from 15 °F to 250 °F.

B. Definitions

In the April 2022 NOPR, DOE discussed removing certain references to volute in pump definitions and HI pump class references. 87 FR 21268, 21281. DOE also proposed new definitions for bowl diameter, SVILs, BB, VT, RSH, RSHIL, and RSHES pumps. 87 FR 21268, 21281–21283. Further, DOE considered updating the definitions for close-coupled and mechanically-coupled pumps. 87 FR 21268, 21283–21284.

DOE received one general comment in response to the definitions proposed in the April 2022 NOPR. China suggested that DOE add corresponding schematic diagrams to textual definitions. (China, No. 29 at p. 3)

DOE understands that diagrams can help provide context and notes that its current test procedure references ANSI/HI 1.1–1.2 and ANSI/HI 2.1/2.2, which includes pump schematics. However, DOE has found that schematics may result in greater confusion, since schematics provide a specific example design but may not apply to other designs. For instance, a diagram may suggest scope restrictions (or expansions) that are not consistent with the definition language. Therefore, DOE is not including schematics or diagrams in addition to its textual definitions.

1. Removing Certain References to Volute

As discussed in the April 2022 NOPR, pumps generally have one of two common discharge types, either a volute or a diffuser. 87 FR 21268, 21281. A volute is made up of one or two scroll-shaped channels, whereas a diffuser has three or more passages that diffuse the liquid that is being pumped. *Id.* The current definitions for end-suction and in-line pumps use only the term ''volute'' when, in practice, either volutes or diffusers may be used for these pump categories. For example, DOE's current definition for end-suction pump specifies that the liquid is discharged through a volute in a plane perpendicular to the shaft, while the definition for ESCC pump, which is an end-suction pump, specifically references OH7 [18] pumps. 10 CFR 431.462. However, Table 14.1.3.7 of HI 14.1–14.2–2019 specifies a diffuser as the standard casing for OH7 pumps. Similarly, DOE's current definition for IL pump states that the liquid is discharged through a volute in a plane perpendicular to the shaft, and specifically references OH4 and OH5 pumps as examples of end-suction pumps. *Id.* In contrast, Table 14.1.3.7 of HI 14.1–14.2–2019 specifies a diffuser as the standard casing for OH4 and OH5 pumps. DOE noted in the April 2022 NOPR that HI 1.1–1.2–2014 did not make these casing distinctions. 87 FR 21268, 21281.

DOE interprets the term ''volute'' in its definitions for ''end-suction pump'' and ''in-line pump'' to mean the part of the pump casing through which liquid is discharged generally, rather than to reference a specific type of discharge. To avoid this unintentional inconsistency between DOE's terminology and the terminology used by the updated industry standard, DOE proposed in the April 2022 NOPR to amend the definitions of in-line pump and end-suction pump to remove the distinction that liquid is discharged ''*through a volute* in a plane perpendicular to the shaft'' [emphasis added] by specifying instead that liquid is discharged ''in a plane perpendicular to the shaft.'' *Id.*

In response to the April 2022 NOPR, HI, Grundfos, and China stated they support the volute clarification. (HI, No. 33 at p. 3; China, No. 29 at p. 4; Grundfos, No. 31 at p. 3)

For the reasons discussed, DOE is adopting the amended definitions for

[18] OH5 and OH7 pumps are defined as close-coupled pumps in ANSI/HI 14.1–14.2–2019. OH4 pumps are defined as rigidly-coupled/short-coupled pumps in ANSI/HI 14.1–14.2–2019.

end-suction and in-line pumps as proposed in the April 2022 NOPR.

2. HI Pump Class References

The current DOE definitions for ESCC pump, ESFM pump, IL pump, RSV pump, and ST pump all include references to ANSI/HI 1.1–1.2–2014 or ANSI/HI 2.1–2.2–2014 pump configurations as examples of pumps that would meet the given definition. In the April 2022 NOPR, DOE proposed to remove references to specific pump configurations as defined in ANSI/HI 1.1–1.2–2014 and ANSI/HI 2.1–2.2–2014 in the definitions for ESCC, ESFM, IL, RSV, and ST pumps since DOE and HI terminology are not wholly consistent. 87 FR 21268, 21281.

In response to the April 2022 NOPR, Grundfos stated it agrees with the proposal to remove the reference to ANSI/HI 1.1–1.2–2014 in DOE's definitions for ESCC, ESFM, IL, RSV, and ST pumps. (Grundfos, No. 31 at p. 3) In its comments, HI recommended replacing references to ANSI/HI 1.1–1.2 and ANSI/HI 2.1–2.2 with the updated ANSI/HI 14.1–14.2–2019, which superseded ANSI/HI 1.1–1.2 and ANSI/HI 2.1–2.2. (HI, No. 33 at p. 4) HI further explained that these references are used as the industry standard and will provide clarity to the market. *Id.*

DOE notes that its definitional language must be clear and consistent on its own without the support of diagrams or schematics, as application of additional diagrams or schematics may confuse the intent of a given definition. To establish self-contained definitions, DOE is removing the references to ANSI/HI 1.1–1.2–2014 and ANSI/HI 2.1–2.2–2014 in the ESCC, ESFM, IL, RSV and ST pump definitions, as proposed in the April 2022 NOPR. DOE has determined that the definitions without references to ANSI/HI 1.1–1.2–2014 and ANSI/HI 2.1–2.2–2014 provide sufficient specificity to clearly define the various pump categories.

3. Bowl Diameter

The current DOE definition for ''bowl diameter'' references the definition of ''intermediate bowl'' in ANSI/HI 2.1–2.2–2014. This mention is the sole remaining reference to ANSI/HI 2.1–2.2–2014 in the test procedure, since DOE is eliminating the HI pump class references to ANSI/HI 1.1–1.2–2014 and ANSI/HI 2.1–2.2–2014. In the April 2022 NOPR, DOE tentatively determined that a self-contained definition for bowl diameter is clearer. 87 FR 21268, 21281. To disassociate the definition of ''bowl diameter'' from ANSI/HI 2.1–2.2–2014, DOE proposed in the April 2022 NOPR to define ''bowl diameter'' as ''the maximum dimension of an imaginary straight line passing through, and in the plane of, the circular shape of the intermediate bowl of the bare pump that is perpendicular to the pump shaft and that intersects the outermost circular shape of the intermediate bowl of the bare pump at both of its ends.'' *Id.* With respect to ''intermediate bowl,'' DOE proposed to define this term as ''the enclosure within which the impeller rotates and which serves as a guide for the flow from one impeller to the next.'' *Id.*

In response to the April 2022 NOPR, both HI and Grundfos encouraged DOE to also update the definition of ''intermediate bowl'' to be ''bowl'' as defined in ANSI/HI 14.1–14.2–2019. (HI, No. 33 at p. 4; Grundfos, No. 31 at p. 3)

Considering comments received, DOE is adopting a definition for ''bowl'' rather than ''intermediate bowl.'' DOE is defining bowl in 10 CFR 431.462 to mean a casing in which the impeller rotates, and that directs flow axially to the next stage or the discharge column. This definition is consistent with the definition for ''bowl'' in ANSI/HI 14.1–14.2–2019. In this final rule, DOE is modifying the definition for bowl diameter proposed in the April 2022 NOPR to refer to ''bowl'' instead of ''intermediate bowl''.

4. Small Vertical Inline Pumps

DOE proposed in the April 2022 NOPR to expand the scope of the test procedure to include SVIL pumps, which are identical to IL pumps except for having a shaft input power less 1 hp. 87 FR 21268, 21282. The Circulator Pump Working Group recommended that SVIL pumps be defined as a single stage, single-axis flow, dry rotor, rotodynamic pump that: (1) has a shaft input power less than 1 hp at the best efficiency point at full impeller diameter, (2) is distributed in commerce with a motor that does not have to be in a horizontal position to function as designed, and (3) discharges the pumped liquid through a volute in a plane perpendicular to the shaft. (Docket No. EERE–2016–BT–STD–0004, No. 58 Recommendations #3C at p. 3)

The recommended definition would distinguish SVIL pumps from DOE's current IL pump definition[19] in that SVIL pumps have a reduced shaft power input range[20] and a different maximum pump power output limitation.[21] The change to shaft input power is the primary distinction between IL and SVIL pumps. In the April 2022 NOPR, DOE tentatively determined this distinction would be necessary to adequately separate the two categories. 87 FR 21268, 21282. The pump power output is a consequence of the shaft power limitations. *Id.* DOE tentatively determined that SVIL pumps do not require a 5 hp pump power output limitation, as their shaft input power is already capped below 1 hp. *Id.*

In the April 2022 NOPR, DOE noted that another difference is that the IL definition includes a group of three parameters to exclude circulator pumps—namely that they are either mechanically-coupled or close-coupled, have a pump power output that is less than or equal to 5 hp at BEP at full impeller diameter, and are distributed in commerce with a horizontal motor. 87 FR 21268, 21282. In contrast, the recommended SVIL definition is meant to exclude circulator pumps through clause (2) (*i.e.,* ''related to distribution in commerce with a motor that does not have to be in a horizontal position to function as designed''). *Id.* On September 9, 2022, DOE published a test procedure final rule for circulator pumps (''Circulator Pumps TP Final Rule''). 87 FR 57264. In the Circulator Pumps TP Final Rule, DOE defined a circulator pump as consisting of a wet-rotor circulator pump; dry rotor, two-piece circulator pump; or dry rotor, three-piece circulator pumps 87 FR 57264, 57269. The Circulator Pumps TP Final Rule also defined these subcategories of circulator pumps. *Id.* In the April 2022 NOPR, DOE proposed that for the SVIL definition, rather than including the recommendation in clause (2), to instead exclude circulator pumps. 87 FR 21268, 21282. For consistency, DOE also proposed to revise the IL pump definition to explicitly exclude circulator pumps instead of including the clauses meant to implicitly exclude them. *Id.*

DOE notes that clause (3) of the SVIL definition recommended in the April 2022 NOPR refers to a volute. For the reasons discussed in section III.B.1 of

[19] An ''in-line (IL) pump'' means a pump that is either a twin-head pump or a single-stage, single-axis flow, dry rotor, rotodynamic pump that has a shaft input power greater than or equal to 1 hp and less than or equal to 200 hp at BEP and full impeller diameter, in which liquid is discharged through a volute in a plane perpendicular to the shaft. Such pumps do not include pumps that are mechanically-coupled or close-coupled, have a pump power output that is less than or equal to 5 hp at BEP at full impeller diameter, and are distributed in commerce with a horizontal motor.

[20] IL pumps are constrained to greater than or equal to 1 hp and less than or equal to 200 hp, whereas SVIL pumps must be less than 1 hp.

[21] IL pumps have a limit of 5 hp at BEP, whereas SVIL pumps have no hp limitation.

this document, DOE is excluding this reference from the SVIL definition.

The recommended SVIL pump definition also requires that these pumps be distributed into commerce with a motor, meaning SVIL pumps cannot be sold as bare pumps. In the April 2022 NOPR, based on a literature search, DOE tentatively determined that all SVIL pumps are sold with a motor. 87 FR 21268, 21282. However, by proposing to replace clause (2) with an exclusion for circulator pumps, this requirement would be eliminated. *Id.*

In the April 2022 NOPR, DOE discussed that, although not addressed in the recommendation from the Circulating Pump Working Group, the defined term ''twin-head pump'' (10 CFR 431.462) would be applicable to SVIL pumps. 87 FR 21268, 21282. Specifically, in the January 2016 Final Rule, DOE adopted a test procedure for ''twin-head pumps'', where a twin-head pump is defined as a ''dry rotor, single-axis flow, rotodynamic pump that contains two impeller assemblies, which both share a common casing, inlet, and discharge, and each of which (1) Contains an impeller, impeller shaft (or motor shaft in the case of close-coupled pumps), shaft seal or packing, driver (if present), and mechanical equipment (if present); (2) Has a shaft input power that is greater than or equal to 1 hp and less than or equal to 200 hp at best efficiency point (BEP) and full impeller diameter; (3) Has the same primary energy source (if sold with a driver) and the same electrical, physical, and functional characteristics that affect energy consumption or energy efficiency; (4) Is mounted in its own volute; and (5) Discharges liquid through its volute and the common discharge in a plane perpendicular to the impeller shaft.'' 81 FR 4086, 4115–4117, 4147.

In the April 2022 NOPR, DOE proposed to define SVIL pumps based on the recommended definition from the Circulator Pump Working Group, with modifications to include SVILs that are small vertical twin-head pumps, to exclude pumps that are circulator pumps, and to remove the current reference to a volute. 87 FR 21268, 21282. Specifically, DOE proposed to define a ''small vertical in-line pump'' as a small vertical twin-head pump or a single stage, single-axis flow, dry rotor, rotodynamic pump that (1) has a shaft input power less than 1 hp at the best efficiency point at full impeller diameter, (2) in which liquid is discharged in a plane perpendicular to the shaft; and (3) is not a circulator pump. *Id.*

Since SVIL pumps are similar to IL pumps but operate at a lower horsepower, and also are available in twin-head configurations, DOE also proposed to define ''small vertical twin-head pump'' in the April 2022 NOPR and to extend the twin-head pump test procedure adopted in the January 2016 Final Rule to small vertical twin-head pumps. 87 FR 21268, 21273.

DOE requested comment on its proposed revision to the IL definition to explicitly exclude circulator pumps. Both Grundfos and HI agreed that DOE should revise the IL definition to explicitly exclude circulator pumps. (HI, No. 33 at p. 4; Grundfos, No. 31 at p. 4) DOE is adopting the definition for IL pumps as proposed in the April 2022 NOPR.

DOE also requested comment on the definitions for ''small vertical in-line pump'' and ''small vertical twin-head pump.'' DOE also requested comment on the percentage of SVIL pumps, if any, that are not sold with a motor, and whether the definition of SVIL pumps should be limited to those sold with a motor.

China requested that DOE provide additional clarity on the number of motor phases used in SVILs under 0.25 hp. (China, No. 29 at p. 4) China also commented that the definition for SVILs contains ''with bearings on both ends of the rotating assembly'' while common IL pumps on the market do not have bearings at both ends (China, No. 29 at p. 3).

HI commented that including SVILs in the pumps test procedure will ensure consistency between IL and SVIL pumps and that SVIL pumps should not be treated differently from IL pumps. (HI, No. 33 at p. 3, 4).

Regarding China's comment on motor phases for SVILs under 0.25 hp, DOE clarifies that the SVIL definition does not, nor does any aspect of the DOE test procedure, limit the number of phases of an SVIL motor below 0.25 hp. In response to China's question about bearings in the SVIL definition, DOE notes that the SVIL definition does not include ''with bearings on both ends of the rotating assembly'' and that the text China referenced is from the proposed definition of BB pumps in the April 2022 NOPR.

In response to DOE's proposed definition for small vertical twin-head pumps, Grundfos suggested that DOE revise the term ''twin head pump'' to ''in-line twin-head pump'' to minimize confusion with the small vertical twin-head pump definition. (Grundfos, No. 31 at p. 3) Additionally, Grundfos stated that ''Twin Head Pump'' is not consistent with the use of ''twin-head'' within the IL definition and needs a hyphen. *Id.* HI suggested that DOE clarify if both the volute discharge and common discharge must meet the ''plane perpendicular to the impeller shaft'' requirement in the small vertical twin-head pump definition. (HI, No. 33 at p. 4)

After consideration, DOE has determined that the twin-head and small vertical twin-head pump definitions are distinct and specific enough to avoid confusion. In response to HI's comment, DOE clarifies that only the common discharge of a twin-head and small vertical twin-head pump have to be in a plane perpendicular to the impeller shaft.

Regarding the percentage of SVILs that are sold with a motor, HI stated that it does not collect data on SVILs sold without motors and recommends asking manufacturers for this information during interviews. (HI, No. 33 at p. 4) While Grundfos commented that it sells a very small number of SVILs without a motor, it stated that SVILs sold without a motor should not be excluded. (Grundfos, No. 31 at p. 4)

In this final rule, DOE is adopting the SVIL definition proposed in the April 2022 NOPR, with the following revision: DOE has added a hyphen to the small vertical twin-head pump term to be consistent with the twin-head pump term.

5. Between-Bearing Pumps

As discussed in section III.A.3.a of the April 2022 NOPR, DOE proposed to add between-bearing pumps to the scope of its test procedure and therefore proposed a definition for this pump category. 87 FR 21268, 21282.

ANSI/HI 14.1–14.2–2019 defines between-bearing pump as a rotodynamic pump with the impeller(s) mounted on a shaft between bearings on either end. In addition, all between-bearing pumps described in ANSI/HI 14.1–14–2–2019 are mechanically-coupled and dry rotor. Based on a literature review, DOE tentatively determined in the April 2022 NOPR that the between-bearing pumps that are most similar to the pumps currently regulated by DOE have axially-split casings and 1 or 2 stages. 87 FR 21268, 21282. Accordingly, using ANSI/HI 14.1–14.2–2019 as the basis for its approach, DOE proposed in the April 2022 NOPR to use the defined terms ''dry rotor pump,'' ''rotodynamic pump,'' and ''mechanically-coupled pump'' to define a between-bearing pump, *i.e.,* ''an axially-split, mechanically-coupled, one- or two-stage, dry rotor, rotodynamic pump with bearings on both ends of the rotating assembly that has a shaft input power greater than or equal to 1 hp and less than or equal to 200 hp at BEP and full impeller diameter and at the number of stages required for testing.'' 87 FR 21268, 218221282–21283.

In response to the April 2022 NOPR, Grundfos agreed with DOE's proposed definition for BB pumps and stated that the definition is sufficient to identify the intended scope. (Grundfos, No. 31 at p. 4) HI recommended amending the definition to be consistent with the definition for BB1 in ANSI/HI 14.1–14.2–2019.[22] (HI, No. 33 at p. 4)

As discussed, DOE is not including BB pumps within the scope of this test procedure; therefore, DOE is not adopting the proposed definition for BB pumps.

DOE also proposed to define ''axially-split pump,'' a term associated with BB pumps, in the April 2022 NOPR. 87 FR 21268, 21283. The term ''axially-split'' refers to a pump casing that can be separated, for maintenance and assembly, in a plane parallel to the impeller shaft. In the April 2022 NOPR, DOE proposed to define an ''axially-split pump'' as ''a pump with a casing that can be separated or split in a plane that is parallel to and which contains the axis of the impeller shaft.'' *Id.*

In response to the April 2022 NOPR, HI and Grundfos supported DOE's proposed definitions for axially-split pumps. (Grundfos, No. 31 at p. 4; HI, No. 33 at p. 4)

Again, since DOE is not including BB pumps within the scope of this test procedure, DOE is not adopting the proposed definition for axially-split pumps.

6. Vertical Turbine Pump

As discussed in section III.A.3.b, DOE is adding vertical turbine pumps to the scope of its test procedure and proposed a definition for vertical turbine pumps in the April 2022 NOPR. ANSI/HI 14.2–14.2–2019 defines vertical turbine pumps as ''single-casing, non-submersible pumps with impellers mounted in a vertically suspended shaft, that discharge liquid through the column.'' Using this definition as a basis, DOE proposed in the April 2022 NOPR to define ''vertical turbine pump'' as a vertically-suspended, single-stage or multi-stage, dry rotor, rotodynamic pump (1) That has a shaft input power greater than or equal to 1 hp and less than or equal to 200 hp at BEP and full impeller diameter and at the number of stages required for testing; (2) For which no external part of such a pump is designed to be submerged in the pumped liquid; (3) That has a single pressure containing boundary (*i.e.,* is single casing), which may consist of but is not limited to bowls, columns, and discharge heads; and (4) That discharges liquid through the same casing in which the impeller shaft is contained. 87 FR 21268, 21283.

In response to the April 2022 NOPR, both HI and Grundfos recommended that DOE update the definition for vertical turbine pumps. (HI, No. 33 at p. 1, 2 and 4; Grundfos, No. 31 at p. 4) Specifically, HI and Grundfos mentioned that clause 2 of DOE's definition, which states ''no external part of such a pump is designed to be submerged in the pumped liquid,'' would exclude all vertical turbine pumps because their typical bowl assembly is submerged. *Id.* HI also explained that, within the pumps industry, vertical turbine pumps are understood to be VS1 and V3 types and do not include VS2 [23] pumps. *Id.* HI therefore recommended that DOE reference ANSI/HI 14.1–14.2–2019. (HI, No. 33 at p. 5)

Grundfos suggested that DOE exclude VS2 pumps and change the term from ''vertical turbine pumps'' to ''vertical turbine, bowl assembly'' to avoid confusion (Grundfos, No. 31 at p. 4). Additionally, Grundfos commented that DOE should add a definition for ''bowl assembly'' and directly reference section 14.1.7.6 of ANSI/HI 14.1–14.2. *Id.* Finally, Grundfos recommended that DOE use the term 'bowl assembly' rather than 'pump', since 'pump' implies that losses for column, line shaft discharge head, etc. would be included. *Id.*

After further evaluation and considering the comments received, DOE has concluded that the definition for vertical turbine pumps proposed in the April 2022 NOPR would exclude all vertical turbine pumps since all or part of the bowl assembly is designed to be submerged in the pumped fluid. This was not DOE's intent; therefore, DOE is adopting a revised definition for vertical turbine pump that excludes only pumps with the driver submerged in the pump liquid. This allows the bowl assembly of vertical turbine pumps to be submerged in the pumped liquid, but still differentiates vertical turbine pumps from submersible turbine pumps. In response to comments from HI and Grundfos about referencing ANSI/HI 14.1–14.2–2019, DOE has determined not to reference ANSI/HI 14.1–14.2–2019 in the definition for vertical turbine pumps. This determination is discussed in detail in section III.C.1. of this document. DOE has determined that the adopted definitions in this final rule are sufficiently specific and detailed to stand on their own without reference to industry definitions.

7. Radially-Split, Multi-Stage Horizontal Pumps

As discussed in section III.A.3.c, DOE is including RSH pumps with both end-suction and in-line flow configurations in the scope of the DOE test procedure. RSH pumps are nearly identical to RSV pumps except for the mounting orientation and flow configurations. As discussed in section III.A.3.c, RSH pumps may have different flow configurations that are expected to impact pump efficiency; therefore, in the April 2022 NOPR, DOE proposed three definitions for RSH pumps based on the existing DOE definition for RSV pumps: one for an overarching category of RSH pumps, which does not characterize flow; one for in-line RHS pumps (''RHSIL''); and one for end-suction RSH pumps (''RSHESS). 10 CFR 431.462; 87 FR 21268, 21283.

In response to the April 2022 NOPR, both HI and Grundfos supported DOE's proposed definitions for RSH, RSHIL, and RSHES pumps. (Grundfos, No. 31 at p. 5; HI, No. 33 at p. 5) However, Grundfos commented that the RSH definitions are quite broad and will likely capture multiple different pump products under the RSHES definition. (Grundfos, No. 31 at p. 2) Grundfos requested that DOE clarify which pumps meet this definition and whether these pumps should be considered as a single pump category. *Id.*

DOE has determined that additional pump category definitions within the RSH definitions are not necessary for the purposes of testing. DOE interprets that the concerns shared by Grundfos are based on differences in hydraulic performance between different RSH pumps. DOE notes that should it find notable hydraulic performance differences between RSH, RSHES, and RSHIL pumps, DOE would consider these differences and define separate equipment classes accordingly for any future energy conservation standards rulemaking.

In this final rule, DOE is adopting the definitions for RHS, RHSES, and RHSILs as proposed in the April 2022 NOPR.

[22] ANSI/HI 14.1–14.2–2019 defines BB1 Pumps as one and two stage axially split casing pumps that are generally characterized by the following attributes: (1) pump and drive have separate shafts; (2) the pump has two integral bearing housings to absorb all pump axial and radial pump hydraulic loads.

[23] VS1, VS2, and VS3 pumps are vertically suspended impeller type pumps that discharge through a column. VS1 pumps have a diffuser, VS2 pumps use a volute, and VS3 pumps have axial flow. They are defined further in section 1.3.3.1.2 of ANSI/HI 14.1–14.2–2019.

8. Close-Coupled and Mechanically-Coupled Pumps

DOE defines a close-coupled pump as a pump having a motor shaft that also acts as the impeller shaft. *See* 10 CFR 431.462. DOE defines a mechanically-coupled pump as a pump that has its own impeller shaft and bearings separate from the motor shaft. *See* 10 CFR 431.462. In the April 2022 NOPR, DOE discussed how its definitions for close-coupled and mechanically-coupled pumps did not account for end suction pumps that do not have bearings separate from the motor and do not have the impellers mounted on the motor shaft. 87 FR 21268, 21283. In the April 2022 NOPR, DOE proposed revisions to the definitions for close-coupled and mechanically-coupled pumps to eliminate this gap. *Id.* DOE proposed that (1) A close-coupled pump means a pump in which the driver's bearings absorb the pump's axial load; and (2) A mechanically-coupled pump means a pump in which bearings external to the driver absorb the pump's axial load. *Id.*

In response to the April 2022 NOPR, HI recognized DOE's effort to clarify the definitions for ESFM and ESCC pumps but provided the following recommendations to further improve clarity: (1) A close-coupled pump means a pump in which radial and axial loads are primarily supported by the driver; and (2) A mechanically-coupled pump means a pump in which radial and axial loads are primarily supported external to the driver. (HI, No. 33 at p. 5)

Grundfos commented that the proposed revisions to the ESFM and ESCC definitions will create additional burden for manufacturers that must reclassify products accordingly. (Grundfos, No. 31 at p. 5)

DOE interprets HI's comment to indicate that the definitions for close-coupled and mechanically-coupled proposed in the April 2022 NOPR did not leave enough flexibility for pumps where most, but not all, of a pump's axial load is supported by either bearings external to the driver or by the driver. DOE acknowledges that some flexibility is important when defining close-coupled and mechanically-coupled to avoid excluding any end suction pumps. However, DOE notes that the definitions recommended by HI are vague, specifically the term ''primarily'' which leaves the suggested definition open to interpretation. In an effort to add flexibility to the definitions while minimizing the need for interpretation, DOE is adopting the following definitions for close-coupled and mechanically-coupled pumps, where the italicized portions of each definition are revisions to the definitions proposed in the April 2022 NOPR. A close-coupled pump means a pump in which the driver's bearings *are designed* to absorb the pump's axial load. A mechanically-coupled pump means a pump in which bearings external to the driver *are designed* to absorb the pump's axial load.

In response to the comment from Grundfos, DOE notes the change in definition is intended to improve clarity rather than substantively shift the bounds of the ESCC or ESFM pump categories. DOE has determined, based on its review of manufacturer literature and the consensus of industry in the form of HI's comments, that the revisions to close-coupled and mechanically-coupled pumps do not change the classification of currently regulated end suction pumps.

C. Updates to Industry Standards

The current DOE test procedure for pumps incorporates the following industry test standards: HI 40.6–2014, ANSI/HI 1.1–1.2–2014, and ANSI/HI 2.1–2.2–2014. 10 CFR 431.463. The following sections describe updates to these industry standards and discuss the industry standards DOE is incorporating by reference in the final rule and the relevant provisions of those industry standards that DOE is referencing.

1. ANSI/HI 40.6

The current DOE test procedure for pumps incorporates HI 40.6–2014 for use in appendix A. The most recent version of HI 40.6 was published in 2021 (''HI 40.6–2021''). HI 40.6–2021 includes the following updates to HI 40.6–2014 (relevant sections of HI 40.6–2021 are included in parentheses after a summary of the modification):

(1) Clarified that the industy testing standard covers efficiency testing of rotodynamic pumps that are subject to DOE's energy conservation standards. (Section 40.6.1 ''Scope'').

(2) Updated the calculation of bare pump efficiency to match the current DOE test procedure requirements for plotting test data to determine the best efficiency point (''BEP'') rate of flow. (Section 40.6.6.3 ''Performance curve'').

(3) Updated the description and requirements of the pressure tap configuration for measurement sections at inlet and outlet of the pump. (Section A.3.1.3 ''Pressure taps'').

(4) Added an informative appendix for determining, applying, and calculating measurement instrument uncertainty. (Appendix H ''Determination, application, and calculation of instrument (systematic) uncertainty (informative)'').

(5) References ANSI/HI 14.1–14.2 ''Rotodynamic Pumps for Nomenclature and Definitions'' (''ANSI/HI 14.1–14.2'') which supersedes ANSI/HI 1.1–1.2–2014 and ANSI/HI 2.1–2.2–2014. (Section 40.6.4.1 ''Vertically suspended pumps''; Section 40.6.4.3 ''All other pump types'').

(6) Includes a new appendix (Appendix E) for the testing of circulator pumps. (Appendix E ''Testing Circulator Pumps'').

In the April 2022 NOPR, DOE tentatively determined that the provisions of HI 40.6–2021 that correspond to the provisions in HI 40.6–2014 are substantively the same and adopting such provisions would not change the current test procedure or measured PEI values. 87 FR 21268, 21285. Therefore, in the April 2022 NOPR DOE proposed to incorporate by reference HI 40.6–2021 in place of HI 40.6–2014, in order to reference the most current industry test procedure. *Id.*

DOE received no comments on its proposal to incorporate HI 40.6–2021 by reference for use in appendix A of the DOE test procedure. Therefore, in this final rule DOE is incorporating HI 40.6–2021 by reference as proposed in the April 2022 NOPR.

While DOE proposed to incorporate by reference HI 40.6–2021 as the basis for its proposed test procedure, DOE tentatively determined in the April 2022 NOPR that certain sections of the industry test standard are not applicable to the DOE test procedure. 87 FR 21268, 21285. Specifically:

(1) Section 40.6.1, Scope, provides the scope specific to the test methods outlined in HI 40.6–2021;

(2) Section 40.6.5.3 provides provisions regarding the generation of a test report;

(3) Appendix ''B'' provides informative guidance on test report formatting;

(4) Appendix ''E'' provides normative test procedures for circulator pumps; and

(5) Appendix ''G'' compares HI 40.6–2021 and DOE's nomenclature. *Id.*

None of these sections are required for testing and rating pumps in accordance with the test procedure that DOE proposed in the April 2022 NOPR. As such, in the April 2022 NOPR, DOE proposed to not adopt Section 40.6.1, Section 40.6.5.3, appendix B, appendix E, and appendix G in the April 2022 NOPR. *Id.*

DOE received no comments on the proposal to exclude the specified sections of HI 40.6–2021 from the DOE test procedure. Therefore, in this final rule, DOE is adopting the exclusions as proposed in the April 2022 NOPR.

Additionally, as discussed in the April 2022 NOPR, certain provisions of HI 40.6–2021 are consistent with the provisions of the current DOE test procedure in appendix A. 87 FR 21268, 21285. DOE proposed to remove these provisions in appendix A and instead reference the appropriate sections of HI 40.6–2021, specifically:

(1) Section I.D.1 of appendix A, which addresses damping devices, is amended to reference the corresponding provisions in HI 40.6.3.2.2;

(2) Section I.D.2 of appendix A, which addresses stabilization, is amended to reference the corresponding provisions in HI 40.6.5.5.1;

(3) Section I.D.3 of appendix A, which addresses calculations and rounding, is amended to reference the corresponding provisions in HI 40.6.6.1.1;

(4) Sections III.D.1, IV.D.1, V.D.1, VI.D.1, and VII.D.1 of appendix A, which outline testing the BEP of different pump configurations, are amended to reference the corresponding provisions in HI 40.6.5.5.1. *Id.*

DOE received no comments on its proposal to remove provisions of appendix A and instead reference the equivalent provisions in HI 40.6–2021 and is therefore adopting the revisions as proposed in the April 2022 NOPR.

2. ANSI/HI 1.1–1.2–2014 and ANSI/HI 2.1–2.2–2014

Subpart Y to part 431 currently incorporates by reference ANSI/HI 1.1–1.2–2014 and ANSI/HI 2.1–2.2–2014. DOE references ANSI/HI 1.1–1.2–2014 and ANSI/HI 2.1–2.2–2014 for defining certain terms in 10 CFR 431.462. In 2019, ANSI/HI 1.1–1.2–2014 and ANSI/HI 2.1–2.2–2014 were updated and combined into ANSI/HI 14.1–14.2–2019, ''American National Standard for Rotodynamic Pumps for Nomenclature and Definitions'' (''ANSI/HI 14.1–14.2–2019''). The notable additions to ANSI/HI 14.1–14.2 that were absent in ANSI/HI 1.1–1.2–2014 and ANSI/HI 2.1–2.2–2014 are outlined below:

(1) ANSI/HI 14.1–14.2–2019 includes additional figures and tables to represent information included in ANSI/HI 1.1–1.2–2014 and ANSI/HI 2.1–2.2–2014;

(2) ANSI/HI 14.1–14.2–2019 adds new pump definitions and pump classifications;

(3) ANSI/HI 14.1–14.2–2019 includes configuration definitions for vertical in-line, vertical end-suction, vertical self-priming, seal-less, magnetic drive, canned motor, and multi-stage pumps;

(4) ANSI/HI 14.1–14.2–2019 adds new definitions for discharge casing, volute, concentric casing, modified concentric casing, vaned diffuser/collector, bowl, and stage casing; and [24]

(5) ANSI/HI 14.1–14.2–2019 includes a new ''preferred operating region'' section to define a guideline for recommended operating flow rates.

As stated previously, the current DOE test procedure incorporates pump designations from ANSI/HI 1.1–1.2–2014 and ANSI/HI 2.1–2.2–2014 as examples for the definitions of ESCC, ESFM, IL, RSV, and ST pumps under the DOE test procedure. 10 CFR 431.462. DOE notes that, in general, the references to ANSI/HI 1.1–1.2–2014 and ANSI/HI 2.1–2.2–2014 are in the context of providing non-limiting examples. DOE is concerned that continued inclusion of HI pump designations as examples of specific pump categories may cause confusion in the market or be misunderstood to limit the scope of the relevant definitions. To minimize potential misapplication of its definitions, DOE is removing the references to ANSI/HI 1.1–1.2–2014 and ANSI/HI 2.1–2.2–2014 as examples of certain pump category definitions, as proposed in the April 2022 NOPR. 87 FR 21268, 21286. Additional detail on the adopted changes to the definitions is discussed in section III.B.2 of this document.

Additionally, DOE's current test procedure definition of ''bowl diameter'' relies on the ''intermediate bowl'' definition in ANSI/HI 2.1–2.2–2014. As proposed in the April 2022 NOPR, DOE is modifying its definition for ''bowl diameter'' and adding a DOE definition for ''bowl'' to remove the current reference to ANSI/HI 2.1–2.2–2014. *Id.* These changes will create a more self-contained definition and are discussed in section III.B.3 of this document.

DOE is incorporating ANSI/HI 14.1–14.2–2019 by reference for use in appendix A since it is referenced in HI 40.6–2019. However, DOE does not directly reference ANSI/HI 14.1–14.2–2019 in appendix A.

D. Metric

The current energy efficiency standards for pumps are based on the PEI metric. 10 CFR 431.465. The PEI metric is a ratio of the pump energy rating (''PER'') of the tested pump to the PER of a minimally compliant pump (''PER_{STD}''). *See* section II of appendix A. The current test procedure defines the PEI_{CL} metric as the pump energy index for a constant load, as applicable to pumps rated as bare pumps or sold with motors; and the PEI_{VL} metric, the pump energy index for a variable load, as applicable to pumps sold with motors and continuous controls or noncontinuous controls. Appendix A, section II.A. A ''continuous control'' is a control that adjusts the speed of the pump driver continuously over the driver's operating speed range in response to incremental changes in the required pump flow, head, or power output. 10 CFR 431.462. A ''non-continuous control'' is a control that adjusts the speed of a driver to one of a discrete number of non-continuous pre-set operating speeds and does not respond to incremental reductions in the required pump flow, head, or power output. *Id.*

PER_{CL} is calculated as the average of driver power input at 75 percent, 100 percent, and 110 percent of flow at the BEP, where the flows are achieved by varying the operating head to follow the pump performance curve. *See* appendix A, section II.A.1 and subsequently referenced sections. PER_{VL} is calculated as the average of driver power input at 25 percent, 50 percent, 75 percent, and 100 percent of flow at BEP, where the flows are achieved by speed reduction to follow a specified system curve. *See* appendix A, section II.A.2 and subsequently referenced sections. BEP is defined as the pump hydraulic power operating point (consisting of both flow and head conditions) that results in the maximum efficiency. 10 CFR 431.462.

This section discusses the regulatory metric for SVIL pumps and additional clean water pumps that DOE is incorporating into its test procedure.

In the April 2022 NOPR, based on manufacturer feedback to this rulemaking and the current circulator pumps rulemaking,[25] DOE tentatively determined that use of PER_{CL} and PER_{VL} and indexing the results against PER_{STD} would be a reasonable and consistent way to evaluate SVIL performance. 87 FR 21268, 21286. This determination was based largely on the similarity of SVILs to in-line pumps, which are evaluated using the PER_{CL} and PER_{VL} metrics. *Id.* As such, DOE proposed in the April 2022 NOPR that the rating metric for SVIL pumps would be PEI_{CL} for constant load pumps and PEI_{VL} for variable load pumps, equivalent to the metric already in use for currently covered commercial and industrial pumps. *Id.*

In the April 2022 NOPR DOE tentatively determined that, for BB, VT, and RSH pumps, the test procedure will measure energy efficiency during a representative average use cycle and not be unduly burdensome to conduct. 87 FR 21268, 21286. This determination was based on the similarities between the pump categories that are addressed in the current test procedure and those that DOE proposed to include in the scope of the test procedure. *Id.* DOE tentatively determined that PEI_{CL} and PEI_{VL} are appropriate metrics for BB, VT, and RSH pumps. *Id.* Using PEI_{CL} and PEI_{VL} for these additional pump categories ensures a consistent rating approach in the market. *Id.* In the April 2022 NOPR, DOE proposed that the PEI_{CL} and PEI_{VL} metric would be used

[24] A volute may also be referred to as a ''housing'' or ''casing.''

[25] A link to the circulator pumps docket web page can be found at *www.regulations.gov/docket/EERE-2016-BT-STD-0004.*

for rating the performance of BB, VT, and RSH pumps. *Id.*

For the reasons discussed in the preceding paragraphs, for SVIL, VT, and RSH pumps, DOE is adopting PEI_{CL} for constant load pumps and PEI_{VL} for variable load pumps, equivalent to the metric already in use for currently covered commercial and industrial pumps.

In response to the April 2022 NOPR, China suggested that DOE revise PER_{std} on the basis of a scientific assessment of the new pumps being added to the test procedure scope. (China, No. 29 at p. 3) DOE notes that this test procedure final rule does contain amendments that may adjust PER_{std} for both current and expanded scope pumps. However, the overall methodology of determining PER_{std} does not differ by pump category; PER_{std} is specific to the flow and specific speed of a given pump model and includes a C-value that sets the energy conservation standard and is specific to a given pump category. Adopting a C-value for the expanded scope pumps would be considered in an energy conservation standard rulemaking rather than in this test procedure rulemaking.

E. Amendments to Test Method

DOE is incorporating HI 40.6–2021 into appendix A of subpart Y of 10 CFR part 431. HI 40.6–2021 specifies calculating pump power input,[26] driver power input (for testing-based methods),[27] pump power output,[28] pump efficiency,[29] bowl efficiency,[30] overall efficiency,[31] and other relevant values at the specified load points necessary to determine PEI_{CL} and PEI_{VL}. HI 40.6–2021 also contains provisions for test methodology, standard rating conditions, equipment specifications, uncertainty calculations, and tolerances.

Sections II through VII of appendix A specify methods for determining PEI_{CL} and PEI_{VL} for pumps based on whether they are distributed into commerce with a motor and/or with controls. These sections are summarized as follows:

- *Section II:* Calculation of PEICL or PEIVL for all pumps based on the pump energy rating for a minimally compliant reference pump (PERCL or PERVL, respectively);
- *Section III:* Test procedure for bare pumps;
- *Section IV:* Testing-based approach for pumps sold with motors;
- *Section V:* Calculation-based approach for pumps sold with motors;
- *Section VI:* Testing-based approach for pumps sold with motors and controls; and
- *Section VII:* Calculation-based approach for pumps sold with motors and controls.

See appendix A, sections I.A.2 through I.A.6.

The following sections summarize the amendments to the current test procedure that DOE proposed in the April 2022 NOPR, address stakeholder comments on these proposals, and finalize provisions for the amended test procedure.

1. Nominal Speed

The scope of the current test procedure is limited to pumps designed to operate with either a 2- or 4-pole induction motor or a non-induction motor with a speed of rotation operating range between 2,880 and 4,320 rpm and/or 1,440 and 2,160 rpm. 10 CFR 431.464(a)(1)(ii)(D). Section I.C.1 of appendix A specifies the selection of nominal speed of rotation of either 1,800 or 3,600 rpm depending on the number of poles of the motor or the operating range of non-induction motors.

As discussed in section III.A.4.b, DOE is including pumps that operate at greater than or equal to 960 rpm and less than 1,440 rpm or are designed to operate with 6-pole motors in the test procedure. In the April 2022 NOPR, DOE proposed that these pumps would be tested with a nominal speed of 1,200 rpm. 87 FR 21268, 21287. DOE also proposed to update the calculation and rounding sections of the test procedure to address this additional nominal speed. *Id.*

China commented that the DOE test procedure for 1,200 rpm pumps may result in cavitation and suggested that DOE instead provide a speed reduction test using pump affinity rules. (China, No. 29 at p. 3)

DOE notes that the test procedure for 1,200 rpm pumps would use a nominal test speed of 1,200 rpm. DOE has determined that this would be most representative of field operation for these pumps. If cavitation occurs at 1,200 rpm for a given pump under test, DOE considers that this is representative of field performance and is therefore a valid test. No other stakeholders identified cavitation as an issue for 1,200 rpm pumps.

HI stated it expects testing 6-pole pumps will significantly increase test burden and test cost; however, HI expects minimal energy savings relative to manufacturer impact since the volume of equipment impacted is small. (HI, No. 33 at p.3). Specifically, HI stated that most of these pumps are already regulated as 4-pole products. *Id.*

In response to HI's comments, DOE notes that increased burden associated with test procedure modifications is estimated and discussed in section III.L of this document. DOE will evaluate energy savings during its energy conservation standards rulemaking.

In this final rule, DOE is adopting the amendments to the test procedure as proposed in the April 2022 NOPR.

2. Testing of Multi-Stage Pumps

The current DOE test procedure specifies that RSV pumps shall be tested with three stages and that ST pumps shall be tested with nine stages. If the unit under test is only available with fewer than the required number of stages, the pump is tested with the maximum number of stages with which the unit is distributed in commerce in the United States. If the unit under test is only available with greater than the number of required stages, the pump is tested with the lowest number of stages with which the unit is distributed in commerce in the United States. If the unit under test is available with both fewer and greater than the required number of stages, but not the required number of stages, the pump is tested with the number of stages closest to the required number of stages. If both the next lower and next higher number of stages are equivalently close to the required number of stages, the pump is tested with the next higher number of stages. *See* appendix A, section I.C.2.

RSH and VT pumps also may be sold with a varying number of stages, in which the same pump may have options for multiple different stages for multiple applications. To reduce testing burden and mirror the practice established for RSV pumps, DOE proposed in the April 2022 NOPR that RSH pumps be tested with three stages. 87 FR 21268, 21287. To reduce testing burden and mirror the

[26] The term ''pump power input'' in HI 40.6–2021 is defined as ''the power transmitted to the pump by its driver'' and is synonymous with the term ''pump shaft input power,'' as used in this document.

[27] The term ''driver power input'' in HI 40.6–2014 is defined as ''the power absorbed by the pump driver'' and is synonymous with the term ''pump input power to the driver,'' as used in this document.

[28] The term ''pump power output'' in HI–40.6–2021 is defined as ''the mechanical power transferred to the liquid as it passes through the pump, also known as pump hydraulic power.'' It is used synonymously with ''pump hydraulic power'' in this document.

[29] The term ''pump efficiency'' is defined in HI 40.6–2014 as a ratio of pump power output to pump power input.

[30] The term ''bowl efficiency'' is defined in HI 40.6–2014 as a ratio of pump power output to bowl assembly power input and is applicable only to VTS and RSV pumps.

[31] The term ''overall efficiency'' is defined in HI 40.6–2014 as a ratio of pump power output to driver power input and describes the combined efficiency of a pump and driver.

practice established for ST pumps, DOE proposed testing VT pumps with nine stages. *Id.* If the pump under test is not distributed in commerce with the number of stages prescribed for testing, DOE proposed that the existing instructions for selecting the correct number of stages during testing would be followed. *Id.*

As defined in section III.B.5, BB pumps can have either one or two stages. For BB basic models that are distributed into commerce with both one and two stages, DOE proposed in the April 2022 NOPR to test BB pumps at two stages. 87 FR 21268, 21287. DOE discussed that this approach is consistent with the provisions in the current test procedure that require multi-stage pumps be tested with more than one stage. *Id.*

In response to the April 2022 NOPR, HI and Grundfos supported the proposed number of stages for testing RSH, VT, and BB pumps. (HI, No. 33 at p. 5; Grundfos, No. 31 at p. 5) HI additionally commented that a one-stage BB pump and a two-stage BB pump will always be different basic models. (HI, No. 33 at p. 5) China requested that DOE provide additional description for when BB pumps would be tested using one-stage versus two-stage. (China, No. 29 at p. 4)

As DOE is not including BB pumps within the scope of this test procedure DOE is not adopting the multi-stage testing provisions for BB pumps proposed in the April 2022 NOPR.

For the reasons discussed in the preceding paragraphs, DOE is adopting the number of stages for testing RSH and VT pumps test procedure as proposed in the April 2022 NOPR.

3. Load Profile

The current test procedure requires that the constant load pump energy rating be determined using 75, 100 and 110 percent of BEP flow with each value multiplied by 0.3333 and the results summed to determine PER_{CL}. Appendix A, sections III.E, IV.E, V.E. Similarly, for variable load pumps, energy ratings are determined at 25, 50, 75, and 100 percent of BEP flow with each point weighted by 0.25 and summed to obtain a value for PER_{VL}. Appendix A, sections VI.E, VII.E.

In the April 2022 NOPR, DOE discussed the current load profiles in response to comments received from stakeholders on the April 2021 RFI. 87 FR 21268, 21288. Specifically, DOE agreed with stakeholders that load profiles vary depending on the pump installation environment and application; however, DOE stated that the existing load profiles provide a consistent method for comparing the performance of different pumps. *Id.* DOE did not propose to modify the current load profiles in the April 2022 NOPR.

NEEA recommended that DOE consider test procedures and metrics that better account for motor and control performance at various load points in the future. (NEEA, No. 34 at p. 5) The CA IOUs stated that they are not aware of any reports that provide BB pump-specific operating hour ranges but suggested that DOE review industrial cooling, boiler feedwater, and municipal water supply application reports. (CA IOUs, No. 32 at p. 3)

As discussed in the April 2022 NOPR, DOE is not revising the current load profiles in this final rule notice. Additionally, SVIL, VT, and RSH pumps will use the same load profiles as other pumps previously covered in the scope of this rulemaking and described in the preceding paragraphs. DOE will continue to evaluate the impact of load profile on PEI.

4. Pumps With BEP at Run-Out

To determine a pump's BEP, the DOE test procedure references testing provisions included in HI 40.6–2014 (excluding sections 40.6.5.3, section A.7 and appendix B) at the following seven flow points: 40, 60, 75, 90, 100, 110, and 120 percent of the expected BEP flow rate of the pump at the nominal speed of rotation. Appendix A, section III.D.1. All pumps have a maximum flow rate which is termed ''run-out.'' For pumps where the BEP is expected to be within 20 percent of the maximum flow rate of the pump (BEP at run-out), section I.D.4 of appendix A provides alternative flow points, with the maximum flow point equal to 100 percent of the expected maximum flow rate so that the pump may safely operate. As discussed in section III.C.1, Sections 40.6.5.5.1 and 40.6.6.3 of HI 40.6–2021 now include provisions related to pumps with BEP at run-out. Section 40.6.5.5.1 provides alternate test points based on the expected BEP rate of flow for pumps with a maximum allowable flow rate as specified by the manufacturer that is less than 120 percent of the BEP flow rate. Section 40.6.6.3 also provides alternate tested load points for the driver input power as a percentage of BEP flow rate for pumps that cannot be safely tested to flows greater than 120 percent of BEP. However, these provisions are based on flow points with respect to expected BEP flow rate rather than expected maximum flow rate.

In the January 2016 Final Rule, DOE responded to a comment from HI that in order to determine the location of BEP, testing must occur at rates of flow greater than 100 percent of expected BEP flow. 81 FR 4086, 4117. DOE stated that its proposal to use flow points only up to 100 percent was with respect to the expected maximum allowable flow rate rather than with respect to expected BEP. *Id.* DOE notes that the existing regulatory text contains an omission in which section I.D.4(1) of appendix A only refers to ''the expected,'' while section I.D.4(2) refers to ''the expected maximum flow rate of the pump.'' In the April 2022 NOPR, DOE proposed to include ''expected maximum flow rate of the pump'' in both section I.D.4(1) and I.D.4(2) of appendix A and would not reference sections 40.6.5.5.1 or 40.6.6.3 of HI 40.6–2021. 87 FR 21268, 21288. DOE requested comment on whether the alternate flow points for pumps with BEP at run-out should be determined with respect to expected maximum flow rate or expected BEP flow rate. *Id.*

In response, HI recommended that DOE modify the test procedure to require testing at 105 percent of BEP as a minimum criterion for pumps that cannot be tested to 120 percent of BEP. (HI, No. 33 at p. 5) HI suggested 105 percent of BEP because lower specific speed pumps can artificially benefit by truncating the actual BEP flow. *Id.* Grundfos commented that using the maximum flow rate provides a better curve for finding BEP and ensures that curve shape after BEP is properly captured (where possible). (Grundfos, No. 31 at p. 5) Grundfos additionally stated that using maximum expected flow can require a second test in some cases, with small additional burden, if BEP is found to be plus or minus 5 percent of the tested points but noted that this burden would be small given the limited systems reporting using BEP at run-out provisions. *Id.*

DOE notes that by relying on maximum expected flow rather than expected BEP flow rate, it is likely that most pumps would test at a minimum of 105 percent of BEP, as in most cases, maximum expected flow would not be less than 5% away from BEP. This addresses HI's suggestion to have a minimum point at 105 percent of BEP, while also making sure that all pumps in this category can be tested. This is also consistent with Grundfos' comment that maximum flow provides a better curve shape, especially after BEP. For these reasons, DOE is adopting BEP at run-out provisions as proposed.

In the April 2022 NOPR, DOE discussed that the current regulatory text would benefit from additional detail as to how the revised loading points should be applied in the determination of PER_{STD}. 87 FR 21268, 21288. DOE proposed to specify that the revised loading points would only be used in application of the α_i coefficient values when determining pump power input, and not when determining specific speed (''Ns'') or the minimally-compliant pump efficiency (''$\eta_{pump,STD}$''), which should always be based on 100 percent of BEP flow for standardization purposes. *Id.* DOE did not receive any comments regarding how the revised loading points should be applied in the determination of PER_{STD}. Therefore, DOE is including the language as proposed in the April 2022 NOPR.

As part of the April 2022 NOPR, DOE also identified that the current provisions for pumps with BEP at run-out do not address how to perform motor sizing for bare pumps, which is based on the horsepower equivalent to, or the next highest horsepower greater than, the pump power input to the bare pump at 120 percent of the BEP flow rate of the tested pump. 87 FR 21268, 21288–21289. DOE proposed that for pumps with BEP at run-out, motor sizing would be based on 100 percent of the BEP flow rate of the tested pump, as there are no flow rates available higher than that level. *Id.* However, DOE acknowledged in the April 2022 NOPR that this proposed change could result in inequitable motor sizing compared to pumps not subject to these provisions. *Id.*

In response to the April 2022 NOPR, Grundfos agreed with the use of maximum flow rate to ensure BEP can be determined for motor sizing for bare pumps. (Grundfos, No. 31 at p. 6)

In this final rule, DOE is including the motor sizing language for pumps with BEP at run-out, as proposed in the April 2022 NOPR.

5. Calibration of Measurement Equipment

The current DOE test procedure references HI 40.6–2014 Appendix D, which specifies the frequency at which measurement equipment should be calibrated. Table D.1 of HI 40.6–2014 states that manufacturer's recommendations on calibration intervals should be followed if they differ from those in Table D.1. However, DOE notes that its test procedure does not explicitly reference Table D.1 of HI 40.6–2021.

In the dedicated-purpose pool pump test procedures included in appendices B and C to subpart Y of 10 CFR part 431 (''appendix B'', ''appendix C''), DOE has included the calibration requirements contained in Appendix D of ANSI/HI 40.6–2014, with modification allowing for calibration periods up to 3 times longer than those specified in Table D.1 of ANSI/HI 40.6–2014 if justified by historical calibration data. *See* appendix B, section I.B.2 and appendix C, section I.B.2.

Similar to the approach that DOE uses in appendix B and appendix C, DOE proposed in the April 2022 NOPR to specifically reference the calibration requirements in Appendix D of HI 40.6–2021 in section I.B of appendix A to improve the overall clarity of its test procedure. 87 FR 21268, 21289.

In response to the April 2022 NOPR, Grundfos agreed that including the reference to HI 40.6, Appendix D provides consistency and clarity regarding the required calibration requirements for testing. (Grundfos, No. 31 at p. 11).

For the reasons discussed in the preceding paragraphs and the stakeholder feedback received, DOE is adopting Table D.1 of ANSI/HI 40.6–2021 as proposed in the April 2022 NOPR.

6. Calculations and Rounding

The DOE test procedure includes provisions for calculations and rounding in section I.D.3 of appendix A. Generally, all measured data must be normalized such that it represents performance at nominal speed of rotation in accordance with HI 40.6–2014, and all calculations must be carried out using raw measured values without rounding. *See* appendix A, section I.D.3. PER is rounded to three significant digits and PEI is rounded to the hundredths place. *Id.* Explicit rounding directions are not provided for other parameters.

In the April 2022 NOPR, DOE did not propose any changes to its current rounding requirements, except for updates to reference the appropriate section of HI 40.6–2021, as discussed in section III.C.1 of this document. 87 FR 21268, 21289.

DOE did not receive comments on this proposal. For the reasons discussed in the preceding paragraphs and in the April 2022 NOPR, DOE is adopting the updated references as proposed in the April 2022 NOPR.

F. Calculation-Based and Testing-Based Options According to Pump Configuration (Table 1 of Appendix A)

The DOE test procedure for pumps includes calculation-based and testing-based options that apply based on pump configuration (including style of motor and control) as distributed in commerce. *See* appendix A, Table 1. The calculation-based options rely on a bare pump test, whereas the testing-based options rely on a ''wire-to-water'' test. The calculation-based options may reduce test burden by allowing a manufacturer to test a sample of bare pumps and use that data to rate multiple pump configurations using calculation-based methods. On the other hand, wire-to-water testing may more accurately represent pump, motor, and control performance.

1. Hybrid Mapping Approach

In response to the April 2021 RFI, NEEA recommended that DOE consider a hybrid approach to testing and calculation, similar to the test method included in Appendix H of ANSI/AMCA Standard 214–21, ''Test Procedure for Calculating Fan Energy Index (FEI) for Commercial and Industrial Fans and Blowers'' (''AMCA 214''), which stipulates a one-time test of the motor at multiple load points, which can be used to determine the input power at the appropriate pump test procedure load points and then used to calculate a rating. With this method, each motor need only be tested once, and the results used for multiple pump configurations. (NEEA, No. 21 at p. 10)

Similarly, in response to the April 2021 RFI, with respect to pumps sold with inverter-only motors, the CA IOUs cautioned against the use of a losses table for permanent magnet inverter-only motors with a non-integrated controller sold with a choice of controller due to variance in performance between drive units (as opposed to induction motors, which are relatively uninfluenced by choice of drive unit) and instead recommended this subset use a hybrid power drive system mapping procedure, which they expected would reduce burden. (CA IOUs, No. 19 at pp. 8–9)

In the April 2022 NOPR, DOE acknowledged that permanent magnet inverter-only motors sold without a controller may perform differently based on the inverter with which it is paired and recognized that a hybrid mapping approach may be beneficial. 87 FR 21268, 21290, 21299. However, DOE stated that it did not expect that the use of a hybrid mapping approach would provide the burden reduction intended by the use of the calculation method. 87 FR 21268, 21299. While the hybrid mapping approach would be less burdensome than multiple wire-to-water tests, it would likely be significantly more burdensome than a calculation-based approach based on a bare pump test, as it would require physical tests of all motors with which the bare pump would be paired. *Id.* Furthermore, DOE tentatively concluded that the calculation-based approach is sufficient to generate appropriately representative values for this equipment—and with the option to allow for a testing-based approach, or an AEDM as discussed in section III.I.2, a manufacturer would be free to refine accuracy of the values for specific equipment. *Id.*

DOE did not propose a hybrid approach in the April 2022 NOPR but requested comment on whether manufacturers would use a hybrid mapping approach, and if so, whether manufacturers would conduct the motor tests or request the tests from their suppliers. 87 FR 21268, 21290. In addition, DOE requested comment on what additional provisions would need to be added to Appendix H of AMCA 214 to make it applicable to pumps, such as speed and load corresponding to pump rating points. *Id.* Finally, DOE requested comment on the merits of using a hybrid mapping approach specific to inverter-only motors and whether it would reduce or increase manufacturer burden compared to the current proposals. 87 FR 21268, 21299.

HI stated that hybrid mapping is not a current practice, so including this would add complexity and confusion, without an understood benefit. (HI, No. 33 at p. 6, 7) HI stated that the hybrid approach would be significantly more burdensome than a calculation-based approach based on a bare pump test, and that the calculation approach based on coefficients and bare pump test is sufficient to generate appropriately representative values or the equipment. (HI, No. 33 at p. 7). HI added that in many cases hybrid mapping data would not be available. For these reasons HI is not in favor of a hybrid mapping approach for inverter-only motors. *Id.*

Grundfos stated that compared to the current proposals of calculated method and AEDM, it did not believe a hybrid mapping approach would reduce burden. (Grundfos, No. 31 at p. 7) Grundfos commented that a hybrid mapping approach is not currently necessary since DOE has proposed a method for calculating PEIs for pumps sold with inverter-only motors. *Id.* at 6. However, Grundfos also stated they believe a hybrid mapping approach could provide more representative PEIs when compared to calculation-based approaches, but that more effort would be necessary to define a suitable motor mapping procedure to ensure it is applicable to pumping. *Id.*

NEEA recommended that in future proceedings DOE consider an optional hybrid approach to testing pumps sold with inverter-only synchronous motors to show the improvement in Pump Energy Index (PEI) from IE5 motors. (NEEA, No. 34 at p. 2)

DOE agrees with stakeholders that it is premature to develop a hybrid mapping approach in this rulemaking, but notes that DOE may consider the issue in future rulemakings.

2. Calculation Method for Pumps Sold With Induction Motors and Controls

Based on its review of available coefficients and part-load loss data, DOE tentatively determined in the April 2022 NOPR that without further data indicating that its current coefficients overstate motor drive system losses for pumps, it would retain its current loss model for motors less than 50 hp. 87 FR 21268, 21296. DOE noted that its current coefficients correspond to about 30 percent added harmonic losses and a 3 percent variable frequency drive (''VFD'') efficiency penalty. *Id.* DOE stated that it would consider revising its coefficients below 50 hp in accordance with the method suggested by HI,[32] or to harmonize with fans or with international standards, given appropriate data specific to pumps. *Id.* To ensure that the calculation method does not overrate pumps, while balancing stakeholders' requests for representativeness, DOE proposed to allow use of an AEDM, as discussed in section III.I.2 of this document. *Id.* DOE requested (1) data indicating whether AHRI 1210-certified data is applicable to pumps as well as any other applicable part-load loss data; (2) data indicating whether 15 percent and 25 percent incremental losses, which are specified as part of IE3 ratings that are not commonly used in the U.S., are applicable to the U.S. and do not overstate performance, and if not, what incremental losses would be appropriate to apply, and (3) data indicating an appropriate VFD efficiency penalty by hp. *Id.*

HI stated that related to item 2, the 15 percent and 25 percent incremental losses are appropriate and should be representative of motors commonly used in the U.S. (HI, No. 33 at p. 6) HI understood that NEMA supported these values and is adopting them into a future American National Standard. *Id.*

In its comment to the April 2021 RFI, HI stated that losses are especially overstated in the 50 hp to 100 hp range. (HI, No. 22 at p.3) In the April 2022 NOPR, DOE discussed its findings that its existing coefficients show a decrease in full-load efficiency at 75 hp, which would not be expected. 87 FR 21268, 21296. In addition, DOE noted that the AHRI 1210-certified data is limited to a maximum of 75 hp and does not exist at higher hp. *Id.* Furthermore, DOE stated that its current coefficients in the 50 hp to 100 hp range correspond to about 60 percent added harmonic losses and a 3 percent VFD penalty, and, based on previous discussion of typical losses, DOE tentatively determined that these losses are too high. *Id.*

In light of the fact that DOE's coefficients in the 50 hp to 100 hp represent harmonic losses that are too high, DOE proposed in the April 2022 NOPR to update its coefficients for motors rated at 50 hp and above. 87 FR 21268, 21296. To adjust its coefficients for motors 50 hp and above, DOE started with the current DOE default losses for the motor-only at full-load and added 15 to 25 percent losses, as applicable, as well as a VFD efficiency penalty of 3 percent. *Id.* DOE then adjusted the current DOE default losses for the motor and control at 100 percent to match the result of adding the incremental harmonic losses and VFD penalty, and applied the same adjustment factor to all load points. *Id.* Table III.1 summarizes DOE's proposal for the induction motor and control part-load loss coefficients. *Id.* DOE requested comment on its proposed part-load loss factors for induction motors and controls greater than 50 hp. *Id.*

TABLE III.1—PROPOSED INDUCTION MOTOR AND CONTROL PART LOAD LOSS FACTOR EQUATION COEFFICIENTS

Motor horsepower (hp)	Coefficients for induction motor and control part load loss factor (z_i)		
	a	b	c
≤5	−0.4658	1.4965	0.5303

[32] HI suggested new part load loss coefficients based on the differences between incremental losses predicted by IEC 60034–31 and the current DOE part load loss coefficients. (HI, No. 22 at p. 3)

TABLE III.1—PROPOSED INDUCTION MOTOR AND CONTROL PART LOAD LOSS FACTOR EQUATION COEFFICIENTS—Continued

Motor horsepower (hp)	Coefficients for induction motor and control part load loss factor (z_i)		
	a	b	c
>5 and ≤20	−1.3198	2.9551	0.1052
>20 and ≤50	−1.5122	3.0777	0.1847
>50 and ≤100	−0.6629	2.1452	0.1952
>100	−0.7583	2.4538	0.2233

Grundfos agreed that the updated coefficients better represent losses for motors greater than 50 hp. (Grundfos, No. 30 at p. 6) HI stated that it reviewed the coefficients proposed by DOE compared to those suggested by HI and noted only minor deviations in the calculated PEI. (HI, No. 33 at p. 6) HI supported the part-load loss factors for induction motors and controls proposed by DOE. *Id.*

For the reasons discussed previously, and based on stakeholder feedback, DOE is finalizing the updated induction motor and control part load loss factor equation coefficients as proposed and shown in Table III.1.

3. Calculation Method for Pumps Sold With Inverter-Only Motors (With or Without Controls)

In the April 2022 NOPR, DOE proposed that, to the extent that DOE adopts a definition, test procedure, and energy conservation standard for synchronous electric motors that are inverter-only electric motors, DOE would reference such regulations in the pumps test procedure, allowing for the use of the calculation method by pumps sold with synchronous electric motors that are inverter-only electric motors. 87 FR 21268, 21298.

a. Reliance on DOE Motors Test Procedure and Development of Coefficients

DOE published a NOPR regarding the test procedures for motors (''Motors TP NOPR''), in which DOE proposed to test inverter-only synchronous electric motors (inclusive of the inverter) that include an inverter in accordance with section 7.7.2 of IEC 61800–9–2:2017, using the test provisions specified in section 7.7.3.5 and testing conditions specified in section 7.10. 86 FR 71710, 71742 (Dec. 17, 2021). DOE proposed to test inverter-only synchronous electric motors that do not include an inverter in the same manner and to specify that testing must be performed using an inverter as recommended in manufacturer catalogs or offered for sale with the electric motor. *Id.* In the April 2022 NOPR, DOE proposed to require the nameplate efficiency of the inverter-only synchronous electric motors tested in accordance with any relevant test procedure in subpart B to part 431, if available, or if not available, in accordance with the DOE motors test procedure, should it be finalized. 87 FR 21268, 21298. DOE noted that this nameplate efficiency, as proposed, would be representative of the motor + inverter efficiency rather than just the motor efficiency. *Id.*

As proposed in the Motors TP NOPR, manufacturers of synchronous electric motors would not be required to test according to the DOE test procedure, if finalized, until the compliance date of energy conservation standards. 86 FR 71710, 71716. In the April 2022 NOPR, DOE stated that should it finalize a test procedure for these motors, there may be a period of time in which motor manufacturers would not be required to publish efficiency information for these motors. 87 FR 21268, 21298. However, DOE stated that since the proposed electric motors test procedure is an IEC test procedure, if DOE's proposal in the Motors TP NOPR were finalized, the tested efficiency of the synchronous inverter-only electric motors + inverters would likely already be available. *Id.*

Based on this premise, DOE proceeded to discuss a proposal regarding development of coefficients for the calculation method for pumps sold with inverter-only motors. 87 FR 21268, 21297–21299. DOE noted that in a submittal responding to the April 2021 RFI, HI stated that it developed coefficients and calculation modifications for inverter-only motors by establishing the incremental loss delta between power drive systems operating with induction motors and power drive systems operating with inverter-only motors. (HI, No. 22 at pp. 1–2) HI commented that it used actual motor data from multiple manufacturers to calculate these coefficients. *Id.* The coefficients developed by HI would require using either IE4 or IE5 minimum efficiencies (IEC 60034–30–2)[33] in the Section VII calculation for the equipped motor efficiency in appendix A. *Id.* HI also provided limited comparisons of the recommended inverter-only calculation method to test data for IE5 products. In five out of six cases, the calculation method resulted in a PEI equivalent to or higher than the test method. *Id.*

In the April 2022 NOPR, DOE stated that while it did not have data to evaluate HI's part load loss model quantitatively, DOE did plot HI's suggested model and preliminarily found the resulting trends in losses to be reasonable in relation to the expected loss differences between induction and synchronous electric motors. 87 FR 21268, 21298. Specifically, HI's suggested model showed inverter-only motors to be more efficient at part-load when compared to DOE's loss model for induction motors. *Id.* Further, HI's suggested model showed higher efficiency at full-load compared to DOE's loss model for induction motors—an expected outcome given that induction motor efficiency is set at a NEMA Premium level, whereas inverter-only efficiency is Super Premium. *Id.*

However, DOE identified three concerns with the HI's suggested model which it discussed in the April 2022 NOPR. 87 FR 21268, 21298. First, the HI-provided comparison of wire-to-water test data with results from the calculation method using the recommended coefficients resulted in one case where the PEI rating determined using the calculation method was lower than the PEI rating determined using the test method. *Id.* Second, HI's proposed coefficients were based on a delta between induction motors and inverter-only motors, and

[33] The International Electrotechnical Commission (''IEC'') standards IEC 60034–30 for variable-speed electric motors establishes an efficiency classification system for these motors. Efficiency classes are designated as IE1, IE2, IE3, IE4, and IE5.nIE4 is an approximation of super premium efficiency motors and IE5 is the IEC designation for ultra-premium efficiency motors.

DOE did not propose to adopt HI's proposed induction motor coefficients in the April 2022 NOPR. *Id.* Third, HI's coefficients are applicable to motor-only efficiency, while DOE's proposed test procedure for inverter-only motors includes efficiency for the motor + inverter combined. *Id.*

Therefore, DOE proposed in the April 2022 NOPR to make slight modifications to the inverter-only coefficients proposed by HI. 87 FR 21268, 21298. Specifically, DOE started with the proposed revised DOE induction motor and control coefficients, then applied the deltas provided by HI (the difference in efficiency points between a synchronous motor + control versus induction motor + control at different load points and different hp ranges), and then normalized to the motor + control losses (rather than the motor only losses). *Id.* Table III.2 shows the inverter-only motor and control part-load loss factor coefficients proposed in the April 2022 NOPR. These coefficients result in slightly higher losses than the HI model across all hp. 87 FR 21268, 21298. DOE requested comment on its proposed inverter-only part-load loss coefficients, specifically on the appropriateness of the delta used to derive these coefficients as well as any other available comparable motor data with which DOE could vet these coefficients. 87 FR 21268, 21299.

TABLE III.2—PROPOSED INVERTER-ONLY MOTOR AND CONTROL PART LOAD LOSS FACTOR EQUATION COEFFICIENTS

Motor horsepower (hp)	Coefficients for induction motor and control part load loss factor (z_i)		
	a	b	c
≤5	−0.0898	1.0251	0.0667
>5 and ≤20	−0.1591	1.1683	−0.0085
>20 and ≤50	−0.4071	1.4028	0.0055
>50 and ≤100	−0.3341	1.3377	−0.0023
>100	−0.0749	1.0864	−0.0096

The Efficiency Advocates supported DOE's proposal to permit use of a calculation-based method for pumps sold with inverter-only motors. (Efficiency Advocates, No. 32 at p. 3) They commented that inverter-only motors are highly efficient, and that a calculation-based method may reduce testing burden and facilitate adoption of pumps using these highly efficient motors. *Id.*

The CA IOUs supported inverter-only calculation methods discussed in the April 2022 NOPR for inverter-only pumps and added that the operating points are consistent with observations on field metered pump load profiles, operating speed assumptions, and other industry standards. (CA IOUs, No. 32 at p. 6) The CA IOUs also agreed that the proposed coefficients provide conservative calculation method results, which do not exceed wire-to-water measured performance and recommended DOE finalize the calculation method. *Id.* However, the CA IOUs stated that VFD to motor harmonic losses on the order of 30 percent is higher than standard practice or current generation products and indicated that they plan to submit data on this topic. *Id.* No such data were submitted.

While Grundfos stated that the method DOE used to determine these coefficients is reasonable, it suggested using the manufacturer interview process to obtain this information from specific manufacturers under both the motor and/or pump rules. (Grundfos, No. 31 at p. 6) Grundfos stated that it follows IEC 61800–9–2 for inverter-only motors and publishes combined motor and inverter efficiency. *Id.*

HI stated there is currently no standard methodology or specification for motor manufacturers to publish efficiency on the nameplate that includes motor and drive losses, and it is not typically available to pump manufacturers. (HI, No. 33 at p. 6) HI added that some manufacturers are measuring and publishing wire-to-shaft efficiency with inverter-only motors, but only when integrated by the manufacturer and this information may not be on the nameplate. *Id.*

HI commented that the coefficients proposed by HI in response to the April 2021 RFI added harmonic and VFD losses to the motor only losses as defined in IEC 60034–30–2, and that HI recommended using IE4 motor efficiencies (IEC 60034–30–1) as a default for the synchronous motors. (HI, No. 33 at p. 6) HI stated it understood that IEC 60034–30–1 provides tables for the motor only and IEC 60034–30–2 provides a calculation method to take IEC 60034–30–1 values and determine the motor efficiency on the drive by applying the incremental losses through calculation. *Id.* Additionally, HI responded that the coefficients proposed by DOE are different than proposed by industry since they start with a combined motor and VFD efficiency, and that this value is not available to pump manufacturers and there is no specification for manufacturers to publish these data. *Id.* HI recommended that instead of using a nameplate value that is not available to pump manufacturers, DOE (1) use the IE4 motor only efficiencies as defaults and specify standard math to add the VFD losses, or (2) start with IE4 motor only efficiencies and include the VFD losses in the coefficients as proposed by HI in the April 2021 RFI. *Id.*

NEEA supported the proposed calculation methodology for inverter-only synchronous motors, but recommended DOE consider an interim approach until these motors are covered by DOE regulations. (NEEA, No. 34 at p. 5) NEEA stated that it will take many years for the motors test procedure, should it proceed as written, to take effect and require testing of synchronous motors, and that this lag would cause confusion in the marketplace and stifle adoption of new technologies. *Id.* at 6. NEEA recommended that DOE incorporate by reference IEC 60034–2–3 until DOE has regulations covering these motors. *Id.* NEEA added that IEC 60034–2–3 is the most appropriate motors test procedure for calculating full load motor efficiency values, and the values do not include inverter losses, therefore producing reasonable full load motor efficiency values to be used with the values DOE proposed in Table III.2 of the pumps NOPR when calculation PER_{VL}.[34] *Id.* NEEA further recommended that incorporation of IEC 60034–2–3 should no longer apply when the motors are covered by DOE regulations. *Id.* NEEA stated that it had no test data with

[34] DOE notes that Table III.2 of the April 2022 NOPR included coefficients relative to motor + inverter efficiency, so it is not clear what NEEA's proposal is referring to.

which to evaluate the coefficients proposed in Table III.2 in the April 2022 NOPR, but supported the method used to determine the coefficients. *Id.*

NEEA additionally recommended that in the future, DOE consider test procedures and metrics that better account for motor and control performance at various load points. (NEEA, No. 34 at p. 5) NEEA stated that as more inverter-only and synchronous motors are developed and deployed, differentiating motor and control performance at part load points will become increasingly important. (NEEA, No. 34 at p. 7) NEEA noted that IE5-level motors can show more variability at part-load. *Id.* NEEA recommended that when IEC 61800–9–2 data are available, DOE consider revising the pumps test procedure to incorporate the specific losses at each load point as opposed to, or in addition to, the default loss curves. *Id.* NEEA stated this would allow manufacturers to showcase their improvements in efficiency and allow for more accurate representation of losses *Id.*

On October 19, 2022, following submission of comments to the April 2022 NOPR, DOE published a final rule regarding test procedures for motors (the ''Motors TP Final Rule''), which adopted a test procedure for inverter-only synchronous motors generally as proposed in accordance with IEC 61800–9–2:2017.87 FR 63588, 63659.

Since the adopted DOE test procedure for electric motors relies on motor and inverter efficiency, and beginning 180 days following publication of that test procedure, any representations of energy consumption for those inverter-only synchronous electric motors must be made in accordance with that test procedure, DOE has determined that it would not be appropriate to have a pumps test procedure that relies on motor only efficiency for these same motors. Instead, the pumps test procedure should rely on motor and inverter efficiency tested in accordance with the DOE electric motors test procedure, consistent with the existing test procedure for pumps sold with induction motors. As such, DOE is finalizing the pump test procedure as proposed in the April 2022 NOPR, to be based on motor and inverter efficiency rather than motor only efficiency. DOE acknowledges that there will be a period of time in which motor and inverter efficiency is not required to be published by motor manufacturers, however, DOE is also declining to develop an interim test procedure. This approach will limit potential deviation between interim ratings and any ratings post motor-standard, should one be finalized, which could cause market confusion, and will allow pump manufacturers to use motor and inverter data when available. Now that the DOE motors test procedure is final, there is more certainty in the market than there was at the time of the April 2022 NOPR, and motor manufacturers may choose to make representations early or upon request of their customers. DOE notes that many motor manufacturers are currently making representations regarding the energy efficiency of their inverter-only synchronous electric motors, and in order to continue doing so after the 180-day mark, those representations must be of motor and inverter efficiency in accordance with the DOE test procedure. Therefore, DOE expects such information to be relatively widely available. DOE is also finalizing an AEDM option for pumps, as discussed in section III.I.2. With this option, pump manufacturers may use their own calculation method, relying on any available data and coefficients they have, including potentially HI or NEEA's recommended approach, as long as such calculation meets the AEDM requirements, as discussed in section III.1.2. In addition, as DOE received no comment on the coefficients excluding the request to base them on motor-only efficiency, DOE is finalizing the coefficients as proposed.

b. Denominator for PEI Metric

In the April 2022 NOPR, DOE stated that the appropriate denominator for pumps sold with inverter-only synchronous electric motors is the same as for other pumps sold with motors with or without controls (*i.e.,* the efficiency standards for NEMA Design B motors in 10 CFR 431.25 is comparable to the PEI metric when comparing pumps across a common baseline). 87 FR 21268, 21298. Consequently, DOE did not propose a revision to the calculation of PER_{STD} for these pumps. *Id.*

DOE received no comments on this issue and is finalizing the denominator as proposed.

c. Applicability

In the April 2022 NOPR, DOE proposed that, to the extent that the calculation-based method would be applicable to pumps sold with synchronous electric motors that are inverter-only electric motors, such provision would apply to pumps sold with inverter-only synchronous electric motors both with and without controls. 87 FR 21268, 21299. DOE also proposed that pumps sold with inverter-only motors with or without controls would apply the testing-based approach in section VI of appendix A (for pumps sold with motors and controls) rather than in section IV of appendix A (for pumps sold with motors), given that section VI results in PEI_{VL}, and DOE assumed that such pumps, even if sold without an inverter, would be tested with an inverter. *Id.* DOE requested comment on its proposal to apply PEI_{VL} to pumps sold with inverter-only synchronous motors without controls, including application of the testing method in section VI of appendix A and the calculation method in section VII of appendix A. *Id.*

Grundfos agreed with the proposal. (Grundfos, No. 31 at p. 7) HI agreed with the proposal to apply PEI_{VL} ratings to pumps sold with inverter-only synchronous motors without controls, assuming they would use section VII of appendix A. (HI, No. 33 at p. 7) However, HI disagreed with section VII.A.2, ''Pumps sold with inverter-only synchronous electric motors regulated by DOE's energy conservation standards in subpart B of this part,'' stating that DOE should allow use of the calculation method using IE4 efficiency from IEC 60034–30–1, since most (if not all) synchronous inverter-only motors will meet the IE4 level. *Id.* HI also disagreed with sections V.A.2 and VII.A.3, ''SVIL pumps sold with small electric motors regulated by DOE's energy conservation standards at § 431.446 or with small non-small-electric-motor electric motors (''SNEMs'') regulated by DOE's energy conservation standards in subpart B of this part (but including motors of such varieties that are less than 0.25 hp) and continuous controls,'' stating that DOE should continue to allow use of the calculation method for non-DOE regulated small or SNEM motors as referenced in previous comments by creating coefficients specific to these motor types for section VII calculations. *Id.*

Based on the comments received, DOE is finalizing its proposal to apply PEI_{VL} to pumps sold with inverter-only synchronous motors without controls, including application of the testing method in section VI of appendix A and the calculation method in section VII of appendix A. DOE has addressed HI's concern with respect to their proposed IE4-based calculation method in section III.F.3.a of this document and discusses the concern regarding small or SNEM motors in section III.G of this document.

4. Pumps Sold With Submersible Motors

For pumps sold with submersible motors, the calculation of PER_{STD}, the test procedure for bare pumps, the calculation-based approach for pumps sold with motors, and the calculation-based approach for pumps sold with motors and controls all include reference to Table 2 of appendix A, which includes default nominal full-load submersible motor efficiency values. These motor efficiency values were developed to allow for pumps sold with submersible motors to be rated using calculation-based methods despite the fact that submersible motors are not included in DOE's current motor regulations. In the Motors TP NOPR, DOE proposed a test procedure for submersible motors based on section 34.4 of NEMA MG1–2016 with its 2018 Supplements. 86 FR 71725, 71749–71750. DOE noted in the April 2022 NOPR that it had not established energy conservation standards for submersible motors, and that were DOE to establish a test procedure for submersible motors, such motors would not be required to be tested according to the DOE test procedure until such time that compliance with any energy conservation standards that DOE may establish is required. 87 FR 21268, 21299.

In the April 2022 NOPR, DOE proposed that for the calculation-based approaches for submersible pumps sold with motors (with or without controls), for determination of PER_{CL} and PER_{VL}, the default efficiency values in Table 2 of appendix A would be used until compliance with an energy conservation standard for submersible motors is required, should such a standard be established. 87 FR 21268, 21299. At such time, calculation of the pump efficiency for submersible pumps would rely on the motor efficiency rating marked on the nameplate and tested in accordance with the relevant DOE test procedure. *Id.* DOE further proposed that if DOE finalized a test procedure for submersible pumps, prior to any required compliance with an energy conservation standard that DOE may establish for these pumps, a manufacturer may rely on the motor efficiency represented by the motor manufacturer, if such a representation were made, or the default values in Table 2 of appendix A. *Id.*

DOE also proposed in the April 2022 NOPR that when determining PER_{STD} using the calculation-based approach for bare pumps, before the compliance date of any future standards for submersible electric motors that publishes after January 1, 2021, the default efficiency values in Table 2 of appendix A would be used. 87 FR 21268, 21299–21300. After the compliance date of any standards for submersible electric motors that publishes after January 1, 2021, any standards applicable to submersible motors in appendix B of part 431 would be used. 87 FR 21268, 21300. DOE requested comment on its proposal for the calculation-based approach for pumps sold with submersible pumps to require use of the rated motor efficiency marked on the nameplate that has been tested in accordance with the relevant DOE test procedure after such time as compliance is required with an energy conservation standard for submersible motors, should such a standard be established. *Id.*

Grundfos commented that this approach would be in line with the current requirements for pump testing using DOE regulated product and agreed with the approach. (Grundfos, No. 31 at p. 7) However, Grundfos stated that Section 34.4 of NEMA MG1–2016 is an inadequate test procedure for submersible motors. *Id.*

HI responded that, consistent with its comments on the Motors TP NOPR, which stated that the proposed submersible motor test procedure was inadequate, it does not believe this language is warranted at this time. (HI, No. 33 at p. 7) Thus, HI recommended that no changes to the test procedure for pumps sold with submersible motors be made at this time. *Id.*

In the Motors TP Final Rule, DOE did not finalize a test procedure for submersible motors. 87 FR 63588, 63605. However, DOE notes that the proposed provision in the pumps test procedure relates to any future standards for submersible motors, and as Grundfos stated, the approach is in line with the current requirements for pump testing with motors covered by DOE. As such, DOE is finalizing the provision as proposed, noting that it will have no impact if and until a future motors rulemaking adopts a test procedure and/or standard for submersible motors.

G. Test Procedure for SVIL Pumps

In this final rule, DOE is expanding the scope of the test procedure to include SVIL pumps. DOE reviewed the general pumps test procedure as finalized in this rule to determine if any modifications were necessary to accommodate SVIL pumps. The amended test procedure is based on the test methods contained in HI 40.6–2021, which DOE has determined also applies to SVIL pumps.

As discussed in section III.F, the general pumps test procedure also contains methods to determine the appropriate PEI using either calculation-based methods or testing-based methods. DOE has determined that these calculation- and testing-based methods are applicable to SVIL pumps just as they are applicable to IL pumps, based on the configuration in which the pump is being sold (*i.e.,* since SVIL pumps are sold as pumps with motors or pumps with motors and controls, the test methods enumerated in Table 1 to Appendix A apply to SVIL pumps). Additionally, the determination of pump performance in the pumps test procedure, as amended in this final rule, would be appropriate for SVIL pumps.

1. Applicable Motor Regulations

The primary differences between SVIL and IL pumps affecting the application of DOE's general pumps test procedure are the size and certain characteristics of the motor with which the SVIL pumps are rated. DOE notes that SVIL pumps, which this final rule defines as pumps having shaft input power less than 1 hp, may be paired with motors that are less than 1 hp and, as such, are not subject to DOE's electric motor regulations specified at 10 CFR 431.25. However, some motors less than 1 hp are subject to DOE's small electric motor regulations specified at 10 CFR 431.446.

In the April 2022 NOPR, DOE stated that its motor regulations at 10 CFR 431.446 exclude totally enclosed fan-cooled electric motors (''TEFC'') and certain other motors considered to be non-general purpose motors, which pump manufacturers had noted are frequently paired with SVIL pumps. 87 FR 21268, 21301. DOE stated that in the Motors TP NOPR, it had proposed adding such motors to the scope of electric motors coverage under the term small non-small electric motor electric motors (''SNEMs''). Specifically, DOE proposed to define SNEMs as agnostic to enclosure and topology, affirmatively stating that the proposed test procedure would apply to general-purpose, definite-purpose, and special-purpose motors. As proposed, SNEMs would include fractional horsepower motors as low as 0.25 hp. 86 FR 71710, 71721–71725. The Motors TP NOPR also proposed testing instructions specific to these motors. 86 FR 71710, 71739. DOE noted that it had not established energy conservation standards for SNEMs, and that were DOE to establish a test procedure for SNEMs, such motors would not be required to test according to the DOE test procedure until such time as compliance with any energy conservation standards be required, should such standards be established. Under DOE's Motors TP NOPR, any definitions, test procedures, and standards finalized for SNEMs would be in found in subpart B of part 431. 87 FR 21268, 21301.

In the April 2022 NOPR, DOE stated that it expected that the proposed definition and test procedure for SNEMs, as well as the proposed test procedure for inverter-only synchronous electric motors, as discussed in section III.F.3, would encompass the additional types of motors discussed by stakeholders that are not currently covered by the standards at 10 CFR 431.446. Therefore, DOE proposed that where the calculation-based test methods refer to the ''represented nominal full-load motor efficiency (*i.e.,* nameplate/DOE-certified value),'' the nominal full-load motor efficiency for an SVIL pump would be determined in accordance with the applicable test procedure in 10 CFR 431.444 or in subpart B of part 431.87 FR 21268, 21301.

DOE also proposed that for SVIL pumps, the determination of PER_{STD} would reference DOE's small electric motor regulations at 10 CFR 431.446 rather than the electric motor regulations at 10 CFR 431.25, and would be the minimum efficiency of the energy conservation standards for polyphase or single-phase (CSIR/CSCR) for the relevant number of poles and motor horsepower. 87 FR 21268, 21301. The single-phase standards only apply to CSCR and CSIR but the proposal would apply the efficiency values found at 10 CFR 431.446 when determining an SVIL pump's PER_{STD}. *Id.* DOE stated that it believed that these values represent an appropriate default for the SVIL market. *Id.* DOE also stated that it would also consider application of efficiency values found for specific SNEMs in subpart B of part 431, if the relevant proposed amendments contained in the Motors TP NOPR were finalized. *Id.* DOE stated that its information did not indicate that SVIL pumps are sold as bare pumps, but that if stakeholders identify such models, DOE would include these same provisions in the calculation method for bare pumps. *Id.*

DOE sought comment on whether the efficiency standards found at 10 CFR 431.446 are appropriate for use in the determination of PERSTD for SVILs, whether certain motor topologies that would be classified as SNEM are more prevalent and significantly less efficient, and whether the minimum efficiency of the polyphase and CSCR/CSIR standards for the relevant number of poles and motor horsepower is appropriate or whether there should be differences depending on the phase of the motor with which the pump is sold. 87 FR 21268, 21301.

HI and Grundfos stated that motor efficiencies found in 10 CFR 431.446 are not the lowest for topologies used in SVIL pumps and are inappropriate for determining PER_{STD} for SVIL products. (HI, No. 33 at p. 7; Grundfos, No. 31 at p. 7) HI and Grundfos stated that DOE must create a minimum efficiency table, similar to that created for submersible motors, to capture the minimums across the motor sizes covered by the SVIL products. *Id.*

NEEA supported DOE's recommendation for the test procedure for SVILs, but stated that they were concerned that the SNEM rulemaking will not conclude in sufficient time to allow for incorporation of those test procedures and standards into this rulemaking, creating a gap during which manufacturers would not have a calculation-based approach. (NEEA, No. 34 at p. 5) NEEA recommended that DOE add an additional calculation-based approach for SVIL pumps sold with motors not covered by the motors standard or test procedure at 10 CFR 431.446. *Id.* NEEA recommended that DOE embed a calculation approach for SVILs that uses IE2 efficiency levels to determine full load motor efficiency, as described in IEC 60034–30–1. *Id.* NEEA stated that these values are appropriate because the motors are not currently covered by a standard, so a conservative value would use an efficiency level below the standard for covered motors of similar sizes, and would not disadvantage manufacturers that choose to wire-to-water test equipment. *Id.* NEEA stated that once any motor TP or standard is in place and covering additional motor types, the embedded calculation-based methodology would no longer be valid. *Id.*

Following receipt of comments, DOE published the Motors TP final rule, which adopted a test procedure for SNEMs in appendix B to subpart B of part 431.87 FR 63588, 63657–63660. However, DOE has yet to adopt any energy conservation standards for SNEM. As a result, there are not currently minimum efficiency values for SNEMs on which DOE could base the calculation of PER_{STD} for SVIL.

DOE acknowledges that in the proposed approach, SVIL paired with SNEM may have worse PER ratings than SVIL paired with small electric motors (''SEM''), given that some SNEMs currently have lower efficiency that DOE's minimum requirements for SEMs. However, this is representative of the energy use of such an SVIL. In addition, DOE notes that the test procedure does not set a standard for SVIL, and that any calculated PER_{STD} is just a reference point. If or when DOE considers setting standards for SVIL, DOE may consider a PEI other than 1.00 as appropriate for this equipment category—depending on the timing and finalization of any DOE standards related to SNEM, and the relationship of SNEM to SEM minimum efficiency. Therefore, HI and Grundfos' concern regarding the lower efficiency of SNEM as compared to SEM can be ameliorated. DOE acknowledges that motor manufacturers will not be required to publish full-load motor efficiency for a given SNEM until the compliance date of any standards for SNEM. However, DOE is declining to develop an interim approach as suggested by NEEA, and is adopting the provisions for motor efficiency in SVIL calculations as proposed. As discussed regarding inverter-only motors in section III.F.3, this approach will limit potential deviation between interim ratings and ratings post motor-standard, if any, which could cause market confusion, and will allow manufacturers to use SNEM motor efficiency when available. Now that the DOE motors test procedure is final, there is more certainty in the market than there was at the time of the April 2022 NOPR, and motor manufacturers may choose to make representations in accordance with the DOE test procedure early such as at the request of customers, or if they are already making representations of energy use or energy efficiency and wish to continue doing so past the 180 day mark following publication of the DOE motors test procedure. DOE is also finalizing an AEDM option for pumps, as discussed in section III.I.2 of this document. With this option, pump manufacturers may use their own calculation method, relying on any available data and coefficients they have, including potentially NEEA's recommended approach, as long as such calculation meets the AEDM requirements, as discussed in section III.1.2.

Since the April 2022 NOPR, DOE has also determined through manufacturer interviews that a small percent of pumps are sold as bare pumps. Therefore, DOE is adopting the same provisions relevant to SVIL in the calculation method for bare pumps.

2. SVIL Paired With Motors Less Than 0.25 Horsepower

In the April 2022 NOPR, DOE stated that its market research indicates that the vast majority of SVILs are sold with motors with a nominal horsepower of 0.25 hp or greater. 87 FR 21268, 21301. However, DOE identified some models with horsepower closer to 0.125 hp. *Id.* Such motors are not subject to the standards in 10 CFR 431.446 and are not proposed to be subject to any test procedure in the Motors TP NOPR. *Id.*

DOE proposed that for determination of PER_{STD} for SVILs sold with a motor nominal horsepower of less than 0.25 hp, the full-load efficiency values in Table III.3 would be used. *Id.* DOE scaled these values from the standards for 0.25 hp pumps (3.9 efficiency point decrease, comparable to the most common decrease from 0.33 to 0.25 hp) and taken the minimum value across polyphase and CSCR/CSIR motors. *Id.* DOE also proposed that the nominal full-load motor efficiency for SVILs would be determined in accordance with the applicable test procedure in 10 CFR 431.444 or in subpart B of part 431, although such test procedure is not required for those motors. *Id.* DOE stated that it may consider alternate methods of determining motor efficiency for motors less than 0.25 hp, or if there is no appropriate test procedure, DOE may consider requiring SVILs sold with such motors to use a testing-based approach. *Id.* DOE sought comment on: (1) how many models of SVILs are sold with motors with a nominal horsepower less than 0.25 hp, (2) whether such motors could be tested in accordance with the relevant test procedures in 10 CFR 431.446 or proposed in the Motors TP NOPR, and if not, how such motors are tested, and (3) whether the efficiency values in Table III.3 are appropriate for such motors, and if not, how those values should be determined. *Id.*

TABLE III.3—AVERAGE FULL LOAD EFFICIENCY FOR SVILS LESS THAN 0.25 HP

Motor horsepower	Average full-load efficiency		
	Open motors (number of poles)		
	6	4	2
<0.25	58.3	64.6	61.7

Grundfos stated that SVIL sales data was provided as part of the manufacturer interview process. (Grundfos, No. 31 at p. 7–8) For testing of motors, Grundfos suggested DOE implement the process the EU follows by publishing coefficients for these motors and allowing for development of manufacturer specified coefficients, where required. *Id.* Grundfos stated that Table III.3 using a 3.9 percent decrease is insufficient and again recommended that DOE create a minimum efficiency table like that for submersible motors. *Id.*

HI recommended that DOE reference manufacturer interviews with regard to sales data. (HI, No. 33 at p. 7) HI did not agree with DOE's methodology for Part 3 and the limited topologies used in the scaling. *Id.* HI noted that this approach misses less efficient motor topologies that are selected because the product's market price point. *Id.*

China stated that DOE did not specify the number of motor phases applicable to SVILs less than 0.25 hp, and suggested that DOE clarify the phase requirement for these motors and set up separate energy efficiency indicators for motors with different phase numbers. (China, No. 29 at p. 4)

Given that DOE is adopting the efficiencies found in 10 CFR 431.446 as discussed in section III.G.1, and for the reasons discussed in that section, DOE is also adopting the proposed efficiencies derived from those values as shown in Table III.3. This will allow the ratings for SVIL with motors less than 0.25 hp to be rated consistently with SVIL with larger motors.

DOE notes that neither Grundfos nor HI explicitly stated whether such motors could be tested in accordance with the relevant test procedures in 10 CFR 431.446 or proposed in the Motors TP NOPR. Grundfos suggested that DOE publish coefficients and allow for manufacturer specified coefficients, where necessary. (Grundfos, No. 31 at p. 7–8) DOE does not have data available with which to develop default efficiency values for these motors. In addition, DOE notes that manufacturers have the ability to develop their own coefficients using an AEDM approach, as discussed in section III.I. For this reason, DOE is adopting its proposal that the nominal full-load motor efficiency for SVILs would be determined in accordance with the applicable test procedure in 10 CFR 431.444 or in subpart B of part 431. DOE notes that if this value is not available, manufacturers may choose to wire-to-water test and/or to use an AEDM.

In response to China, the test procedure proposed in the April 2022 NOPR and adopted in this final rule does not restrict the number of phases for motors paired with SVILs.

3. SVIL Paired With Other Motors Not Covered by DOE Regulations

In the April 2022 NOPR, DOE stated that it expected that the existing regulations for small electric motors at 10 CFR 431.446, as well as any finalized regulations for SNEMs and inverter-only synchronous electric motors, would account for the vast majority of motors sold with SVIL pumps. 87 FR 21268, 21302. However, DOE proposed that any SVIL pumps that are distributed in commerce with motors that are not regulated by DOE's electric motor regulations at 10 CFR 431.25, DOE's small electric motor regulations at 10 CFR 431.446, or any electric motor regulations in subpart B to part 431 established after January 1, 2022, as applicable, would need to apply the testing-based methods currently specified in sections IV and VI of appendix A and as proposed to be modified in the proposed rule. *Id.* Given that DOE proposed for PER_{STD} to reference motor efficiencies relevant to SVIL pumps, DOE proposed not to have an option for SVIL pumps sold with single-phase motors to be rated as bare pumps. *Id.*

If regulations for SNEMs and inverter-only synchronous electric motors are not set, DOE stated that it may consider allowing an option for SVIL pumps sold with single-phase motors to be rated as bare pumps. In this case, DOE would reference the efficiency values in 10 CFR 431.446 to determine bare pump performance. 87 FR 21268, 21302.

DOE sought comment on its proposal to require testing of SVIL pumps distributed in commerce with motors not regulated by DOE's current electric motor regulations or any motor regulations finalized after January 1, 2022. 87 FR 21268, 21302. DOE also sought comment on whether it should allow such pumps to be rated as bare pumps only if any motor regulations finalized after January 1, 2022, do not include SNEMs and inverter-only synchronous electric motors. *Id.*

Grundfos stated that DOE should consider the impact of this mandatory testing-based approach if motor regulations are not finalized for motors used in SVIL products. (Grundfos, No. 31 at p. 8) Grundfos added that the testing burden would exceed the burden the inverter-only calculation method was created to eliminate, due to the basic model 'band rule' and varying motor topologies used in SVIL. *Id.*

HI disagreed with sections V.A.2 and VII.A.3 and recommended that DOE should continue to allow the calculation method for non-DOE regulated small, SNEM motors, or inverter-only motors by creating coefficients specific to these motor types for Section VII calculation. (HI, No. 33 at p. 8)

Following comments received on the April 2022 NOPR, DOE published the Motors TP Final Rule, which adopted test procedures for SNEM and inverter-only synchronous motors in Appendix B to Subpart B of part 431. 87 FR 63588, 63657–63660. At the time of publication of this final rule, DOE has not adopted any energy conservation standards for SNEM or inverter-only synchronous motors. As discussed, DOE believes that the test procedures for SEM, SNEM, and inverter-only synchronous motors would account for the vast majority of motors sold with SVIL pumps. For this reason, DOE adopts its proposal to limit the calculation methods to SVIL sold with motors subject to a DOE test procedure, and to require testing of SVIL pumps distributed in commerce with motors not regulated by DOE's current electric motor regulations or any motor test procedure and/or energy conservation standards finalized after January 1, 2022. DOE notes that such SVIL pumps could also be rated using an AEDM, as discussed in section III.I of this document.

4. Part-Load Loss Curves

As stated in section III.F.1, the general pumps test procedure includes calculation-based methods that specify part-load loss curves for pumps sold with motors, accounting for the part-load losses of the motor at each load point, as well as part-load loss curves for pumps sold with motors and continuous controls, which account for additional losses.

In the April 2022 NOPR, DOE stated that it understood that part-load loss curves (*i.e.,* the variation in efficiency as a function of load) do not vary significantly between 1 hp motors and drives and motors and drives that are less than 1 hp. 87 FR 21268, 21302. DOE stated that it did not receive any newer data or any indication that the SVIL market has changed such that data collected in 2017 would no longer be applicable. *Id.* DOE did not propose to revise its part-load loss curves for motors and drives less than 5 hp. Therefore, DOE proposed to apply the existing motor and combined motor and drive part-load loss curves that are applicable to 1 hp motors and drives to the fractional horsepower motors and drives with which SVIL pumps may be sold. *Id.* DOE noted that IEC standards do not include motors below ¾ kw (1 hp), and that many SVIL pumps may use integrated packages rather than separate motors and drives—and may be specific to each manufacturer. *Id.* Consequently, there may be more variation in losses across manufacturers or models compared to larger hp motors and drives. *Id.* As discussed in section III.I.2, DOE proposed to allow use of AEDMs for pumps. DOE stated that in cases where a manufacturer wishes to use an alternative to the part-load loss coefficient method, it may choose to perform wire-to-water testing of SVILs or employ an AEDM under DOE's proposal. *Id.*

DOE sought comment on whether the market for SVIL pumps has changed such that the data collected by DOE in 2017 would no longer be applicable, and whether the use of AEDM would address concerns related to part-load loss curves specific to low-horsepower motors. 87 FR 21268, 21302.

Grundfos stated that data was submitted as part of the manufacturer interview process. (Grundfos, No .31 at p. 8) Grundfos added that because the calculated method should remain, allowing AEDM will not solve the issue of part-load loss curves for SVIL products in the short term. *Id.*

HI did not believe the market has changed since 2017, but suggested that DOE consider manufacturer interviews. (HI, No. 33 at p. 8) HI recommended that DOE conduct research on the part load loss factors for these lower horsepower motors to inform the calculation method. *Id.* HI stated that the use of AEDM to improve the part load loss calculation would increase burden compared to a calculation method. *Id.*

NEEA recommended that DOE rely on market data already in its possession from previous rulemaking proceedings. (NEEA, No. 34 at p. 5) NEEA stated that this data, made public in 2017, is recent enough that it represents the current market for this pump class. *Id.* NEEA stated that considering the viability of DOE's data and similarity to covered pump classes, there is no reason to delay this rulemaking further with an additional round of data acquisition and analysis. *Id.* NEEA recommended that DOE proceed with data from 2017. *Id.*

DOE has not received any additional data indicating that the part-load loss curves for SVIL with motors less than 1 hp should be any different than those for SVIL paired with1 hp motors. Therefore, DOE is finalizing the part-load loss curve as proposed, consistent with NEEA's suggestion. Regarding HI and Grundfos' concern with the added burden of an AEDM as compared to a calculation approach, as discussed previously, an AEDM could be as simple as the calculation method that includes different part load loss coefficients. If such data are available to manufacturers, there should be no additional burden. If such data are not available, manufacturers can rely on the calculation method.

H. Test Procedure for Other Expanded Scope Pumps

DOE has evaluated the amended test procedure as proposed in the April 2022 NOPR to determine if modifications are necessary to accommodate RSH, and VT pumps, pumps designed to operate with 6-pole induction motors, and pumps designed to operate with non-induction motors with an operating range greater than or equal to 960 rpm and less than 1,440 rpm (''pumps tested with a nominal speed of 1,200 rpm''). 87 FR 21268, 21302–21303.

1. Testing Other Expanded Scope Pumps to HI 40.6

In the April 2022 NOPR, DOE tentatively determined that the amended test procedure is applicable to BB, RSH, and VT pumps, as well as to pumps tested with a nominal speed of 1,200 rpm for determining pump performance. 87 FR 21268, 21302. As discussed in section III.C.1, DOE is updating its test procedure to reference HI 40.6–2021. In the April 2022 NOPR, DOE requested comment on its proposed test procedure for BB, RSH, and VT pumps. 87 FR 21268, 21303. Grundfos agreed that the proposed test procedure for BB, RSH, and VT pumps is appropriate. (Grundfos, No. 31 at p. 8) HI commented that, in general, BB, RSH, and VT pumps can be tested using HI 40.6–2021 without modification. (HI, No. 33 at p. 1, 8) HI also commented that HI 40.6–2021 is fully applicable to VS1 and VS3 [35] pump types. (HI, No. 33 at pp. 2–3) HI stated that in general, for any discharge through column pump, DOE must focus on bowl or pump efficiency that excludes the column friction losses and line-shaft bearing losses. *Id.*

China recommended that DOE use the current test procedure for testing RSH pumps since RSH pumps work similarly to RSV pumps. (China, No. 29 at p. 4) DOE interprets the comment from China to mean that the test procedure for RSV pumps should be identical to that for

[35] VS1 and VS3 pumps are HI pump categories that meet the DOE definition of a vertical turbine pump.

RSH pumps, which is consistent with DOE's proposal in the April 2022 NOPR.

The CA IOUs and China agreed that HI 40.6–2021, as written, can be used to test between bearing pumps. (CA IOUs, No. 32 at p. 3; China, No. 29 at p. 4) HI explained that there are two industry definitions for determining specific speed that potentially apply to BB pumps. (HI, No. 33 at p. 1) HI encouraged DOE to clarify in its data gathering for BB pumps that BEP flow rate used to determine specific speed for double-inlet impellers products is calculated using BEP flow divided by 2. *Id.* Further, HI stated that BB1 pumps are not as abundant as other in-scope pumps, and there will be limited samples available for testing of basic models. *Id.*

DOE acknowledges that VT pumps are sold in many configurations, making it unrealistic to consider all potential shaft depths during testing. To clarify DOE's intent and to reduce unnecessary test burden, DOE is therefore revising the test procedure language proposed in the April 2022 NOPR to explicitly state that when testing VT pumps, only the bowl performance should be measured, as specified in section 40.6.4.1 of HI 40.6–2021.

Since DOE is not including BB pumps in the scope of this test procedure, DOE is not adopting any changes to the calculation of specific speed.

Aside from the minor revisions discussed in the preceding paragraphs, DOE is adopting the remainder of the test procedures for RSH, and VT pumps, as well as to pumps tested with a nominal speed of 1,200 rpm as proposed in the April 2022 NOPR.

2. Testing Other Expanded Scope Pumps With Motors

As discussed in section III.F, the pumps test procedure contains methods for determining PEI using either a calculation-based or a testing-based method. In the April 2022 NOPR, DOE tentatively determined that these calculation- and testing-based methods are applicable to BB, RSH, and VT pumps, as well as pumps tested with a nominal speed of 1,200 rpm and would be applied in the same way that they are applied to other pumps. DOE understands that the motors paired with BB, RSH, and VT pumps are typically similar to those paired with pumps that are currently in scope. 87 FR 21268, 21302. As such, DOE tentatively determined that Table 1 and the relevant test and calculation options are appropriate for these expanded scope pumps and that no modifications are needed. 87 FR 21268, 21303.

In the April 2022 NOPR, DOE requested comment on whether motors typically sold with BB, RSH and VT pumps are subject to DOE's electric motor standards. 87 FR 21268, 21303. *See* 10 CFR 431.25. In response, HI agreed that the motors sold with BB, RSH, and VT pumps are currently regulated motors, and that Table 1 with relevant calculation and testing options are appropriate. (HI, No. 33 at p. 8).

DOE has determined that Table 1 and the relevant test and calculation options as adopted in this final rule are appropriate for these expanded scope pumps.

In the April 2022 NOPR DOE tentatively determined that the existing test procedure references to 10 CFR 431.25 for nominal full load motor efficiencies are appropriate for 6-pole motors since 10 CFR 431.25 includes efficiencies for 6-pole motors. 87 FR 21268, 21303. Additionally, DOE determined that the part-load loss factors in Table 4 of appendix A, as proposed in the April 2022 NOPR are appropriate. *Id.* As a result, DOE did not propose to revise these references and part load loss factors.

The current DOE test procedure references Table 2 of appendix A for determining default full load submersible motor efficiencies. Table 2 does not currently provide default full load submersible motor efficiencies for 6-pole motors. In the April 2022 NOPR, DOE proposed to expand Table 2 to include such values. 87 FR 21268, 21303.

DOE requested comment on its proposed default submersible motor efficiency values for 6-pole motors in the April 2022 NOPR. 87 FR 21268, 21303. In response, HI stated it does not have sufficient data to provide a response since the number of 6-pole ST pumps sold is very small and it does not expect that regulating 6-pole ST pumps will result in any measurable energy savings (HI, No. 33 at p. 8).

DOE did not receive any alternative 6-pole motor coefficients or data to support the development of 6-pole submersible motor coefficients. As such, DOE is adopting the 6-pole submersible motor coefficients as proposed in the April 2022 NOPR. As discussed in section III.F.3, Table 2 may be replaced with energy conservation standard values for submersible motors if such standards are ever developed and adopted.

DOE acknowledges that ST pumps that use 6-pole motors are not common; however, to ensure consistent coverage across ST pump families, prevent potential loopholes, and provide consumers with information to compare the performance of these pumps, DOE is including them in the scope of this test procedure. DOE will evaluate potential energy savings in the ongoing pumps energy conservation standards rulemaking.

I. Sampling Plan, AEDMs, Enforcement Provisions, and Basic Model

1. Sampling Plan for Determining Represented Values

DOE currently provides sampling plans for all covered equipment that manufacturers must use when certifying their equipment as compliant with the relevant standards and when making written representations of energy consumption and efficiency. (*See generally* 10 CFR parts 429 and 431) In the April 2022 NOPR, DOE stated that SVIL, RSH, VT, and BB pumps are expected to have the same testing uncertainty and manufacturing variability as IL, RSV, ST and end-suction pumps, respectively, since they are similar in construction and design and would apply the same test procedure under DOE's proposal. 87 FR 21268, 21303. Additionally, DOE discussed in the April 2022 NOPR that it expects pumps tested at a nominal speed of 1,200 rpm would have the same testing uncertainty and manufacturing variability as pumps that are currently regulated and tested at nominal speeds of 1,800 rpm and 3,600 rpm. *Id.*

In the April 2022 NOPR, DOE requested comment on whether SVIL, BB, RSH, VT, and pumps tested at a nominal speed of 1,200 rpm have the same testing uncertainty and manufacturing variability as currently regulated pumps. 87 FR 21268, 21303. DOE also requested comment on its proposal to adopt the same statistical sampling plans which are currently in place for commercial industrial pumps for SVIL, BB, RSH, VT, and pumps tested at a nominal speed of 1,200 rpm. *Id.*

HI and Grundfos agreed that testing uncertainty and manufacturing variability are similar for expanded-scope pumps and for those currently in scope, and that it is reasonable to adopt the same statistical sampling plans for the expanded-scope pumps. (HI, No. 33 at p. 8; Grundfos, No. 31 at p. 8)

In this final rule, DOE is adopting the statistical sampling plans for expanded-scope pumps (*i.e.,* SVIL, RSH, VT, and 1,200 rpm pumps) as proposed in the April 2022 NOPR.

For purposes of certification testing, determining whether a basic model complies with the applicable energy conservation standard is based on testing using the DOE test procedure and sampling plan. The general sampling requirement currently applicable to all covered products and equipment provides that a sample of sufficient size must be randomly selected and tested to ensure compliance and that, unless otherwise specified, a minimum of two units must be tested to certify a basic model as compliant. 10 CFR 429.11. This minimum is implicit in the requirement to calculate a mean—an average—that requires at least two values. However, if only one unit of a basic model is produced, that single unit must be tested, and the test results must demonstrate that the basic model performs at or better than the applicable standards. *Id.* Subsequently, if one or more units of the basic model are manufactured, compliance with the default sampling and representations provisions is required. *Id.*

In the April 2022 NOPR, DOE proposed to expand the requirements in 10 CFR 429.11 to SVIL, BB, RSH, VT, and 1,200 rpm pumps. 87 FR 21268, 21303. DOE discussed that manufacturers may need to test a sample of more than two units depending on the variability of their sample, as provided by the statistical sampling plan. *Id.*

Additionally, the current certification requirements state that other performance parameters derived from the test procedure must be reported, but provides no sampling plan for these other parameters, which include: pump total head in feet at BEP and nominal speed, volume per unit time (*i.e.,* flow rate) in gallons per minute at BEP and nominal speed, and calculated driver power input at each load point (*i.e.,* corrected to nominal speed in horsepower). 10 CFR 429.59(b)(2).

Regarding representative values other than PEI and PER, DOE proposed in the April 2022 NOPR that if more than one unit is tested for a given sample, represented values (other than PEI and PER) would be determined using the arithmetic mean of the individual units. 87 FR 21268, 21303. For example, if three units are tested for a given sample, and pump total head at BEP is measured at 99.1 ft, 96.2 ft, and 97.3 ft, the reported values for head would be the sum of the three values divided by three (*i.e.,* 97.5 ft). *Id.* This proposal applied to both the existing and proposed expanded scope of pumps that would be addressed by the pumps test procedure. *Id.*

In the April 2022 NOPR, DOE requested comment on its proposed statistical sampling procedures and representation requirements for SVIL, BB, RSH, VT, and 1,200 rpm pumps. 87 FR 21268, 21303. Grundfos agreed with the proposal. (Grundfos, No. 31 at p. 9) HI stated that 1,200 rpm pumps will take longer and cost more to manufacture and test since they are physically larger pumps. (HI, No. 33 at p. 8) HI additionally commented that two samples will not be available for test in many cases, in which case published data will be the result of a single sample. (HI, No. 33 at p. 8) As discussed previously, the language in 10 CFR 429.11 addresses the sampling plan for a basic model when only a single sample is available for test. Further, as discussed in section III.I.2, DOE is adopting AEDM provisions that allow a pump manufacturer to certify basic models, including low-volume basic models, using a validated AEDM.

In this final rule, DOE is adopting the statistical sampling procedures and representation requirements for SVIL, RSH, VT, and 1,200 rpm pumps as proposed in the April 2022 NOPR. Since DOE is not including BB pumps in the scope of this test procedure, DOE is not adopting statistical sampling procedures for them.

2. Alternative Efficiency Determination Methods

Pursuant to the requirements of 10 CFR 429.70, DOE may permit use of an AEDM in cases where actual testing of regulated equipment may present considerable burdens to a manufacturer and use of that AEDM can reasonably predict the equipment's energy efficiency performance. Although specific requirements vary by product or equipment, use of an AEDM entails development of a mathematical model that estimates energy efficiency or energy consumption characteristics of the basic model, as would be measured by the applicable DOE test procedure. The AEDM must be based on engineering or statistical analysis, computer simulation or modeling, or other analytic evaluation of performance data. A manufacturer must validate an AEDM by demonstrating that its predicted efficiency performance of the evaluated equipment agrees with the performance as measured by actual testing in accordance with the applicable DOE test procedure. The validation procedure and requirements, including the statistical tolerance, number of basic models, and number of units tested vary by product.

Once developed, an AEDM may be used to represent the performance of untested basic models in lieu of physical testing. Use of an AEDM for any basic model is optional. One potential advantage of an AEDM is that it may free a manufacturer from the burden of physical testing—but this advantage must be weighed against the potential risk that an AEDM may not perfectly predict performance and could result in a finding that the equipment has an invalid rating and/or that the manufacturer has distributed a noncompliant basic model. The manufacturer, by using an AEDM, bears the responsibility and risk of the validity of the ratings, including cases where the manufacturer receives and relies on performance data for certain components from a component manufacturer.

Given stakeholder requests for the calculation methods to be more representative, and to balance the risk of allowing overrating through calculation methods, DOE proposed allowing manufacturers to use AEDMs to determine performance ratings for pumps in the April 2022 NOPR. 87 FR 21268, 21304. DOE requested feedback regarding all aspects of its proposal to permit use of an AEDM for pumps. 87 FR 21268, 21305. DOE specifically sought comment on its proposed validation classes, and whether groupings should be considered where performance variation between two equipment classes or nominal speeds is well established. *Id.* In addition, DOE requested comment on whether the calculation-based methods would still be necessary if manufacturers were permitted to use AEDMs in addition to physical testing. *Id.*

In the NOPR public meeting, ebm-pabst asked if it is possible to keep AEDM information proprietary between the manufacturer and DOE or if it would be public knowledge. (ebm-pabst, Public Meeting Transcript, No. 35 at p. 41) DOE notes that AEDM information provided to DOE is not publicly available.

In response to the April 2022 NOPR, HI and Grundfos supported the use of AEDMs. (HI, No. 33 at p. 9; Grundfos, No. 31 at p. 9) However, HI and Grundfos encouraged DOE to maintain the current calculation option since they believe it is less burdensome than an AEDM. *Id.* HI and Grundfos further stated that DOE should consider removing the calculation methods only when AEDMs are being used by all manufacturers for all reporting. *Id.* Additionally, HI and Grundfos expressed general agreement with the proposed validation classes. *Id.*

The Efficiency Advocates commented that the calculation-based approach in the DOE test method and AEDMs proposed by DOE can be used in lieu of physical testing to help mitigate the burden of testing the larger pumps. (Efficiency Advocates, No. 30 at p. 3)

In this final rule, DOE is adopting provisions in 10 CFR 429.59(i) that allow the use of AEDMs for pumps as proposed in the April 2022 NOPR. Additionally, DOE is maintaining the calculation methods in the test procedure.

3. Enforcement Provisions

Enforcement provisions govern the process DOE would follow when performing an assessment of basic model compliance with standards, as described under subpart C of part 429. Specifically, subpart C of part 429 describes the notification requirements, legal processes, penalties, specific prohibited acts, and testing protocols related to testing covered equipment to determine or verify compliance with standards.

In the April 2022 NOPR, DOE proposed to apply the same general enforcement provisions contained in subpart C of part 429 to the proposed expanded scope of pumps. 87 FR 21268, 21305. Additionally, DOE proposed in the product-specific enforcement provisions in 10 CFR 429.134(i) that DOE will test each pump unit according to the test method specified by the manufacturer, and if the model of pump unit was rated using an AEDM, DOE may conduct enforcement testing using either a testing approach or calculation approach. *Id.*

In the April 2022 NOPR, DOE requested comment on its enforcement provision proposals. 87 FR 21268, 21305. In response, Grundfos agreed with the proposal but stated that DOE needs to clearly state that enforcement for AEDM reported products will apply the AEDM tolerances. (Grundfos, No. 31 at p. 9) Similarly, HI agreed with the standard enforcement requirements in 10 CFR 429, subpart C for expanded scope pumps but suggested the following modification to clause ii: DOE will test each pump unit according to the test method specified by the manufacturer in the certification report submitted pursuant to § 429.59(b); if the model or pump unit was rated using an AEDM, DOE may use either a testing approach or calculation approach using the basic model tolerances found at 429.70(i)(2)(ii). (HI, No. 33 at p. 9)

In response to the comments from HI and Grundfos, DOE notes that an AEDM is a mathematical model that a manufacturer develops to accurately represent the tested performance of a specific pump validation class. To validate an AEDM, the manufacturer must test at least two basic models within a given validation class (*see* 10 CFR 429.70(j)(2)(i)). If the PEI calculated by the AEDM is no more than five percent less than the tested PEI, the AEDM has been validated (*see* 10 CFR 429.70(j)(2)((ii)). If the PEI calculated by the AEDM is more than five percent less than the tested PEI, the AEDM is not validated and will need to be revised and compared to tested results until it is not more than five percent less than the tested PEI. For example, if tested PEI is equal to 1.0 and AEDM results are 0.97, the AEDM would be considered valid; however, if tested PEI is equal to 1.0 and AEDM results are 0.94, the AEDM is not valid. When certifying basic models through testing, DOE specifies the determination of represented value in 10 CFR 429.59(a). When determining representations for basic models using an AEDM, it is the manufacturer's responsibility to ensure that the represented value is consistent with the requirements in 10 CFR 429.59(a).

The previous paragraph addresses manufacturer responsibilities, specifically validation of an AEDM and represented values. DOE is also adopting provisions at 10 CFR 429.70(j)(5) to describe how DOE may conduct testing on individual pump models to verify basic model compliance with an energy consumption standard. DOE emphasizes that this compliance enforcement is separate and distinct from manufacturer certification requirements. 10 CFR 429.7(j)(5)(v) specifies that the result of a DOE verification test must be less than or equal to the certified rating multiplied by (1 + the applicable tolerance), where the applicable tolerance is 5 percent (*see* Table 4 to paragraph (j)(5)(vi)). Therefore, if results of an individual model tested by DOE are greater than 1.05 percent of a manufacturer's certified rating (*i.e.,* the value the manufacturer certifies to DOE), this model's certified rating would be invalid, and DOE would pursue the actions listed in 10 CR 429.70(j)(v). For example, if a manufacturer were to certify a pump basic model with a PEI equal to 0.94 and DOE testing yields a PEI of 0.97, DOE would consider the model to meet its certified rating, since 0.97 is less than 1.05 percent of the certified PEI value of 0.94 (1.05 multiplied by 0.94 is 0.987). However, if DOE testing were to yield a PEI of 0.99, DOE would consider the model's certified rating to be invalid.

In sum, DOE is adopting the five percent tolerance for both AEDM validation and AEDM verification testing. DOE is also adopting product-specific enforcement provisions at 10 CFR 429.134 to specify that DOE will test each pump unit according to the test method specified by the manufacturer, and for pumps rated using an AEDM, DOE may conduct enforcement testing using either a testing approach or calculation approach.

4. Basic Model Definition

As discussed in the April 2022 NOPR, pump manufacturers may elect to group similar individual pump models within the same equipment class into the same basic model to reduce testing burden, provided all representations regarding the energy use of pumps within that basic model are identical and based on the most consumptive unit. 87 FR 21268, 21305. Accordingly, manufacturers may pair a given bare pump with several different motors (or motor and controls) and can include all combinations under the same basic model if the certification of energy use and all representations made by the manufacturer are based on the most consumptive bare pump/motor (or motor and controls) combination for each basic model and all individual models are in the same equipment class. 86 FR 20075, 20083–20084.

In the case of pumps, ''*basic model*'' means all units of a given class of pump manufactured by one manufacturer, having the same primary energy source, and having essentially identical electrical, physical, and functional (or hydraulic) characteristics that affect energy consumption, energy efficiency, water consumption, or water efficiency; and, in addition, for pumps that are subject to the standards specified in § 431.465(b), the following provisions in § 431.462 apply:

(1) All variations in numbers of stages of bare RSV and ST pumps must be considered a single basic model;

(2) Pump models for which the bare pump differs in impeller diameter, or impeller trim, may be considered a single basic model; and

(3) Pump models for which the bare pump differs in number of stages or impeller diameter, and which are sold with motors (or motors and controls) of varying horsepower may only be considered a single basic model if:

(i) For ESCC, ESFM, IL, and RSV pumps, each motor offered in the basic model has a nominal full load motor efficiency rated at the Federal minimum (see the current table for NEMA Design B motors at § 431.25) or the same number of bands above the Federal minimum for each respective motor horsepower (see Table 3 of appendix A); or

(ii) For ST pumps, each motor offered in the basic model has a full load motor efficiency at the default nominal full load submersible motor efficiency shown in Table 2 of appendix A to or the same number of bands above the default nominal full load submersible motor efficiency for each respective motor horsepower (see Table 3 of appendix A).

10 CFR 431.462.

Clauses (1) and (2) of the basic model definition, which are applicable to pumps that are subject to the standards specified in 10 CFR 431.465(b), align the scope of the ''basic model'' definition for pumps with the requirements that testing be conducted at a certain number of stages for RSV and ST pumps and at full impeller diameter. 10 CFR 431.462. Clause (3) of the definition, applicable to pumps that are subject to the standards specified in 10 CFR 431.465(b), addresses basic models inclusive of pump models for which the bare pump differs in number of stages or impeller diameter. *Id.* Specifically, variation in motor sizing (*i.e.,* variation in the horsepower rating of the paired motor as a result of different impeller trims or stages within a basic model) is not a basis for requiring units to be rated as unique basic models. However, variation in motor sizing may also be associated with variation in motor efficiency, which is a performance characteristic; typically, larger motors are more efficient than smaller motors. 86 FR 20075, 20084.

In the April 2022 NOPR, DOE stated that for motors not currently subject to the DOE test procedure for electric motors, it is not clear how manufacturers would determine the full-load efficiency of a given motor, or specifically, determine the number of bands above the Federal minimum or, for submersible pumps, above the default efficiency. 87 FR 21268, 21306–21307. For inverter-only motors, DOE noted that the IEC recently published an industry test procedure that provides test methods for measuring the efficiency of these motors: IEC 60034–2–3:2020, ''Rotating electrical machines—Part 2–3: Specific test methods for determining losses and efficiency of converter-fed AC motors'' (''IEC 60034'') and IEC 61800–9–2:2017. *Id.*

DOE proposed in the April 2022 NOPR that PER_{STD} for inverter-only motors would still be based on DOE's standards for NEMA Design B motors. 87 FR 21268, 21307. Additionally, DOE proposed to amend clause (3) for inverter-only motors so that the current band rule does not apply, and instead the grouping can be based on anything above the Federal minimum for NEMA Design B motors as long as the rating is based on the lowest number of bands above the minimum. *Id.*

In the April 2022 NOPR, following consideration of stakeholder's comments, DOE did not propose to allow the grouping of single-phase and polyphase products into a single basic model. 87 FR 21268, 21307. Instead, DOE proposed to require that pumps sold with single-phase motors can continue to be rated as bare pumps (with the exception of SVIL as discussed in section III.G). *Id.*

DOE requested comment on its proposed amendments to the definition of the basic model in the April 2022 NOPR. 87 FR 21268, 21307. In response, HI and Grundfos stated that they agreed with the proposed amendments to the basic model but recommended adding the models in the proposed scope expansion to the basic model definition if/when the expanded scope pumps are added. (HI, No. 33 at p. 9; Grundfos, No. 31 at p. 9)

Grundfos disagreed with DOE's interpretation of how horsepower affects multi-stage pump basic models. (Grundfos, No. 31 at p. 11) This comment is discussed in detail in section III.A.4.d as it pertains to the scope of this test procedure.

Additionally, Grundfos recommended DOE change clause (3) of the basic model definition. (Grundfos, No. 31 at p. 5) Grundfos commented that it finds certain applications of bowl assemblies could lead to a product where both impeller trim and motor size vary. *Id.* Grundfos recommended that DOE change clause (3) to read: ''Pump models for which the bare pump differs in number of stages and/or impeller diameter . . .'' *Id.* The current clause only includes ''or,'' which would imply the only allowance is either in the number of stages or impeller trim when it could be both. *Id.* DOE agrees with the clarification Grundfos offers and is revising the definition for basic model as Grundfos recommends.

DOE will address expanded scope pumps in the basic model definition in any future rulemaking related to the certification of these pumps.

J. Representations of Energy Use and Energy Efficiency

DOE understands manufacturers often make representations (graphically or in numerical form) of energy use metrics, including pump efficiency, overall (wire-to-water) efficiency, bowl efficiency, driver power input, pump power input (brake or shaft horsepower), and/or pump power output (hydraulic horsepower). Manufacturers often make these representations at multiple impeller trims, operating speeds, and number of stages for a given pump. In the April 2022 NOPR, DOE proposed to allow manufacturers to continue making these representations to ensure consistent and standardized representations across the pump industry. 87 FR 21268, 21308. To ensure such representations are not in conflict with the reported PEI for any given pump model, DOE proposed to establish optional testing procedures for these parameters that are part of the DOE test procedure. *Id.* DOE also proposed that, to the extent manufacturers wish to make representations regarding the performance of pumps using these additional metrics, they would be required to do so based on testing in accordance with the DOE test procedure. *Id.*

In the April 2022 NOPR, DOE requested comment on its proposal to adopt optional test provisions for the measurement of overall (wire-to-water) efficiency, driver power input, and/or pump power output (hydraulic horsepower). 87 FR 21268, 21308. Grundfos commented that it has concerns with these proposed revisions since the testing is conducted only against a basic model and does not cover the full performance range for all possible individual models that a basic model represents. (Grundfos, No. 31 at p. 9) HI agreed that representations should be consistent, but also suggested that DOE allow pump manufacturers to represent data over the full performance range, including trims of the impeller and cases where the maximum or minimum speed range is outside the rated nominal speed range (*i.e.,* a pump within scope but with an operating speed range that goes above 4,320 rpm). (HI, No. 33 at p. 9)

DOE also requested comment on its understanding that HI 40.6–2021 contains all the necessary methods to determine overall (wire-to-water) efficiency, driver power input, and/or pump power output (hydraulic horsepower) and that further specification is not necessary. HI and Grundfos agreed that HI 40.6–2021 provides all the necessary methods. (HI, No. 33 at p. 9; Grundfos, No. 31 at p. 9)

After further review and consideration of stakeholder comments, DOE has determined that any requirements for additional representations of pump energy use and energy efficiency will not be addressed in the current rulemaking. Specifically, in order to meet its stated goal of ensuring representations of metrics other than PEI are not in conflict with the reported PEI for any given pump model, it would only be necessary to finalize provision related to metrics used in the determination of PEI, which would include driver input power at load points used in the determination of PEI. However, given that these metrics are a component of PEI, they must already be determined in accordance with the DOE test procedure including relevant provisions of HI 40.6–2021. For these reasons, DOE is not finalizing its proposal with respect to optional representations.

K. Test Procedure Costs and Harmonization

EPCA requires that test procedures proposed by DOE not be unduly burdensome to conduct. (42 U.S.C. 6314(a)(2)) The following sections discuss DOE's evaluation of estimated costs and savings associated with the final amendments.

1. Test Procedure Costs and Impact

In the April 2022 NOPR, DOE proposed to amend the existing test procedure at appendix A for pumps by: (1) expanding the scope to include SVIL pumps; (2) expanding the scope to include other specified clean water pumps; (3) reducing the pump bowl diameter restriction to include more ST pumps; (4) changing the definitions of ESFM and ESCC pumps to cover all end-suction pumps; (5) incorporating a nominal speed of 1,200 rpm, in addition to 1,800 rpm and 3,600 rpm; (6) providing a calculation method for pumps sold with inverter-only motors; and (7) updating the part-load loss coefficients for pumps sold with induction motors. 87 FR 21268, 21309. DOE has determined that the test procedure finalized in this notice will not be unduly burdensome for manufacturers to conduct. Further discussion of the cost impacts of the test procedure amendments are presented in the following paragraphs.

In the April 2022 NOPR, DOE requested comment on whether pump manufacturers had to limit any pump features due to the time and cost of evaluating pumps performance according to DOE's current test procedure, including, but not limited to, the nature of the features that manufacturers have had to forego providing, the extent of the limits that manufacturers have had to place, and the manner in which manufacturers have had to apply these limits—such as on the basis of intended markets (*e.g.,* higher-end vs. budget-end). 87 FR 21268, 21309. DOE also requested information regarding how these burdens may be mitigated to reduce the likelihood of manufacturers having to limit the inclusion of features with their pumps. *Id.*

In response, Grundfos stated it has limited modifications to and restricted sales of certain equipment because of the testing burden created by DOE's regulations. (Grundfos, No. 31 at p. 10) HI commented that manufacturers have chosen to limit modifications to equipment (*i.e.,* new casting forms, engineered-to-order product, alternative/new VFD or motor technology) because it poses a substantial testing burden. (HI, No. 33 at p. 9) HI asserted that these limitations impact end users because they result in pump manufacturers providing fewer product offerings, and because testing results in excessive lead times. *Id.*

DOE notes that pump manufacturers must comply with the energy conservation standards that were established in 2016 and required compliance beginning on January 27, 2020. 81 FR 4368 (January 26, 2016) (''January 2016 ECS Final Rule''). First-time compliance costs associated with meeting those energy conservation standards included testing costs, potential capital costs, and other one-time manufacturer costs associated with developing a testing and certification protocol. DOE also recognizes that the current test procedure does not provide a calculation method for pumps sold with motors that do not have a DOE energy efficiency standard; therefore, for pumps that rely on such motors, wire-to-water testing is required for each basic model. Finally, DOE notes that for all pumps currently subject to the energy conservation standards, the applicable energy efficiency values must be determined for all basic models according to the DOE test procedure, which includes the calculation method for certain pumps.

In the April 2022 NOPR, DOE estimated a per unit test cost of $1,600, and estimated that 59 percent of the models certified in DOE's Compliance Certification Database (''CCD'') were certified using the calculation-based approach. 87 FR 21268, 21309. DOE estimated that it would take a mechanical engineer two hours to calculate and determine a rating for each basic model. *Id.* Assuming a fully burdened engineering hourly wage of $66.16,[36] DOE estimates the labor cost of performing the pump calculation method to be $132.31 per basic model. These cost estimates apply to the discussion in the following sections.

DOE has determined that the test procedure amendments in this final rule will impact testing costs as discussed in the following sections.

a. Scope Expansion

In the April 2022 NOPR, DOE proposed to expand the scope of this test procedure to include SVIL pumps, other specified clean water pumps, ST pumps with bowl diameters greater than 6 inches, currently uncovered end-suction pumps, and pumps designed to operate with a 6-pole induction motor or with a non-induction motor with an operating range that includes speeds of rotation between 960 and 1,440 rpm. 87 FR 21268, 21273–21281. DOE also assumed a sampling plan consistent with that for pumps currently subject to the test procedure, which requires a sample size of at least two units per pump basic model be tested when determining representative values of PEI, as well as other pump performance metrics. 87 FR 21268, 21303. Additionally, DOE assumed that manufacturers would test pumps in-house. 87 FR 21268, 21310. To test a pump in-house, each manufacturer might have to undertake the construction and maintenance of a test facility that is capable of testing pumps in compliance with the test procedure, including acquisition and calibration of any necessary measurement equipment. *Id.* DOE also assumed that manufacturers have a pump test facility available but may not have the equipment required to conduct the DOE test procedure and that the cost of purchasing such equipment is approximately $4,000 based on a review of available testing equipment on the market. *Id.*

In the April 2022 NOPR, DOE assumed that pump manufacturers who are member companies of HI or who conduct testing in accordance with the January 2016 Final Rule for other product offerings already conduct testing in accordance with HI 40.6–2014, and would not incur any additional capital expenditures to be able to conduct the proposed DOE pump test procedure. 87 FR 21268, 21310. Pump manufacturers who are not members of HI may need to purchase electrical measurement equipment with plus or minus 2 percent accuracy to conduct the pump test procedure. In the April 2022 NOPR, DOE estimated that calibrating the flowmeter, torque sensor, power quality meter, pressure transducer, and laser tachometer, together, will cost a manufacturer about $1,250 per year. *Id.*

[36] DOE used the mean hourly wage of $46.64, taken from BLS's ''Occupational Employment and Wages, May 2021'' using the Occupation Profile of ''Mechanical Engineers'' (17–2141). *See: www.bls.gov/oes/current/oes172141.htm.* Last accessed on October 11, 2022.

Additionally, DOE used data from the ''Employer Costs for Employee Compensation—June 2022'' to estimate that a Private Industry Worker's wages and salary are 70.5% of an employee's total compensation. *See: www.bls.gov/news.release/pdf/ecec.pdf.* Last accessed on October 11, 2022.

Therefore, total employer hourly cost is $66.16 = $46.64 ÷ 0.705.

DOE requested comment on its assumptions and understanding of the anticipated impact and potential costs to pump manufacturers if DOE expands the scope of the pumps test procedure. 87 FR 21268, 21310. Additionally, DOE requested comment on any potential cost manufacturers may incur, if any, from this NOPR's proposed scope expansion. *Id.*

In response, HI and Grundfos stated that adding additional pump categories to the test procedure scope will increase burden on manufactures due to annual recertification, surveillance, testing, reporting, and documentation burden. (HI, No. 33 at p. 10; Grundfos, No. 31 at p. 10) HI also commented that larger pumps with higher flow rates within the proposed scope expansion may require different testing infrastructure and instrumentation with substantial capital investment required. (HI, No. 33 at p. 10) Specifically, HI stated that BB1 pumps are considerably larger, and the cost and burden associated with testing BB pumps will be significantly higher. (HI, No. 33 at p. 2) Grundfos stated adding 6-pole product requires upgrades to testing facilities and infrastructure that will increase costs. (Grundfos, No. 31 at p. 10)

DOE acknowledges that larger pumps may require additional investments in testing facilities. However, since no test cost data was provided by manufacturers, DOE was unable to adjust the test cost estimates for this final rule. DOE notes that it is not adopting the proposal to include ST and VT pumps with bowl diameters larger than 6 inches or BB pumps in the scope of this test procedure. Therefore, the burden associated with test facility modifications is reduced compared to the burden associated with the proposals in the April 2022 NOPR.

b. Calculation Method for Testing Pumps With Inverter-Only Motors

In the April 2022 NOPR, DOE proposed a calculation method for testing pumps with inverter-only motors. 87 FR 21268, 21310. The current test procedure does not include a calculation method for motors that do not have a DOE efficiency standard; therefore, manufacturers are required to conduct wire-to-water testing for pumps sold with these (*i.e.,* inverter) motors. Aside from the proposed calculation approach, the test procedure, metrics, and sampling plan for pumps remain consistent with the requirements established in the January 2016 Final Rule and, among other things, require a sample size of at least two units per pump basic model be tested when determining representative values of PEI, as well as other pump performance metrics.

For pumps already certified, DOE would not expect any additional costs to manufacturers. DOE has determined that the calculation method for inverter-only motors proposed in the April 2022 NOPR would provide results that are conservative when compared to results from wire-to-water testing, which is still an option in the test procedure. Consequently, DOE does not expect manufacturers will need to rerate their basic models. For new basic models where the bare pump is already certified (*i.e.,* the only change is in the inverter-only motor sold with the pump), DOE expects manufacturer cost to be the labor required to run the calculations (*i.e.,* $132.32 per basic model), providing an estimated savings of $3,070 per basic model (*i.e.,* test cost savings).[37] DOE expects that there would be no change in test cost for new bare pump basic models paired with an inverter-only motor, since the bare pump would still need to be tested.

In the April 2022 NOPR, DOE requested comment on its assumptions and understanding of the anticipated impact and potential cost savings to manufacturers of pumps sold with inverter-only motors if DOE were to adopt the proposed calculation method. 87 FR 21268, 21310. Additionally, DOE requested comment on any potential costs or savings that manufacturers may incur, if any, from this proposal. *Id.*

In response, Grundfos and HI agreed that there will be reduced testing burden and cost savings. (HI, No. 33 at p. 10; Grundfos, No. 31 at p. 10) HI additionally estimated that the reduction of testing burden associated with consolidation can range from 2 to 8 basic models. (HI, No. 33 at p. 10) HI also recommended that DOE consider other actions to reduce test cost such as sample pumps, management of basic models, other indirect labor, etc. *Id.*

DOE has concluded that the adopted calculation method for inverter-only motors will significantly reduce test burden. DOE may consider the additional actions to reduce test cost recommended by HI in a future test procedure rulemaking.

c. Updated Calculation Method for Testing Pumps With Induction Motors

In the April 2022 NOPR, DOE proposed an updated calculation method for testing pumps with induction motors. 87 FR 21268, 21310. The updated calculation method provides less conservative part-load loss coefficients than those provided in the current test procedure; however, DOE tentatively determined that the coefficients would still be conservative relative to wire-to-water testing. *Id.* Aside from the updated part-load motor coefficients, the test procedure, metrics, and sampling plan for pumps remains consistent with the requirements established in the January 2016 Final Rule and, among other things, requires that a sample size of at least two units per pump basic model be tested when determining representative values of PEI, as well as other pump performance metrics. *Id.*

In the April 2022 NOPR, DOE also explained that, for pumps already certified, DOE does not expect any additional costs to manufacturers since the current calculation method provides the most conservative results. 87 FR 21268, 21310. DOE expects that there will be no change in test cost for new bare pump basic models paired with an induction motor, since the bare pump will need to be tested. *Id.*

In the April 2022 NOPR, DOE requested comment on its assumptions and understanding that there will be no cost impact to manufacturers if DOE adopts the proposed updated coefficients for part-load motor losses. 87 FR 21268, 21310. Additionally, DOE requested comment on any potential costs or savings that manufacturers may incur, if any, from this proposal. *Id.*

HI and Grundfos responded that there would be some cost to update procedures and calculators to reflect the revised method. (HI, No. 33 at p. 10; Grundfos, No. 31 at p. 10) Specifically, Grundfos expected no manufacturer cost savings associated with this change. (Grundfos, No. 31 at p. 10) HI said that because the revised method can provide a better PEI, manufacturers who want to improve their PEI representation will have costs associated with updating representations in marketing, nameplates, and certification of data. (HI, No. 33 at p. 10)

DOE notes that it is primarily concerned with increased test costs associated with a test procedure revision that would require manufacturers to retest and recertify their basic models. In this case, DOE understands that manufacturers would be voluntarily recertifying certain basic models for marketing purposes only.

d. Additional Amendments

DOE does not anticipate that the remaining amendments, proposed in the April 2022 NOPR and as follows, would impact test costs.

[37] As previously stated, DOE estimated that the per unit test cost is $1,600 and at least two units need to be tested. Therefore, the calculation method is estimated to save approximately $3,070 = ($1,600 × 2) − $132.32.

(1) Incorporate by reference HI 40.6–2021 into 10 CFR 431.463;

(2) Remove the incorporations by reference of ANSI/HI 1.1–1.2–2014 and ANSI/HI 2.1–2.2–2014;

In the April 2022 NOPR DOE tentatively determined that manufacturers would be able to rely on data generated under the current test procedure and would not have to retest for reporting, certification or labeling purposes. 87 FR 21268, 21310. DOE maintains that determination in this final rule.

2. Harmonization With Industry Standards

DOE's established practice is to adopt relevant industry standards as DOE test procedures 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 or period of use. *See* 10 CFR part 430, subpart C, appendix A, section 8(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 testing standards as needed to adopt the procedure as the DOE test procedure.

The current test procedure for pumps at subpart Y to part 431 incorporates by reference ANSI/HI 40.6–2014 for rotodynamic pump efficiency testing and ANSI/HI 1.1–1.2–2014 and ANSI/HI 2.1–2.2–2014 that includes pumps nomenclature and definitions. As discussed, the amendments finalized in this rule update the DOE test procedure to reference the most recent version of HI 40.6–2021. DOE is removing its reference ANSI/HI 1.1–1.2–2014 and ANSI/HI 2.1–2.2–2014 since these industry standards have been replaced by ANSI/HI 14.1–14.2–2019, which is in turn referenced by HI 40.6–2021. The industry standards that DOE is incorporating by reference in this document are summarized in section IV.N of this document.

In the April 2022 NOPR, DOE requested comment on the benefits and burdens of the proposed updates and additions to industry standards referenced in the test procedure for pumps. 87 FR 21268, 21311. While DOE received no specific comments on the burdens associated with its proposal, both HI and Grundfos recommended that DOE incorporate ANSI/HI 14.1–14.2 instead of recreating definitions for regulatory clarity. (HI, No. 33 at p. 10; Grundfos, No. 31 at p. 10) Grundfos also recommended that DOE create its own terms when deviating from industry terms. (Grundfos, No. 31 at p. 10)

As discussed in section III.B.2, DOE notes that its definitional language must be clear and consistent on its own without references to industry standards. Therefore, DOE is not referencing ANSI/HI 14.1–14.2–2019 in its definitions.

L. Compliance Date

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 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 this 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.

B. Review Under the Regulatory Flexibility Act

The Regulatory Flexibility Act (5 U.S.C. 601 *et seq.*) requires preparation of a final regulatory flexibility analysis (''FRFA'') for any final rule where the agency was first required by law to publish a proposed rule for public comment, unless the agency certifies that the rule, if promulgated, will not have a significant economic impact on a substantial number of small entities. As required by Executive Order 13272, ''Proper Consideration of Small Entities in Agency Rulemaking,'' 67 FR 53461 (August 16, 2002), DOE published procedures and policies on February 19, 2003, to ensure that the potential impacts of its rules on small entities are properly considered during the DOE rulemaking process. 68 FR 7990. DOE has made its procedures and policies available on the Office of the General Counsel's website: *www.energy.gov/gc/office-general-counsel.* DOE reviewed this final rule under the provisions of the Regulatory Flexibility Act and the procedures and policies published on February 19, 2003. DOE has concluded that this rule will not have a significant impact on a substantial number of small entities. The factual basis for this certification is set forth below.

DOE has recently conducted a focused inquiry into small business manufacturers of the equipment covered by this rulemaking. DOE used the Small

Business Administration's (''SBA'') small business size standards to determine whether any small entities would be subject to the requirements of the rule. The size standards are listed by North American Industry Classification System (''NAICS'') code as well as by industry description and are available at *www.sba.gov/document/support--table-size-standards.* Manufacturing commercial and industrial pumps is classified under NAICS 333914, ''measuring, dispensing, and other pumping equipment manufacturing.'' The SBA sets a threshold of 750 employees or fewer for an entity to be considered as a small business for this category. DOE used available public information to identify potential small manufacturers. DOE accessed the Compliance Certification Database [38] to create a list of companies that import or otherwise manufacture the equipment covered by this rulemaking . Once DOE created a list of potential manufacturers, DOE used market research tools to determine whether any met the SBA's definition of a small entity, based on the total number of employees for each company including parent, subsidiary, and sister entities.

Based on DOE's analysis, 46 companies potentially selling commercial and industrial pumps covered by this test procedure were identified. DOE screened out companies that do not meet the small entity definition, and additionally screened out companies that are largely or entirely foreign-owned and operated. Of the 46 companies, 21 were therefore further identified as a small business. Based on a review of publicly available model databases, DOE estimated the number of models currently covered by the test procedure for each small business, excluding four small businesses not reflected in the model databases. DOE attributes a total of 779 unique basic models of covered pumps to small businesses, ranging from one model to 503 models for an average of approximately 46 models per small business. DOE was able to find revenue estimates for all 21 small businesses.

DOE estimates that this test procedure would not require any manufacturer to incur any additional testing burden associated with the test procedure. If finalized, DOE recognizes that commercial and industrial pump energy conservation standards may be proposed or promulgated in the future and pump manufacturers would then be required to test all covered pumps in accordance with the test procedures. (*See* Docket No. EERE–2020–BT–STD–0013). Therefore, although such testing is not yet required, DOE is presenting the costs associated with testing equipment and procedure consistent with the requirements of the test procedure, as would be required to comply with any future energy conservation standards for pumps. Additionally, since the list of small businesses was drawn from manufacturers with products covered by the previous test procedure, DOE assumes that each noted small business already possesses the necessary equipment for testing under the test procedure. Impacts for each test procedure amendment are reviewed below:

SVIL Product Class Scope Expansion

DOE examined the websites and, when available, product catalogs of all previously identified 20 potential small businesses for listings of SVIL pumps. DOE identified two small businesses manufacturing SVIL pumps—producing an estimated total of 65 basic models, with one small business producing nine basic models and another producing as many as 56 basic models. DOE estimated that it would cost approximately $1,600 per unit tested—a sample of two units being required per basic model. Accordingly, all small businesses combined would incur costs of approximately $208,000—with the first small business incurring a cost of $28,800 and the second incurring a cost of $179,200. However, such testing would only be required upon the compliance date of any future energy conservation standard for SVIL pumps.

DOE was able to find revenue estimates for both small businesses. Testing costs for newly covered SVIL pumps represent significantly less than one percent of estimated annual revenue for one of the small businesses and would constitute as much as ten percent of estimated annual revenue for the small business producing 56 models.

Other Clean Water Pump Scope Expansion

DOE examined the websites and, when available, the product catalogs of all previously identified 21 potential small businesses for listings of any of the clean water pumps that are newly covered under this test procedure. DOE identified four small businesses manufacturing clean water pumps covered by this rulemaking that are not covered by the current test procedure. One of these manufacturers also produce SVIL pumps. Although a newly covered model count estimate was not possible for two small businesses, the remaining two small businesses produce an estimated total of 37 newly covered basic models, the first producing 15 basic models and the second producing 22 newly covered basic models. The first small business produces approximately 15 models that would fall under the 1,200 rpm scope expansion. With the second small business, approximately one-third of newly covered unique basic models are submersible pumps and two-thirds are vertical turbine pumps, several of which also fall under the 1,200 rpm scope expansion. DOE estimated that it would cost approximately $1,600 per unit tested—a sample of two being required per unique basic model. Accordingly, the small businesses combined would incur costs of approximately $118,400—with the first incurring a cost of $48,000and the second incurring a cost of $70,400. The first small business produces both SVIL pumps and newly covered clean water pumps and would incur an approximate total testing cost of $76,800.

DOE was able to find revenue estimates for both small businesses. Testing costs for newly covered clean water pumps represent significantly less than one percent of estimated annual revenue for both small businesses. However, such testing would only be required upon the compliance date of any future energy conservation standard for SVIL pumps.

Calculation Method Changes

Relative to the current test procedure calculation methodology, the calculation changes are conservative; therefore, manufacturers would not have to recalculate or re-rate existing models. Accordingly, DOE does not anticipate that updating the part-load loss coefficients for pumps sold with induction motors or providing a calculation method for pumps sold with inverter-only motors would impose any costs on small businesses when the test procedure is in force. Likewise, permitting the use of AEDMs in lieu of the calculation-based test is not expected to result in additional costs for affected small businesses, as they will continue to be able to employ the calculation-based test.

Conclusion

DOE identified a total of five small business OEMs affected by this final rule. The affected small businesses represent approximately 25 percent of all identified small business OEMs producing pumps covered under this rulemaking. DOE believes this to be a substantial number of affected small

[38] U.S. Department of Energy Compliance Certification Database, available at: *www.regulations.doe.gov/certification-data.*

entities in the context of the pumps industry. However, as noted previously, the presented costs would not be incurred as a result of this test procedure taking effect and are, with one exception, estimated to constitute less than one percent of the affected small businesses' revenue if DOE establishes energy conservation standards for pumps not currently subject to DOE's energy conservation standards.

Based on the de minimis cost impacts, DOE certifies that this final rule does not have a ''significant economic impact on a substantial number of small entities,'' and determined that the preparation of a FRFA is not warranted. DOE will transmit a certification and supporting statement of factual basis to the Chief Counsel for Advocacy of the Small Business Administration for review under 5 U.S.C. 605(b).

C. Review Under the Paperwork Reduction Act of 1995

Manufacturers of pumps 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 pumps. (*See generally* 10 CFR part 429.) The collection-of-information requirement for the certification and recordkeeping is subject to review and approval by OMB under the Paperwork Reduction Act (PRA). This requirement has been approved by OMB under OMB control number 1910–1400. Public reporting burden for the certification is estimated to average 35 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

DOE is not amending the certification or reporting requirements for pumps in this final rule. Instead, DOE may consider proposals to amend the certification requirements and reporting for pumps under a separate rulemaking regarding appliance and equipment certification. DOE will address changes to OMB Control Number 1910–1400 at that time, as necessary.

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

D. Review Under the National Environmental Policy Act of 1969

In this final rule, DOE establishes test procedure amendments that it expects will be used to develop and implement future energy conservation standards for pumps. 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.

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 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 pumps adopted in this final rule incorporates testing methods contained in certain sections of the following commercial standards: HI 40.6–2021, HI 9.6.1–2017, HI 9.6.6–2016, HI 9.8–2018, HI 14.1–14.2–2019, the HI Engineering Data Book, ANSI/ASME MFC–5M–1985, ASME MFC–3M–2004, ASME MFC–8M–2001, ASME MFC–12M–2006, ASME MFC–16–2014, ASME MFC–22–2007, AWWA E103–2015, CSA C390–10, IEEE 112–2017, IEEE 114–2010, ISO 1438:2017, ISO 2186:2007, ISO 2715:2017, ISO 3354:2008, ISO 3966:2020, ISO 5167–1:2003, ISO 5198:1987, ISO 6416:2017, and ISO 20456:2017. 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

In this final rule, DOE incorporates by reference the following standards:

(1) HI 40.6–2021. This standard establishes testing protocols for testing of rotodynamic pumps for determination of pump efficiency in a uniform manner.
(2) ANSI/HI 9.6.1–2017. This standard, referenced in HI 40.6–2021, applies to rotodynamic pumps and defines calculation of net positive suction head (''NPSH'') margin and recommends NPSH margin for these pumps based on specific application considerations, pump design, and the flow relative to the BEP.
(3) ANSI/HI 9.6.6–2016. This standard is referenced in HI 40.6–2021 and details pump piping requirements for rotodynamic pumps and effects of inlet/outlet piping on pump performance.
(4) ANSI/HI 9.8–2018. This standard is referenced in HI 40.6–2021 and discusses appropriate design for various pump intakes.
(5) ANSI/HI 14.1–14.2–2019. This standard is referenced in HI 40.6–2021 and covers types, nomenclature, and definitions for commercial and industrial pump types.
(6) HI Engineering Data Book—Second Edition. This document is referenced in HI 40.6–2021 and covers fluid

characteristics, fluid flow, and characteristics of piping materials.

Copies of HI 40.6–2021, ANSI/HI 9.6.1–2017, ANSI/HI 9.6.6–2016, ANSI/HI 9.8–2018, ANSI/HI 14.1–14.2–2019, and the HI Engineering Data Book—Second Edition can be obtained from the Hydraulics Institute, 300 Interpace Parkway, Bldg. a 3rd floor, Parsippany, NJ 07054, (973) 267–9700, or online at: *pumps.org.*

(7) ANSI/ASME MFC–5M–1985. This standard is referenced in HI 40.6–2021 and provides information on ultrasonic flowmeters that operate on the measurement of acoustic signal transit times.

(8) ASME MFC–3M–2004. This standard is referenced in HI 40.6–2021 and specifies the geometry and method of use for pressure differential devices (*i.e.,* orifice, nozzle, and venturi meters) for measuring full-pipe liquid flow in a closed conduit.

(9) ASME MFC–8M–2001. This standard is referenced in HI 40.6–2021 and describes a method for connecting pressure signal transmissions between primary and secondary devices.

(10) ASME MFC–12M–2006. This standard is referenced in HI 40.6–2021 and provides information on the use of multiport averaging Pitot head-type devices used to measure liquids and gases.

(11) ASME MFC–16–2014. This standard is referenced in HI 40.6–2021 and provides information on industrial electromagnetic flowmeters and their application in the measurement of liquid flow.

(12) ASME MFC–22–2007. This standard is referenced in HI 40.6–2021 and describes the criteria for application of turbine flowmeters with rotating blades for measuring full-pipe liquid flow through closed conduit.

Copies of ANSI/ASME MFC–5M–1985, ASME MFC–3M–2004, and ASME MFC–8M–2001, ASME MFC–12M–2006, ASME MFC–16–2014, and ASME MFC–22–2007, can be obtained from the American Society of Mechanical Engineers, Two Park Avenue, New York, NY 10016–5990, (800) 843–2763, or online at: *asme.org.*

(13) AWWA E103–2015. This standard is referenced in HI 40.6–2021 and provides minimum requirements for horizontal centrifugal pumps and for vertical line-shaft pumps for installation in wells, water treatment plants, water transmission systems, and water distribution systems.

Copies of AWWA E103–2015 can be obtained from the American Water Works Association, 6666 W Quincy Avenue, Denver, CO 80235, (303) 794–7711, or online at: *awwa.org.*

(14) CSA C390–10. This standard is referenced in HI 40.6–2021 and establishes test methods, marking requirements, and energy efficiency levels for three-phase induction motors.

Copies of CSA C390–10 can be obtained from the Canadian Standards Association, 178 Rexdale Blvd., Toronto, ON, Canada M9W 1R3, (800) 463–6727, or online at *csagroup.org.*

(15) IEEE 112–2017. This standard is referenced in HI 40.6–2021 and contains instructions for conducting and reporting the more generally applicable and acceptable tests of polyphase induction motors and generators.

(16) IEEE 114–2010. This standard is referenced in HI 40.6–2021 and contains instructions to determine the performance characteristics of single-phase induction motors.

Copies of IEEE 112–2017 and IEEE 114–2010 can be obtained from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, Piscataway, NJ 08854–4141, (732) 981–0060, or online at *standards.ieee.org.*

(17) ISO 1438:2017. This standard is referenced in HI 40.6–2021 and specifies methods for the measurement of water flow in open channels using rectangular and triangular-notch (V-notch) thin-plate weirs.

(18) ISO 2186:2007. This standard is referenced in HI 40.6–2021 and specifies provisions for the design, lay-out and installation for transmitting pressure signals from a primary to a secondary device without signal distortion.

(19) ISO 2715:2017. This standard is referenced in HI 40.6–2021, describes and discusses the characteristics of turbine flowmeters, and is applicable to metering any appropriate liquid.

(20) ISO 3354:2008. This standard is referenced in HI 40.6–2021 and specifies a method for the determination of the volume flow rate in a closed conduit.

(21) ISO 3966:2020. This standard is referenced in HI 40.6–2021 and specifies a method for determining volume flowrate in a closed conduit using propeller-type current-meters.

(22) ISO 5167–1:2003. This standard is referenced in HI 40.6–2021 and establishes methods of measuring and calculating flowrate in a conduit using pressure differential devices (*i.e.,* orifice plates, nozzles, and Venturi tubes).

(23) ISO 5198:1987. This standard is referenced in HI 40.6–2021 and specifies precision class tests (*i.e.,* high accuracy) for testing centrifugal, mixed flow, and axial pumps.

(24) ISO 6416:2017. HI 40.6–2021 references ISO/TR 12765 which is identical to this standard, which describes the establishment and operation of an ultrasonic gauging station for the continuous measurement of discharge in a river, an open channel or a closed conduit.

(25) ISO 20456:2017. HI 40.6–2021 references ISO 9104:1991 which has since been revised to ISO 20456:2017, which cancels and replaces ISO 9104:1991. ISO 20456:2017 describes how industrial electromagnetic flowmeters are used for the measurement of flowrate of a conductive liquid in a closed conduit running full.

Copies of ISO 1438:2017, ISO 2186:2007, ISO 2715:2017, ISO 3354:2008, ISO 3966:2020, ISO 5167–1:2003, ISO 5198:1987, ISO 6416:2017, and ISO 20456:2017 can be obtained from the International Organization for Standardization, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, +41 22 749 01 11, or online at: *iso.org.*

The following standards are already approved for the sections where they appear: CSA C747–2009, FM Class Number 1319, HI 40.6–2014, HI 41.5–2022, IEEE 113–1985, IEEE 114–2010, NFPA 20–2016, NSF/ANSI 50–2015, UL 448, and UL 1081.

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 February 28, 2023, 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 March 15, 2023.

Treena V. Garrett,

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

For the reasons stated in the preamble, DOE amends parts 429 and 430 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. Amend § 429.59 by:
■ a. Revising paragraph (a) introductory text;
■ b. Redesignating paragraphs (a)(2)(iv) through (vii) as paragraphs (a)(2)(v) through (viii); and
■ c. Adding new paragraph (a)(3).

The revision and additions read as follows:

§ 429.59 Pumps.

* * * * *

(a) *Determination of represented value.* Manufacturers must determine the represented value, which includes the certified rating, for each basic model of general purpose pump either by testing (which includes the calculation-based methods in the test procedure), in conjunction with the following sampling provisions, or by application of an AEDM that meets the requirements of § 429.70 and the provisions of this section. Manufacturers must determine the represented value, which includes the certified rating, for each basic model of dedicated-purpose pool pump by testing, in conjunction with the following sampling provisions. Manufacturers must update represented values to account for any change in the applicable motor standards in subpart B of part 431 of this chapter and certify amended values as of the next annual certification.

* * * * *

(2) * * *

(iv) *General pumps.* The representative values for pump total head in feet at BEP and nominal speed, volume per unit time in gallons per minute at BEP and nominal speed, and calculated driver power input at each load point must be the arithmetic mean of the value determined for each tested unit of general pump.

* * * * *

(3) *Alternative efficiency determination methods.* In lieu of testing, a represented value of efficiency or consumption for a basic model of pump must be determined through the application of an AEDM pursuant to the requirements of § 429.70 and the provisions of this section, where:

(i) Any represented value of energy consumption or other measure of energy use of a basic model for which consumers would favor lower values shall be greater than or equal to the output of the AEDM and less than or equal to the Federal standard for that basic model; and

(ii) Any represented value of energy efficiency or other measure of energy consumption of a basic model for which consumers would favor higher values shall be less than or equal to the output of the AEDM and greater than or equal to the Federal standard for that basic model.

* * * * *

■ 3. Amend § 429.70 by adding paragraph (m) to read as follows:

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

* * * * *

(m) *Alternative efficiency determination method (AEDM) for general pumps*—(1) *Criteria an AEDM must satisfy.* A manufacturer may not apply an AEDM to a basic model to determine its efficiency pursuant to this section, unless:

(i) The AEDM is derived from a mathematical model that estimates the energy efficiency or energy consumption characteristics of the basic model as measured by the applicable DOE test procedure;

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

(iii) The manufacturer has validated the AEDM, in accordance with paragraph (m)(2) of this section.

(2) *Validation of an AEDM.* Before using an AEDM, the manufacturer must validate the AEDM's accuracy and reliability as follows:

(i) *AEDM overview.* The manufacturer must select at least the minimum number of basic models for each validation class specified in paragraph (m)(2)(iv) of this section to which the particular AEDM applies. Using the AEDM, calculate the PEI for each of the selected basic models. Test each basic model and determine the represented value(s) in accordance with § 429.63(a). Compare the results from the testing and the AEDM output according to paragraph (m)(2)(ii) of this section. The manufacturer is responsible for ensuring the accuracy and repeatability of the AEDM.

(ii) *AEDM basic model tolerances.* (A) The predicted representative PEI for each basic model calculated by applying the AEDM may not be more than five percent less than the represented PEI determined from the corresponding test of the model.

(B) The predicted constant or variable load pump energy index for each basic model calculated by applying the AEDM must meet or exceed the applicable federal energy conservation standard.

(iii) *Additional test unit requirements.* (A) Each AEDM must be supported by test data obtained from physical tests of current models; and

(B) Test results used to validate the AEDM must meet or exceed current, applicable Federal standards as specified in part 431 of this chapter; and

(C) Each test must have been performed in accordance with the applicable DOE test procedure with which compliance is required at the time the basic models used for validation are distributed in commerce.

(iv) *Pump validation classes.*

Validation class	Minimum number of distinct basic models that must be tested
(A) Constant Load End-suction Closed-Coupled Pumps and Constant Load End-suction Frame-Mounted Pumps	2 Basic Models.
(B) Variable Load End-suction Closed-Coupled Pumps and Variable Load End-suction Frame-Mounted Pumps	2 Basic Models.
(C) Constant Load Inline Pumps and Constant Load Small Vertical Inline Pumps	2 Basic Models.
(D) Variable Load Inline Pumps and Variable Load Small Vertical Inline Pumps	2 Basic Models.
(E) Constant Load Radially-Split Multi-Stage Vertical Pumps and Constant Load Radially-Split Multi-Stage Horizonal Pumps.	2 Basic Models.
(F) Variable Load Radially-Split Multi-Stage Vertical Pumps and Variable Load Radially-Split Multi-Stage Horizontal Pumps.	2 Basic Models.

Validation class	Minimum number of distinct basic models that must be tested
(G) Constant Load Submersible Turbine Pumps and Constant Load Vertical Turbine Pumps	2 Basic Models.
(H) Variable Load Submersible Turbine Pumps and Variable Load Vertical Turbine Pumps	2 Basic Models.

(3) *AEDM records retention requirements.* If a manufacturer has used an AEDM to determine representative values pursuant to this section, the manufacturer must have available upon request for inspection by the Department records showing:

(i) The AEDM, including the mathematical model, the engineering or statistical analysis, and/or computer simulation or modeling that is the basis of the AEDM;

(ii) Regarding the units tested that were used to validate the AEDM pursuant to paragraph (m)(2) of this section, equipment information, complete test data, AEDM calculations, and the statistical comparisons; and

(iii) For each basic model to which the AEDM was applied, equipment information and AEDM calculations.

(4) *Additional AEDM requirements.* If requested by the Department, the manufacturer must:

(i) Conduct simulations before representatives of the Department to predict the performance of particular basic models of the equipment to which the AEDM was applied;

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

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

(5) *AEDM verification testing.* DOE may use the test data for a given individual model generated pursuant to § 429.104 to verify the certified rating determined by an AEDM as long as the following process is followed:

(i) *Selection of units.* DOE will obtain units for test from retail, where available. If units cannot be obtained from retail, DOE will request that a unit be provided by the manufacturer.

(ii) *Lab requirements.* DOE will conduct testing at an independent, third-party testing facility of its choosing. In cases where no third-party laboratory is capable of testing the equipment, it may be tested at a manufacturer's facility upon DOE's request.

(iii) *Manufacturer participation.* Testing will be performed without manufacturer representatives on-site.

(iv) *Testing.* All verification testing will be conducted in accordance with the applicable DOE test procedure, as well as each of the following to the extent that they apply:

(A) Any active test procedure waivers that have been granted for the basic model;

(B) Any test procedure guidance that has been issued by DOE;

(C) If during test set-up or testing, the lab indicates to DOE that it needs additional information regarding a given basic model in order to test in accordance with the applicable DOE test procedure, DOE may organize a meeting between DOE, the manufacturer and the lab to provide such information.

(D) At no time during the process may the lab communicate directly with the manufacturer without DOE present.

(v) *Failure to meet certified rating.* If a model's test results are worse than its certified rating by an amount exceeding the tolerance prescribed in paragraph (f)(5)(vi) of this section, DOE will notify the manufacturer. DOE will provide the manufacturer with all documentation related to the test set up, test conditions, and test results for the unit. Within the timeframe allotted by DOE, the manufacturer may then present all claims regarding testing validity.

(vi) *Tolerances.* For consumption metrics, the result from a DOE verification test must be less than or equal to the certified rating × (1 + the applicable tolerance).

TABLE 7 TO PARAGRAPH (m)(5)(vi)

Equipment	Metric	Applicable tolerance (%)
General Pumps	Constant or Variable Load Pump Energy Index	5

(vii) *Invalid rating.* If, following discussions with the manufacturer and a retest where applicable, DOE determines that the testing was conducted appropriately in accordance with the DOE test procedure, the rating for the model will be considered invalid. The manufacturer must conduct additional testing and re-rate and re-certify the basic models that were rated using the AEDM based on all test data collected, including DOE's test data.

(viii) *AEDM use.* This paragraph (m)(5)(viii) specifies when a manufacturer's use of an AEDM may be restricted due to prior invalid represented values.

(A) If DOE has determined that a manufacturer made invalid ratings on two or more models rated using the same AEDM within a 24-month period, the manufacturer must take the action listed in the table corresponding to the number of invalid certified ratings. The twenty-four month period begins with a DOE determination that a rating is invalid through the process outlined previously. Additional invalid ratings apply for the purposes of determining the appropriate consequences if the subsequent determination(s) is based on selection of a unit for testing within the twenty-four-month period (*i.e.,* subsequent determinations need not be made within 24 months).

TABLE 8 TO PARAGRAPH (m)(5)(viii)(A)

Number of invalid certified ratings from the same AEDM [1] within a rolling 24-month period [2]	Required manufacturer actions
2	Submit different test data and reports from testing to validate that AEDM within the validation classes to which it is applied.[3] Adjust the ratings as appropriate.
4	Conduct double the minimum number of validation tests for the validation classes to which the AEDM is applied. Note, the tests required under this paragraph (m)(5)(viii) must be performed on different models than the original tests required under paragraph (m)(2) of this section.
6	Conduct the minimum number of validation tests for the validation classes to which the AEDM is applied at a third-party test facility; And Conduct additional testing, which is equal to ½ the minimum number of validation tests for the validation classes to which the AEDM is applied, at either the manufacturer's facility or a third-party test facility, at the manufacturer's discretion. Note, the tests required under this paragraph (m)(5)(viii) must be performed on different models than the original tests performed under paragraph (m)(2) of this section.
> = 8	Manufacturer has lost privilege to use AEDM. All ratings for models within the validation classes to which the AEDM applied should be rated via testing. Distribution cannot continue until certification(s) are corrected to reflect actual test data.

[1] The "same AEDM" means a computer simulation or mathematical model that is identified by the manufacturer at the time of certification as having been used to rate a model or group of models.
[2] The twenty-four month period begins with a DOE determination that a rating is invalid through the process outlined above. Additional invalid ratings apply for the purposes of determining the appropriate consequences if the subsequent determination(s) is based on testing of a unit that was selected for testing within the twenty-four month period (i.e., subsequent determinations need not be made within 24 months).
[3] A manufacturer may discuss with DOE's Office of Enforcement whether existing test data on different basic models within the validation classes to which that specific AEDM was applied may be used to meet this requirement.

(B) If, as a result of eight or more invalid ratings, a manufacturer has lost the privilege of using an AEDM for rating, the manufacturer may regain the ability to use an AEDM by:

(*1*) Investigating and identifying cause(s) for failures;

(*2*) Taking corrective action to address cause(s);

(*3*) Performing six new tests per validation class, a minimum of two of which must be performed by an independent, third-party laboratory to validate the AEDM; and

(*4*) Obtaining DOE authorization to resume use of the AEDM.

* * * * *

■ 3. Section 429.134 is amended by revising paragraph (i)(1)(ii):

§ 429.134 Product-specific enforcement provisions.

* * * * *

(i) * * *

(1) * * *

(ii) DOE will test each pump unit according to the test method specified by the manufacturer in the certification report submitted pursuant to § 429.59(b); if the model of pump unit was rated using an AEDM, DOE may use either a testing approach or calculation approach.

* * * * *

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

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

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

■ 5. Amend § 431.462 by:
■ a. Revising the introductory text;
■ b. Revising the definition of "Basic model";
■ c. Adding in alphabetical order a definition for "Bowl";
■ d. Revising the definitions of "Bowl diameter", "Close-coupled pump", "End suction close-coupled (ESCC) pump", "End suction frame mounted/own bearings (ESFM) pump", "End suction pump", "In-line (IL) pump", and "Mechanically-coupled pump";
■ e. Adding in alphabetical order definitions for "Radially-split, multi-stage, horizontal, diffuser casing (RSH) pump", "Radially-split, multi-stage, horizontal, end-suction diffuser casing (RSHES) pump", and "Radially-split, multi-stage, horizontal, in-line diffuser casing (RSHIL) pump";
■ f. Revising the definition of "Radially-split, multi-stage, vertical, in-line diffuser casing (RSV) pump";
■ g. Adding in alphabetical order definitions for "Small vertical in-line (SVIL) pump" and "Small vertical twin-head pump";
■ h. Revising the definition of "Submersible turbine (ST) pump"; and
■ i. Adding in alphabetical order a definition for "Vertical turbine pump".

The revisions and additions read as follows:

§ 431.462 Definitions.

The following definitions are applicable to this subpart, including appendices A, B, and C. In cases where definitions reference design intent, DOE will consider marketing materials, labels and certifications, and equipment design to determine design intent.

* * * * *

Basic model means all units of a given class of pump manufactured by one manufacturer, having the same primary energy source, and having essentially identical electrical, physical, and functional (or hydraulic) characteristics that affect energy consumption, energy efficiency, water consumption, or water efficiency; and, in addition, for pumps that are subject to the test procedures specified in § 431.464(a), the following provisions also apply:

(1) All variations in numbers of stages of bare RSV and ST pumps must be considered a single basic model;

(2) Pump models for which the bare pump differs in impeller diameter and/or impeller trim, may be considered a single basic model; and

(3) Pump models for which the bare pump differs in number of stages and/or impeller diameter and which are sold with motors (or motors and controls) of varying horsepower may only be considered a single basic model if:

(i) For ESCC, ESFM, IL, and RSV pumps, each motor offered in the basic model has a nominal full load motor efficiency rated at the Federal minimum (see the applicable table at § 431.25) or the same number of bands above the Federal minimum for each respective motor horsepower (*see* table 3 of appendix A to this subpart); or for pumps sold with inverter-only synchronous electric motors, any number of bands above the Federal minimum for each respective motor horsepower provided that the rating is based on the lowest number of bands; or

(ii) For ST pumps, each motor offered in the basic model has a full load motor efficiency at the default nominal full load submersible motor efficiency shown in table 2 of appendix A to subpart Y of this part or the same number of bands above the default nominal full load submersible motor efficiency for each respective motor horsepower (*see* table 3 of appendix A to this subpart) or for inverter-only synchronous electric motors, any number of bands above the default nominal full load submersible motor efficiency provided the rating is based on the lowest number of bands.

* * * * *

Bowl means a casing in which the impeller rotates, and that directs flow axially to the next stage or the discharge column.

Bowl diameter means the maximum dimension of an imaginary straight line passing through and in the plane of the circular shape of the bowl of the bare pump that is perpendicular to the pump shaft and that intersects the outermost circular shape of the bowl of the bare pump at both of its ends.

* * * * *

Close-coupled pump means a pump in which the driver's bearings are designed to absorb the pump's axial load.

* * * * *

End-suction close-coupled (ESCC) pump means a close-coupled, dry rotor, end-suction pump that has a shaft input power greater than or equal to 1 hp and less than or equal to 200 hp at BEP and full impeller diameter and that is not a dedicated-purpose pool pump.

End-suction frame mounted/own bearings (ESFM) pump means a mechanically-coupled, dry rotor, end-suction pump that has a shaft input power greater than or equal to 1 hp and less than or equal to 200 hp at BEP and full impeller diameter and that is not a dedicated-purpose pool pump.

End-suction pump means a single-stage, rotodynamic pump in which the liquid enters the bare pump in a direction parallel to the impeller shaft and on the side opposite the bare pump's driver-end. The liquid is discharged in a plane perpendicular to the shaft.

* * * * *

In-line (IL) pump means a pump that is either a twin head pump or a single-stage, single-axis flow, dry rotor, rotodynamic pump that has a shaft input power greater than or equal to 1 hp and less than or equal to 200 hp at BEP and full impeller diameter, in which liquid is discharged in a plane perpendicular to the shaft. Such pumps do not include circulator pumps.

* * * * *

Mechanically-coupled pump means a pump in which bearings external to the driver are designed to absorb the pump's axial load.

* * * * *

Radially-split, multi-stage, horizontal, diffuser casing (RSH) pump means a horizontal, multi-stage, dry rotor, rotodynamic pump:

(1) That has a shaft input power greater than or equal to 1 hp and less than or equal to 200 hp at BEP and full impeller diameter and at the number of stages required for testing;

(2) In which liquid is discharged in a plane perpendicular to the impeller shaft;

(3) For which each stage (or bowl) consists of an impeller and diffuser; and

(4) For which no external part of such a pump is designed to be submerged in the pumped liquid.

Radially-split, multi-stage, horizontal, end-suction diffuser casing (RSHES) pump means a RSH pump in which the liquid enters the bare pump in a direction parallel to the impeller shaft and on the side opposite the bare pump's driver-end.

Radially-split, multi-stage, horizontal, in-line diffuser casing (RSHIL) pump means a single-axis flow RSH pump in which the liquid enters the pump in a plane perpendicular to the impeller shaft.

Radially-split, multi-stage, vertical, diffuser casing (RSV) pump means a vertically suspended, multi-stage, single-axis flow, dry rotor, rotodynamic pump:

(1) That has a shaft input power greater than or equal to 1 hp and less than or equal to 200 hp at BEP and full impeller diameter and at the number of stages required for testing;

(2) In which liquid is discharged in a plane perpendicular to the impeller shaft;

(3) For which each stage (or bowl) consists of an impeller and diffuser; and

(4) For which no external part of such a pump is designed to be submerged in the pumped liquid.

* * * * *

Small vertical in-line (SVIL) pump means a small vertical twin-head pump or a single stage, single-axis flow, dry rotor, rotodynamic pump that:

(1) Has a shaft input power less than 1 horsepower at its BEP at full impeller diameter; and

(2) In which liquid is discharged in a plane perpendicular to the shaft; and

(3) Is not a circulator pump.

Small vertical twin-head pump means a dry rotor, single-axis flow, rotodynamic pump that contains two equivalent impeller assemblies, each of which:

(1) Contains an impeller, impeller shaft (or motor shaft in the case of close-coupled pumps), shaft seal or packing, driver (if present), and mechanical equipment (if present); and

(2) Has a shaft input power that is less than or equal to 1 hp at BEP and full impeller diameter; and

(3) Has the same primary energy source (if sold with a driver) and the same electrical, physical, and functional characteristics that affect energy consumption or energy efficiency; and

(4) Is mounted in its own volute; and

(5) Discharges liquid through its volute and the common discharge in a plane perpendicular to the impeller shaft.

* * * * *

Submersible turbine (ST) pump means a single-stage or multi-stage, dry rotor, rotodynamic pump that is designed to be operated with the motor and stage(s) fully submerged in the pumped liquid; that has a shaft input power greater than or equal to 1 hp and less than or equal to 200 hp at BEP and full impeller diameter and at the number of stages required for testing; and in which each stage of this pump consists of an impeller and diffuser, and liquid enters and exits each stage of the bare pump in a direction parallel to the impeller shaft.

* * * * *

Vertical turbine (VT) pump means a vertically suspended, single-stage or multi-stage, dry rotor, single inlet, rotodynamic pump:

(1) That has a shaft input power greater than or equal to 1 hp and less than or equal to 200 hp at BEP and full impeller diameter and at the number of stages required for testing;

(2) For which the pump driver is not designed to be submerged in the pumped liquid;

(3) That has a single pressure containing boundary (*i.e.,* is single casing), which may consist of, but is not limited, to bowls, columns, and discharge heads; and

(4) That discharges liquid through the same casing in which the impeller shaft is contained.

* * * * *

■ 6. Revise § 431.463 to read as follows:

§ 431.463 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, DOE must publish a document in the **Federal Register** and the material must be available to the public. All approved incorporation by reference (IBR) 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, visit *www.archives.gov/federal-register/cfr/ibr-locations.html* or email *fr.inspection@nara.gov.* The material may be obtained from the following sources:

(b) *ASME.* American Society of Mechanical Engineers, Two Park Avenue, New York, NY 10016–5990; (800) 843–2763; *www.asme.org.*

(1) ASME MFC–3M–2004 (Reaffirmed 2017) (''ASME MFC–3M–2004''), *Measurement of Fluid Flow in Pipes Using Orifice, Nozzle, and Venturi,* Issued January 1, 2004; IBR approved for appendix A to this subpart.

(2) ANSI/ASME MFC–5M–1985 (Reaffirmed 2006) (''ASME MFC–5M–1985''), *Measurement of Liquid Flow in Closed Conduits Using Transit-Time Ultrasonic Flowmeters,* Issued July 15, 1985; IBR approved for appendix A to this subpart.

(3) ASME MFC–8M–2001 (Reaffirmed 2011) (''ASME MFC–8M–2001''), *Fluid Flow in Closed Conduits: Connections for Pressure Signal Transmissions Between Primary and Secondary Devices,* Issued September 1, 2001; IBR approved for appendix A to this subpart.

(4) ASME MFC–12M–2006 (Reaffirmed 2014) (''ASME MFC–12M–2006''), *Measurement of Fluid Flow in Closed Conduits Using Multiport Averaging Pitot Primary Elements,* Issued October 9, 2006; IBR approved for appendix A to this subpart.

(5) ASME MFC–16–2014, *Measurement of Liquid Flow in Closed Conduits with Electromagnetic Flowmeters,* Issued March 14, 2014; IBR approved for appendix A to this subpart.

(6) ASME MFC–22–2007 (Reaffirmed 2014) (''ASME MFC–22–2007''), *Measurement of Liquid by Turbine Flowmeters,* Issued April 14, 2008; IBR approved for appendix A to this subpart.

(c) *AWWA.* American Water Works Association, Headquarters, 6666 W Quincy Ave, Denver, CO 80235; (303) 794–7711; *www.awwa.org.*

(1) ANSI/AWWA E103–2015 (''AWWA E103–2015''), *Horizontal and Vertical Line-Shaft Pumps,* approved 7, 2015; IBR approved for appendix A to this subpart.

(2) [Reserved]

(d) *CSA.* Canadian Standards Association, 5060 Spectrum Way, Suite 100, Mississauga, Ontario, L4W 5N6, Canada; (800) 463–6727; *www.csagroup.org.*

(1) CSA C390–10 Test methods, marking requirements, and energy efficiency levels for three-phase induction motors, Updated March 2010; IBR approved for appendix A to this subpart.

(2) CSA C747–2009 (Reaffirmed 2014) (''CSA C747–2009 (RA 2014)''), *Energy efficiency test methods for small motors,* CSA reaffirmed 2014; IBR approved for appendices B and C to this subpart, as follows:

(i) Section 1, ''Scope'';

(ii) Section 3, ''Definitions'';

(iii) Section 5, ''General Test Requirements''; and

(iv) Section 6, ''Test Method.''

(e) *FM.* FM Global, 1151 Boston-Providence Turnpike, P.O. Box 9102, Norwood, MA 02062; (781) 762–4300; *www.fmglobal.com.*

(1) FM Class Number 1319, *Approval Standard for Centrifugal Fire Pumps (Horizontal, End Suction Type),* January 2015; IBR approved for § 431.462.

(2) [Reserved]

(f) *HI.* Hydraulic Institute, 300 Interpace Parkway, 3rd Floor, Parsippany, NJ 07054–4406; 973–267–9700; *www.Pumps.org.*

(1) ANSI/HI 9.6.1–2017 (''HI 9.6.1–2017'') ''*Rotodynamic Pumps—Guideline for NPSH Margin,* ANSI-approved January 6, 2017; IBR approved for appendix A to this subpart.

(2) ANSI/HI 9.6.6–2016 (''HI 9.6.6–2016'') ''*Rotodynamic Pumps for Pump Piping,* ANSI-approved March 23, 2016; IBR approved for appendix A to this subpart.

(3) ANSI/HI 9.8–2018 (''HI 9.8–2018'') ''*Rotodynamic Pumps for Pump Intake Design,* ANSI-approved January 8, 2018; IBR approved for appendix A to this subpart.

(4) ANSI/HI 14.1–14.2–2019 (''HI 14.1–14.2–2019'') ''*Rotodynamic Pumps for Nomenclature and Definitions,* ANSI-approved April 9, 2019; IBR approved for appendix A to this subpart.

(5) HI 40.6–2014 (''HI 40.6–2014–B''), *Methods for Rotodynamic Pump Efficiency Testing,* copyright 2014, IBR approved for appendices B and C to this subpart, excluding the following:

(i) Section 40.6.4.1 ''Vertically suspended pumps'';

(ii) Section 40.6.4.2 ''Submersible pumps'';

(iii) Section 40.6.5.3 ''Test report'';

(iv) Section 40.6.5.5 ''Test conditions'';

(v) Section 40.6.5.5.2 ''Speed of rotation during test'';

(vi) Section 40.6.6.1 ''Translation of test results to rated speed of rotation'';

(vii) Appendix A ''Test arrangements (normative)'': A.7 ''Testing at temperatures exceeding 30 °C (86 °F)''; and

(viii) Appendix B, ''Reporting of test results (normative)'').

(6) HI 40.6–2021, *Hydraulic Institute Standard for Methods for Rotodynamic Pump Efficiency Testing,* approved February 17, 2021; IBR approved for appendices A and D to this subpart.

(7) HI 41.5–2022, *Hydraulic Institute Program Guideline for Circulator Pump Energy Rating Program,* approved June 16, 2022; IBR approved for appendix D to this subpart.

(8) HI Engineering Data Book, Second Edition copyright 1990; IBR approved for appendix A to this subpart.

(g) *IEEE.* Institute of Electrical and Electronics Engineers, Inc., 45 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855–1331; (732) 981–0060; *www.ieee.org.*

(1) IEEE 112–2017, I*EEE Standard Test Procedure for Polyphase Induction Motors and Generators,* published February 14, 2018; IBR approved for appendix A to this subpart.

(2) IEEE 113–1985, *IEEE Guide: Test Procedures for Direct-Current Machines,*'' copyright 1985, IBR approved for appendices B and C to this subpart, as follows:

(i) Section 3, Electrical Measurements and Power Sources for all Test Procedures:

(A) Section 3.1, ''Instrument Selection Factors'';

(B) Section 3.4 ''Power Measurement''; and

(C) Section 3.5 ''Power Sources'';

(ii) Section 4, Preliminary Tests:

(A) Section 4.1, Reference Conditions, Section 4.1.2, ''Ambient Air''; and

(B) Section 4.1, Reference Conditions, Section 4.1.4 ''Direction of Rotation''; and

(iii) Section 5, Performance Determination:

(A) Section 5.4, Efficiency, Section 5.4.1, ''Reference Conditions''; and

(B) Section 5.4.3, Direct Measurements of Input and Output, Section 5.4.3.2 ''Dynomometer or Torquemeter Method.''

(3) IEEE 114–2010 (''IEEE 114–2010–A''), *IEEE Standard Test Procedure for Single-Phase Induction Motors,* published December 23, 2010; IBR approved for appendix A to this subpart.

(3) IEEE 114–2010 (''IEEE 114–2010''), ''IEEE Standard Test Procedure for Single-Phase Induction Motors,'' approved September 30, 2010, IBR approved for appendices B and C to this subpart, as follows:

(i) Section 3, ''General tests'', Section 3.2, ''Tests with load'';

(ii) Section 4 ''Testing facilities''; and

(iii) Section 5, ''Measurements'':

(A) Section 5.2 ''Mechanical measurements'';

(B) Section 5.3 ''Temperature measurements''; and

(iv) Section 6 ''Tests.''

(h) *ISO.* International Organization for Standardization, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, +41 22 749 01 11. *www.iso.org.*

(1) ISO 1438:2017(E) (''ISO 1438:2017''), *Hydrometry—Open channel flow measurement using thin-plate weirs,* Third edition, April 2017; IBR approved for appendix A to this subpart.

(2) ISO 2186:2007(E) (''ISO 2186:2007''), *Fluid flow in closed conduits—Connections for pressure signal transmissions between primary and secondary elements,* Second edition, March 1, 2007; IBR approved for appendix A to this subpart.

(3) ISO 2715:2017(E) (''ISO 2715:2017''), *Liquid hydrocarbons—Volumetric measurement by turbine flowmeter,* Second edition, November 1, 2017; IBR approved for appendix A to this subpart.

(4) ISO 3354:2008(E) (''ISO 3354:2008''), *Measurement of clean water flow in closed conduits—Velocity-area method using current-meters in full conduits and under regular flow conditions,* Third edition, July 15, 2008; IBR approved for appendix A to this subpart.

(5) ISO 3966:2020(E) (''ISO 3966:2020''), *Measurement of fluid flow in closed conduits—Velocity area method using Pitot static tubes,* Third edition, July 27, 2020; IBR approved for appendix A to this subpart.

(6) ISO 5167–1:2003(E) (''ISO 5167–1:2003''), *Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full—Part 1: General principles and requirements,* Second edition, March 1, 2003; IBR approved for appendix A to this subpart.

(7) ISO 5198:1987(E) (''ISO 5198:1987''), *Centrifugal, mixed flow and axial pumps—Code for hydraulic performance tests—Precision class,* First edition, July 1, 1987; IBR approved for appendix A to this subpart.

(8) ISO 6416:2017(E) (''ISO 6416:2017''), *Hydrometry—Measurement of discharge by the ultrasonic transit time (time of flight) method,* Fourth edition, October 2017; IBR approved for appendix A to this subpart.

(9) ISO 20456:2017(E) (''ISO 20456:2017''), *Measurement of fluid flow in closed conduits—Guidance for the use of electromagnetic flowmeters for conductive liquids,* First edition, September 2017; IBR approved for appendix A to this subpart.

(i) *NFPA.* National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169–7471; (617) 770–3000; *www.nfpa.org.*

(1) NFPA 20 (''NFPA 20–2016''), *Standard for the Installation of Stationary Pumps for Fire Protection,* 2016 Edition, approved June 15, 2015, IBR approved for § 431.462.

(2) [Reserved]

(j) *NSF.* NSF International, 789 N. Dixboro Road, Ann Arbor, MI 48105; (743) 769–8010; *www.nsf.org.*

(1) NSF/ANSI 50–2015, *Equipment for Swimming Pools, Spas, Hot Tubs and Other Recreational Water Facilities,* Annex C, *normative Test methods for the evaluation of centrifugal pumps,* Section C.3, *Self-priming capability,* ANSI-approved January 26, 2015; IBR approved for § 431.462 and appendices B and C to this subpart.

(2) [Reserved]

(k) *UL.* UL, 333 Pfingsten Road, Northbrook, IL 60062; (847) 272–8800; *www.ul.com.*

(1) UL 448 (''ANSI/UL 448–2013''), *Standard for Safety Centrifugal Stationary Pumps for Fire-Protection Service,* 10th Edition, June 8, 2007, including revisions through July 12, 2013; IBR approved for § 431.462.

(2) UL 1081 (''ANSI/UL 1081–2016''), *Standard for Swimming Pool Pumps, Filters, and Chlorinators,* 7th Edition, ANSI-approved October 21, 2016; IBR approved for § 431.462.

■ 7. Section 431.464 is amended by revising paragraphs (a)(1)(i) through (iii) to read as follows:

§ 431.464 Test procedure for the measurement of energy efficiency, energy consumption, and other performance factors of pumps.

(a) * * *

(1) * * *

(i) The following categories of clean water pumps that have the characteristics listed in paragraph (a)(1)(iii) of this section.

(A) End suction close-coupled (ESCC);

(B) End suction frame mounted/own bearings (ESFM);

(C) In-line (IL);

(D) Radially split, multi-stage, vertical, in-line casing diffuser (RSV); and

(E) Submersible turbine (ST) pumps.

(ii) The additional following categories of clean water pumps that have the characteristics listed in paragraph (a)(1)(iii) of this section:

(A) Radially-split, multi-stage, horizontal, end-suction diffuser casing (RSHES);

(B) Radially-split, multi-stage, horizontal, in-line diffuser casing (RSHIL);

(C) Small vertical in-line (SVIL); and

(D) Vertical Turbine (VT).

(iii) Pump characteristics:

(A) Flow rate of 25 gpm or greater at BEP and full impeller diameter;

(B) Maximum head of 459 feet at BEP and full impeller diameter and the number of stages required for testing (*see* section 1.2.2 of appendix A of this subpart);

(C) Design temperature range wholly or partially in the range of 15 to 250 °F;

(D) Designed to operate with either:

(*1*) A 2- or 4- or 6-pole induction motor, or

(*2*) A non-induction motor with a speed of rotation operating range that includes speeds of rotation between 2,880 and 4,320 revolutions per minute (rpm) and/or 1,440 and 2,160 rpm and/or 960 and 1,439 revolutions per minute, and in each case, the driver and impeller must rotate at the same speed;

(E) For ST, and VT pumps, a 6-inch or smaller bowl diameter; and

(F) For ESCC, and ESFM pumps, a specific speed less than or equal to 5,000 when calculated using U.S. customary units.

* * * * *

■ 8. Appendix A to subpart Y of part 431 is amended by:

■ a. Revising the note to the beginning of the appendix;

■ b. Revising section I;

■ c. In section II,

■ i. Revising paragraphs A.1, A.2, B.1.1.1.1, B.1.2.1.2, B.1.2.1.2.1., and B.1.2.1.2.2; and

■ ii. Adding paragraph B.1.2.1.2.3;

■ d. In section III, revising paragraphs A through D, E.1.2.1.2, E.1.2.1.2.1., and E.1.2.1.2.2.;

■ e. In section IV, revising paragraphs A through D;

■ f. In section V, revising paragraphs A through D, E.1.1, E.1.2.1.1, E.1.2.1.1.1. and E.1.2.1.1.2.;

■ g. In section VI, revising paragraphs A through D;

■ h. In section VII,
■ i. Revising paragraphs A through D, the definition of L $_{full}$ in paragraph E.1.2, paragraphs E.1.2.1, E.1.2.1.1, E.1.2.1.1.1, and E.1.2.1.1.2,
■ ii. Adding paragraph E.1.2.1.1.3; and
■ iii. Revising paragraph E.1.2.2;
■ i. Revising Tables 2 and 4; and
■ j. Adding Table 5.

The revisions and additions read as follows:

Appendix A to Subpart Y of Part 431—Uniform Test Method for the Measurement of Energy Consumption of Pumps

Note: Prior to September 20, 2023, representations with respect to the energy use or efficiency (including compliance certifications) of pumps specified in § 431.464(a)(1)(i), excluding pumps listed in § 431.464(a)(1)(iv), must be based on testing conducted in accordance with the applicable provisions of this appendix as they appeared in the January 1, 2022 edition of the Code of Federal Regulations of subpart Y of part 431 in 10 CFR parts 200 through 499.

On or after September 20, 2023, representations with respect to the energy use or efficiency (including compliance certifications) of pumps specified in § 431.464(a)(1)(i), excluding pumps listed in § 431.464(a)(1)(iv), must be based on testing conducted in accordance with the applicable provisions of this appendix.

Any representations with respect to the energy use or efficiency of pumps specified in § 431.464(a)(1)(ii), excluding pumps listed in § 431.464(a)(1)(iv), made on or after September 20, 2023 must be made in accordance with the results of testing pursuant to this appendix. Manufacturers must use the results of testing under this appendix to determine compliance with any energy conservation standards established for pumps specified in § 431.464(a)(1)(ii), excluding pumps listed in § 431.464(a)(1)(iv), that are published after January 1, 2022.

I. Test Procedure for Pumps

0. Incorporation by Reference.

DOE incorporated by reference in § 431.463 the entire standard for HI 40.6–2021, HI 9.6.1–2017, HI 9.6.6–2016, HI 9.8–2018, HI 14.1–14.2–2019, the HI Engineering Data Book, ASME MFC–5M–1985, ASME MFC–3M–2004, ASME MFC–8M–2001, ASME MFC–12M–2006, ASME MFC–16–2014, ASME MFC–22–2007, AWWA E103–2015, CSA C390–10, IEEE 112–2017, IEEE 114–2010–A, ISO 1438:2017, ISO 2186:2007, ISO 2715:2017, ISO 3354:2008, ISO 3966:2020, ISO 5167–1:2003, ISO 5198:1987, ISO 6416:2017, and ISO 20456:2017; however, certain enumerated provisions of HI 40.6–2021, as follows are inapplicable. To the extent that there is a conflict between the terms or provisions of a referenced industry standard and the CFR, the CFR provisions control.

0.1 HI 40.6–2021

(a) Section 40.6.1 Scope

(b) Section 40.6.5.3 Test report

(c) Appendix B Reporting of test results (informative)

(d) Appendix E Testing Circulator Pumps (normative)

(e) Appendix G DOE Compared to HI 40.6 Nomenclature

0.2 [Reserved]

A. *General.* To determine the constant load pump energy index (PEI_{CL}) for bare pumps and pumps sold with electric motors or the variable load pump energy index (PEI_{VL}) for pumps sold with electric motors and continuous or non-continuous controls, perform testing in accordance with HI 40.6–2021, except section 40.6.5.3, ''Test report'', including the applicable provisions of HI 9.6.1–2017, HI 9.6.6–2016, HI 9.8–2018, HI 14.1–14.2–2019, the HI Engineering Data Book, ASME MFC–3M–2004, ASME MFC–5M–1985, ASME MFC–8M–2001, ASME MFC–12M–2006, ASME MFC–16–2014, ASME MFC–22–2007, AWWA E103–2015, CSA C390–10, IEEE 112–2017, IEEE 114–2010–A, ISO 1438:2017, ISO 2186:2007, ISO 2715:2017, ISO 3354:2008, ISO 3966:2020, ISO 5167–1:2003, ISO 5198:1987, ISO 6416:2017, and ISO 20456:2017, as referenced in HI 40.6, with the modifications and additions as noted throughout the provisions below. Where HI 40.6–2021 refers to ''pump,'' the term refers to the ''bare pump,'' as defined in § 431.462. Also, for the purposes of applying this appendix, the term ''volume per unit time,'' as defined in section 40.6.2, ''Terms and definitions,'' of HI 40.6–2021 shall be deemed to be synonymous with the term ''flow rate'' used throughout that standard and this appendix. In addition, the specifications in section 40.6.4.1 of HI 40.6–2021, ''Vertically suspended pumps,'' do not apply to ST pumps and the performance of ST bare pumps considers bowl performance only. However, the specifications in the first paragraph of section 40.6.4.1 of HI 40.6–2021 (including the applicable provisions of HI 14.1–14.2–2019, the HI Engineering Data Book, and AWWA E103–2015, as referenced in section 40.6.4.1 of HI 40.6), ''Vertically suspended pumps,'' do apply to VT pumps and the performance of VT bare pumps considers bowl performance only.

A.1 *Scope.* Section II of this appendix applies to all pumps and describes how to calculate the pump energy index (section II.A) based on the pump energy rating for the minimally-compliant reference pump (PER_{STD}; section II.B) and the constant load pump energy rating (PER_{CL}) or variable load pump energy rating (PER_{VL}) determined in accordance with one of sections III through VII of this appendix, based on the configuration in which the pump is distributed in commerce and the applicable testing method specified in sections III through VII and as described in Table 1 of this appendix.

TABLE 1—APPLICABILITY OF CALCULATION-BASED AND TESTING-BASED TEST PROCEDURE OPTIONS BASED ON PUMP CONFIGURATION

Pump configuration	Pump sub-configuration	Applicable test methods
Bare Pump	Bare Pump OR Pump + Single-Phase Induction Motor (Excluding SVIL) OR Pump + Driver Other Than Electric Motor.	Section III: Test Procedure for Bare Pumps.
Pump + Motor OR Pump + Motor + Controls other than continuous or non-continuous controls (*e.g.,* ON/OFF switches).	Pump + Motor Listed at § 431.25(g) OR SVIL Pump + Motor Covered by DOE's Test Procedure and/or Energy Conservation Standards * OR Pump + Submersible Motor.	Section IV: Testing-Based Approach for Pumps Sold with Motors OR Section V: Calculation-Based Approach for Pumps Sold with Motors.
	Pump (Including SVIL) + Motor Not Covered by DOE's Motor Energy Conservation Standards (Except Submersible Motors) ** OR Pump (Other than SVIL) + Single-Phase Induction Motor (if Section III is not used).	Section IV: Testing-Based Approach for Pumps Sold with Motors.
Pump + Motor + Continuous Controls OR Pump + Motor + Non-Continuous Controls OR Pump + Inverter-Only Synchronous Electric Motor *** (With or Without Controls).	Pump + Motor Listed at § 431.25(g) + Continuous Control OR SVIL Pump + Motor Covered by DOE's Test Procedure and/or Energy Conservation Standards * + Continuous Control OR Pump + Submersible Motor + Continuous Control OR Pump + Inverter-Only Synchronous Electric Motor *** (With or Without Continuous Control).	Section VI: Testing-Based Approach for Pumps Sold with Motors and Controls OR Section VII: Calculation-Based Approach for Pumps Sold with Motors Controls.
	Pump + Motor Listed at § 431.25(g) + Non-Continuous Control OR SVIL Pump + Motor Covered by DOE's Test Procedure and/or Energy Conservation Standards * + Non-Continuous Control OR Pump + Submersible Motor + Non-Continuous Control.	Section VI: Testing-Based Approach for Pumps Sold with Motors and Controls.

TABLE 1—APPLICABILITY OF CALCULATION-BASED AND TESTING-BASED TEST PROCEDURE OPTIONS BASED ON PUMP CONFIGURATION—Continued

Pump configuration	Pump sub-configuration	Applicable test methods
	Pump (Including SVIL) + Motor Not Covered by DOE's Motor Test Procedure and/or Energy Conservation Standards ** (Except Submersible Motors) + Continuous or Non-Continuous Controls OR Pump (Other than SVIL) + Single-Phase Induction Motor + Continuous or Non-Continuous Controls (if Section III is not used).	Section VI: Testing-Based Approach for Pumps Sold with Motors and Controls.

* All references to "Motor Covered by DOE's Motor Test Procedure and/or Energy Conservation Standards" refer to those listed at § 431.446 of this chapter or those for Small Non-Small Electric Motor Electric Motors (SNEMs) at Subpart B to Part 431, including motors of such varieties that are less than 0.25 hp.

** All references to "Motor Not Covered by DOE's Test Procedure and/or Motor Energy Conservation Standards" refer to motors not listed at § 431.25 of this chapter or, for SVIL, not listed at either § 431.446 of this chapter or in Subpart B to Part 431 (excluding motors of such varieties that are less than 0.25 hp).

*** All references to "Inverter-Only Synchronous Electric Motor" refer to inverter-only electric motors that are synchronous electric motors, both as defined in subpart B to Part 431.

A.2 Section III of this appendix addresses the test procedure applicable to bare pumps. This test procedure also applies to pumps sold with drivers other than motors and ESCC, ESFM, IL, RSHES, RSHIL, RSV, ST, and VT pumps sold with single-phase induction motors.

A.3 Section IV of this appendix addresses the testing-based approach for pumps sold with motors, which applies to all pumps sold with electric motors, except for pumps sold with inverter-only synchronous electric motors, but including pumps sold with single-phase induction motors. This test procedure also applies to pumps sold with controls other than continuous or non-continuous controls (*e.g.,* on/off switches).

A.4 Section V of this appendix addresses the calculation-based approach for pumps sold with motors, which applies to:

A.4.1 Pumps sold with polyphase electric motors regulated by DOE's energy conservation standards for electric motors at § 431.25(g), and

A.4.2 SVIL pumps sold with small electric motors regulated by DOE's energy conservation standards at § 431.446 or sold with SNEMs regulated by DOE's test procedure and/or energy conservation standards in subpart B of this part but including motors of such varieties that are less than 0.25 hp, and

A.4.3 Pumps sold with submersible motors.

A.5 Section VI of this appendix addresses the testing-based approach for pumps sold with motors and controls, which applies to all pumps sold with electric motors (including single-phase induction motors) and continuous or non-continuous controls and to pumps sold with inverter-only synchronous electric motors with or without controls.

A.6 Section VII of this appendix discusses the calculation-based approach for pumps sold with motors and controls, which applies to:

A.6.1 Pumps sold with polyphase electric motors regulated by DOE's energy conservation standards for electric motors at § 431.25(g) and continuous controls and

A.6.2 Pumps sold with inverter-only synchronous electric motors regulated by DOE's test procedure and/or energy conservation standards in subpart B of this part,

A.6.3 SVIL pumps sold with small electric motors regulated by DOE's energy conservation standards at § 431.446 (but including motors of such varieties that are less than 0.25 hp) and continuous controls or with SNEMs regulated by DOE's test procedure and/or energy conservation standards at subpart B of this part (but including motors of such varieties that are less than 0.25 hp) and continuous controls, and

A.6.4 Pumps sold with submersible motors and continuous controls.

B. *Measurement Equipment.*

B.1 Instrument Accuracy. For the purposes of measuring pump power input, driver power input to the motor or controls, and pump power output, the equipment specified in HI 40.6–2021 Appendix C (including the applicable provisions of ASME MFC–5M–1985, ASME MFC–3M–2004, ASME MFC–8M–2001, ASME MFC–12M–2006, ASME MFC–16–2014, ASME MFC–22–2007, CSA C390–10, IEEE 112–2017, IEEE 114–2010–A, ISO 1438:2017, ISO 2186:2007, ISO 2715:2017, ISO 3354:2008, ISO 3966:2020, ISO 5167–1:2003, ISO 5198:1987, ISO 6416:2017, and ISO 20456:2017, as referenced in Appendix C of HI 40.6) necessary to measure head, speed of rotation, flow rate, temperature, torque, and electrical power must be used and must comply with the stated accuracy requirements in HI 40.6–2021 Table 40.6.3.2.3 except as noted in sections III.B, IV.B, V.B, VI.B, and VII.B of this appendix. When more than one instrument is used to measure a given parameter, the combined accuracy, calculated as the root sum of squares of individual instrument accuracies, must meet the specified accuracy requirements.

B.2 Calibration. Calibration requirements for instrumentation are specified in Appendix D of HI 40.6–2021.

C. *Test Conditions.* Conduct testing at full impeller diameter in accordance with the test conditions, stabilization requirements, and specifications of HI 40.6–2021 Section 40.6.3, "Pump efficiency testing;" Section 40.6.4, "Considerations when determining the efficiency of certain pumps" including the applicable provisions of HI 14.1–14.2–2019, the HI Engineering Data Book, and AWWA E103–2015, as referenced in section 40.6.4 of HI 40.6; section 40.6.5.4 (including appendix A), "Test arrangements," including the applicable provisions of HI 9.6.1–2017, HI 9.6.6–2016, HI 9.8–2018, HI Engineering Data Book, and AWWA E103–2015 as referenced in appendix A of HI 40.6; and section 40.6.5.5, "Test conditions" including the applicable provisions of HI 9.6.1–2017 as referenced in section 40.6.5.5.1 of HI 40.6–2021. For ST pumps, head measurements must be based on the bowl assembly total head as described in section A.5 of 40.6–2021, including the applicable provisions of the HI Engineering Data Book and AWWA E103–2015 as referenced in ins section A.5 of HI 40.6–2021, and the pump power input or driver power input, as applicable, must be based on the measured input power to the driver or bare pump, respectively; section 40.6.4.1, "Vertically suspended pumps," does not apply to ST pumps.

C.1 Nominal Speed of Rotation. Determine the nominal speed of rotation based on the range of speeds of rotation at which the pump is designed to operate, in accordance with sections I.C.1.1, I.C.1.2, and I.C.1.3 of this appendix, as applicable. When determining the range of speeds at which the pump is designed to operate, DOE will refer to published data, marketing literature, and other publicly-available information about the pump model and motor, as applicable.

C.1.1 For pumps sold without motors, select the nominal speed of rotation based on the speed for which the pump is designed.

C.1.1.1 For bare pumps designed for speeds of rotation including 2,880 to 4,320 revolutions per minute (rpm), the nominal speed of rotation shall be 3,600 rpm.

C.1.1.2 For bare pumps designed for speeds of rotation including 1,440 to 2,160 rpm, the nominal speed of rotation shall be 1,800 rpm.

C.1.1.3 For bare pumps designed for speeds of rotation including 960 to 1,439 rpm, the nominal speed of rotation shall be 1,200 rpm.

C.1.2 For pumps sold with induction motors, select the appropriate nominal speed of rotation.

C.1.2.1 For pumps sold with 6-pole induction motors, the nominal speed of rotation shall be 1,200 rpm.

C.1.2.2 For pumps sold with 4-pole induction motors, the nominal speed of rotation shall be 1,800 rpm.

C.1.2.3 For pumps sold with 2-pole induction motors, the nominal speed of rotation shall be 3,600 rpm.

C.1.3 For pumps sold with non-induction motors, select the appropriate nominal speed of rotation.

C.1.3.1 Where the operating range of the pump and motor includes speeds of rotation between 2,880 and 4,320 rpm, the nominal speed of rotation shall be 3,600 rpm.

C.1.3.2 Where the operating range of the pump and motor includes speeds of rotation between 1,440 and 2,160 rpm, the nominal speed of rotation shall be 1,800 rpm.

C.1.3.3 Where the operating range of the pump and motor includes speeds of rotation between 960 and 1,439, the nominal speed of rotation shall be 1,200 rpm.

C.2 Multi-Stage Pumps. Perform testing on the pump with three stages for RSH and RSV pumps, and nine stages for ST and VT pumps. If the basic model of pump being tested is only available with fewer than the required number of stages, test the pump with the maximum number of stages with which the basic model is distributed in commerce in the United States. If the basic model of pump being tested is only available with greater than the required number of stages, test the pump with the lowest number of stages with which the basic model is distributed in commerce in the United States. If the basic model of pump being tested is available with both fewer and greater than the required number of stages, but not the required number of stages, test the pump with the number of stages closest to the required number of stages. If both the next lower and next higher number of stages are equivalently close to the required number of stages, test the pump with the next higher number of stages.

C.3 Twin-Head Pumps. For twin-head pumps, perform testing on an equivalent single impeller IL or SVIL pump as applicable, constructed by incorporating one of the driver and impeller assemblies of the twin-head pump being rated into an adequate IL-style or SVIL-style, single impeller volute and casing. An adequate IL-style or SVIL-style, single impeller volute and casing means a volute and casing for which any physical and functional characteristics that affect energy consumption and energy efficiency are the same as their corresponding characteristics for a single impeller in the twin-head pump volute and casing.

D. *Data Collection and Analysis.*

D.1 Damping Devices. Use of damping devices, as described in section 40.6.3.2.2 of HI 40.6–2021, are only permitted to integrate up to the data collection interval used during testing.

D.2 Stabilization. Record data at any tested load point only under stabilized conditions, as defined in HI 40.6–2021 section 40.6.5.5.1, including the applicable provisions of HI 9.6.1–2017 as referenced in section 40.6.5.5.1 of HI 40.6, where a minimum of two measurements are used to determine stabilization.

D.3 Calculations and Rounding. Normalize all measured data to the nominal speed of rotation of 3,600 or 1,800 or 1,200 rpm based on the nominal speed of rotation selected for the pump in section I.C.1 of this appendix, in accordance with the procedures specified in section 40.6.6.1.1 of HI 40.6–2021. Except for the ‘‘expected BEP flow rate,’’ all terms and quantities refer to values determined in accordance with the procedures set forth in this appendix for the rated pump. Perform all calculations using raw measured values without rounding. Round PER_{CL} and PER_{VL} to three significant digits, and round PEI_{CL}, and PEI_{VL} values, as applicable, to the hundredths place (*i.e.,* 0.01).

D.4 Pumps with BEP at Run Out. Test pumps for which the expected BEP corresponds to a volume rate of flow that is within 20 percent of the expected maximum flow rate at which the pump is designed to operate continuously or safely (*i.e.,* pumps with BEP at run-out) in accordance with the test procedure specified in this appendix, but with the following exceptions:

D.4.1 Use the following seven flow points—40, 50, 60, 70, 80, 90, and 100 percent of the expected maximum flow rate for determination of BEP in sections III.D, IV.D, V.D, VI.D, and VII.D of this appendix instead of the flow points specified in those sections.

D.4.2 Use flow points of 60, 70, 80, 90, and 100 percent of the expected maximum flow rate of the pump to determine pump power input or driver power input instead of the flow points of 60, 75, 90, 100, 110, and 120 percent of the expected BEP flow rate specified in sections III.E.1.1, IV.E.1, V.E.1.1, VI.E.1, and VII.E.1.1 of this appendix.

D.4.3 To determine PER_{CL} in sections III.E, IV.E, and V.E and to determine PER_{STD} in section II.B, use load points of 65, 90, and 100 percent of the BEP flow rate determined with the modified flow points specified in this section I.D.4 of this appendix instead of 75, 100, and 110 percent of BEP flow. In section II.B.1.1, where alpha values are specified for the load points 75, 100, and 110 percent of BEP flow rate, instead apply the alpha values to the load points of 65, 90, and 100 percent of the BEP flow rate determined with the modified flow points specified in this section I.D.4 of this appendix. However, in sections II.B.1.1.1 and II.B.1.1.1.1 of this appendix, use 100 percent of the BEP flow rate as specified to determine $\eta_{pump,STD}$ and Ns as specified. To determine motor sizing for bare pumps in sections II.B.1.2.1.1 and III.E.1.2.1.1 of this appendix, use a load point of 100 percent of the BEP flow rate instead of 120 percent.

II. Calculation of the Pump Energy Index

A. * * *

A.1. For pumps rated as bare pumps or pumps sold with motors (other than inverter-only synchronous electric motors), determine the PEI_{CL} using the following equation:

$$PEI_{CL} = \frac{PER_{CL}}{PER_{STD}}$$

Where:

PEI_{CL} = the pump energy index for a constant load (hp),

PER_{CL} = the pump energy rating for a constant load (hp), determined in accordance with either section III (for bare pumps; ESCC, ESFM, IL, RSHES, RSHIL, RSV, ST or VT pumps sold with single-phase induction motors; and pumps sold with drivers other than electric motors), section IV (for pumps sold with motors and rated using the testing-based approach), or section V (for pumps sold with motors and rated using the calculation-based approach) of this appendix, and

PER_{STD} = the PER_{CL} for a pump that is minimally compliant with DOE's energy conservation standards with the same flow and specific speed characteristics as the tested pump (hp), as determined in accordance with section II.B of this appendix.

A.2 For pumps rated as pumps sold with motors and continuous controls or non-continuous controls (including pumps sold with inverter-only synchronous electric motors with or without controls), determine the PEI_{VL} using the following equation:

$$PEI_{VL} = \frac{PER_{VL}}{PER_{STD}}$$

PEI_{VL} = the pump energy index for a variable load (hp),

PER_{VL} = the pump energy rating for a variable load (hp), determined in accordance with section VI (for pumps sold with motors and continuous or non-continuous controls rated using the testing-based approach) or section VII of this appendix (for pumps sold with motors and continuous controls rated using the calculation-based approach), and

PER_{STD} = the PER_{CL} for a pump that is minimally compliant with DOE's energy conservation standards with the same flow and specific speed characteristics as the tested pump (hp), as determined in accordance with section II.B of this appendix.

B. * * *

B.1.1.1.1 Determine the specific speed of the rated pump using the following equation:

$$N_s = \frac{n_{sp} \times \sqrt{Q_{100\%}}}{(H_{100\%}/S)^{0.75}}$$

Where:

Ns = specific speed,

n_{sp} = the nominal speed of rotation (rpm),

$Q'_{100\%}$ = the measured BEP flow rate of the tested pump at full impeller and nominal speed of rotation (gpm),

$H_{100\%}$ = pump total head at 100 percent of the BEP flow rate of the tested pump at full impeller and nominal speed of rotation (ft), and

S = the number of stages with which the pump is being rated

B.1.2.1.2 Determine the default nominal full load motor efficiency as described in section II.B.1.2.1.2.1 of this appendix for ESCC, ESFM, IL, RSHES, RSHIL, RSV, and VT pumps; section II.B.1.2.1.2.2 of this appendix for ST pumps; and section II.B.1.2.1.2.3 for SVIL pumps.

B.1.2.1.2.1. For ESCC, ESFM, IL, RSHES, RSHIL, RSV, and VT pumps, the default nominal full load motor efficiency is the minimum of the nominal full load motor efficiency standards (open or enclosed) from the table containing the current energy conservation standards for NEMA Design B motors at § 431.25, with the number of poles relevant to the speed at which the pump is being tested (see section I.C.1 of this appendix) and the motor horsepower determined in section II.B.1.2.1.1 of this appendix.

B.1.2.1.2.2. For ST pumps, prior to the compliance date of any energy conservation standards for submersible motors in subpart B of this part, the default nominal full load motor efficiency is the default nominal full load submersible motor efficiency listed in table 2 of this appendix, with the number of poles relevant to the speed at which the pump is being tested (see section I.C.1 of this appendix) and the motor horsepower determined in section II.B.1.2.1.1 of this appendix. Starting on the compliance date of any energy conservation standards for submersible motors in subpart B of this part, the default nominal full load motor efficiency shall be the minimum of any nominal full load motor efficiency standard from the table containing energy conservation standards for submersible motors in subpart B of this part, with the number of poles relevant to the speed at which the pump is being tested (see section I.C.1 of this appendix) and the motor horsepower determined in section II.B.1.2.1.1 of this appendix.

B.1.2.1.2.3. For SVIL pumps, the default nominal full load motor efficiency is the minimum full load motor efficiency standard from the tables containing the current energy conservation standards for polyphase or CSCR/CSIR small electric motors at § 431.446, with the number of poles relevant to the speed at which the pump is being tested (see section I.C.1 of this appendix) and the motor horsepower determined in section II.B.1.2.1.1 of this appendix, or for SVIL pumps sold with motors less than 0.25 hp, the default nominal full load motor efficiency is 58.3% for 6-pole, 64.6% for 4-pole, and 61.7% for 2-pole motors.

* * * * *

III. Test Procedure for Bare Pumps

A. Scope. This section III applies only to:

A.1 Bare pumps,

A.2 Pumps sold with drivers other than electric motors, and

A.3 ESCC, ESFM, IL, RSHES, RSHIL, RSV, ST, and VT pumps sold with single-phase induction motors.

B. Measurement Equipment. The requirements regarding measurement equipment presented in section I.B of this appendix apply to this section III. In addition, when testing pumps using a calibrated motor, electrical measurement equipment shall meet the requirements of section C.4.3 of HI 40.6–2021 (including the applicable provisions of CSA C390–10, IEEE 112–2017, IEEE 114–2010–A, as referenced in section C.4.3 of HI 40.6), and motor power input shall be determined according to section 40.6.3.2.3 of HI 40.6–2021 and meet the requirements in Table 40.6.3.2.3 of HI 40.6–2021.

C. Test Conditions. The requirements regarding test conditions presented in section I.C of this appendix apply to this section III. In addition, when testing pumps using a calibrated motor, the conditions in section C.4.3.1 of HI 40.6–2021 shall be met, including the applicable provisions of CSA C390–10, IEEE 112–2017, IEEE 114–2010–A, as referenced in section C.4.3.1 of HI 40.6–2021.

D. Testing BEP for the Pump. Determine the best efficiency point (BEP) of the pump as follows:

D.1. Adjust the flow by throttling the pump without changing the speed of rotation of the pump and conduct the test at a minimum of the following seven flow points: 40, 60, 75, 90, 100, 110, and 120 percent of the expected BEP flow rate of the pump at the nominal speed of rotation, as specified in section 40.6.5.5.1 of HI 40.6–2021, including the applicable provisions of HI 9.6.1–2017 as referenced in section 40.6.5.5.1 of HI 40.6–2021.

D.2. Determine the BEP flow rate as the flow rate at the operating point of maximum pump efficiency on the pump efficiency curve, as determined in accordance with section 40.6.6.3 of HI 40.6–2021, where the pump efficiency is the ratio of the pump power output divided by the pump power input, as specified in Table 40.6.2 of HI 40.6–2021, disregarding the calculations provided in section 40.6.6.2 of HI 40.6–2021.

* * * * *

E.1.2.1.2 Determine the default nominal full load motor efficiency as described in section III.E.1.2.1.2.1 of this appendix for ESCC, ESFM, IL, RSHES, RSHIL, RSV, and VT pumps; or section III.E.1.2.1.2.2. of this appendix for ST pumps; or section III.E.1.2.1.2.3 of this appendix for SVIL pumps.

E.1.2.1.2.1. For ESCC, ESFM, IL, RSHES, RSHIL, RSV, and VT pumps, the default nominal full load motor efficiency is the minimum of the nominal full load motor efficiency standards (open or enclosed) from the table containing the current energy conservation standards for NEMA Design B motors at § 431.25, with the number of poles relevant to the speed at which the pump is being tested (see section I.C.1 of this appendix) and the motor horsepower determined in section III.E.1.2.1.1 of this appendix.

E.1.2.1.2.2. For ST pumps, prior to the compliance date of any energy conservation standards for submersible motors in subpart B of this part, the default nominal full load motor efficiency is the default nominal full load submersible motor efficiency listed in table 2 of this appendix, with the number of poles relevant to the speed at which the pump is being tested (see section I.C.1 of this appendix) and the motor horsepower determined in section III.E.1.2.1.1 of this appendix. Starting on the compliance date of any energy conservation standards for submersible motors in subpart B of this part, the default nominal full load motor efficiency is the minimum of any nominal full load motor efficiency standard from the table containing energy conservation standards for submersible motors in subpart B of this part, with the number of poles relevant to the speed at which the pump is being tested (see section I.C.1 of this appendix) and the motor horsepower determined in accordance with section III.E.1.2.1.1 of this appendix.

E.1.2.1.2.3. For SVIL pumps, the default nominal full load motor efficiency is the minimum full load motor efficiency standard from the tables containing the current energy conservation standards for polyphase or CSCR/CSIR small electric motors at § 431.446, with the number of poles relevant to the speed at which the pump is being tested (see section I.C.1 of this appendix) and the motor horsepower determined in section III.E.1.2.1.1 of this appendix, or for SVIL pumps sold with motors less than 0.25 hp, the default nominal full load motor efficiency is 58.3% for 6-pole, 64.6% for 4-pole, and 61.7% for 2-pole motors.

* * * * *

IV. Testing-Based Approach for Pumps Sold With Motors

A. *Scope.* This section IV applies only to pumps sold with electric motors (excluding pumps sold with inverter-only synchronous electric motors regulated by DOE's test procedure and/or energy conservation standards in subpart B of this part), including single-phase induction motors.

B. *Measurement Equipment.* The requirements regarding measurement equipment presented in section I.B of this appendix apply to this section IV. In addition, when testing pumps using a calibrated motor, electrical measurement equipment shall meet the requirements of section C.4.3 of HI 40.6–2021 (including the applicable provisions of CSA C390–10, IEEE 112–2017, IEEE 114–2010–A, as referenced in section C.4.3 of HI 40.6), and motor power input shall be determined according to section 40.6.3.2.3 of HI 40.6–2021 and meet the requirements in Table 40.6.3.2.3 of HI 40.6–2021.

C. *Test Conditions.* The requirements regarding test conditions presented in section I.C of this appendix apply to this section IV. In addition, when testing pumps using a calibrated motor, the conditions in section C.4.3.1 of HI 40.6–2021, including the applicable provisions of CSA C390–10, IEEE 112–2017, IEEE 114–2010–A, as referenced in Section C.4.3.1 of HI 40.6, shall be met.

D. *Testing BEP for the Pump.* Determine the best efficiency point (BEP) of the pump as follows:

D.1. Adjust the flow by throttling the pump without changing the speed of rotation of the pump and conduct the test at a minimum of the following seven flow points: 40, 60, 75, 90, 100, 110, and 120 percent of the expected BEP flow rate of the pump at the nominal speed of rotation, as specified in section 40.6.5.5.1 of HI 40.6–2021, including the applicable provisions of HI 9.6.1–2017 as referenced in section 40.6.5.5.1 of HI 40.6–2021.

D.2. Determine the BEP flow rate as the flow rate at the operating point of maximum pump efficiency on the pump efficiency curve, as determined in accordance with Section 40.6.6.3 of HI 40.6–2021, where the pump efficiency is the ratio of the pump power output divided by the pump power input, as specified in Table 40.6.2 of HI 40.6–2021, disregarding the calculations provided in section 40.6.6.2 of HI 40.6–2021.

* * * * *

V. Calculation-Based Approach for Pumps Sold With Motors

A. *Scope.* This section V can only be used in lieu of the test method in section IV of this appendix to calculate the index for pumps sold with motors listed in section V.A.1, V.A.2, or V.A.3 of this appendix.

A.1 Pumps sold with motors subject to DOE's energy conservation standards for polyphase electric motors at § 431.25(g),

A.2 SVIL pumps sold with small electric motors regulated by DOE's energy conservation standards at § 431.446 or with SNEMs regulated by DOE's test procedure and/or energy conservation standards in subpart B of this part but including motors of such varieties that are less than 0.25 hp, and

A.3. Pumps sold with submersible motors.

A.4. Pumps sold with motors not listed in sections V.A.1, V.A.2, or V.A.3 of this appendix cannot use this section V and must apply the test method in section IV of this appendix.

B. *Measurement Equipment.* The requirements regarding measurement equipment presented in section I.B of this appendix apply to this section V. In addition, when testing pumps using a calibrated motor, electrical measurement equipment shall meet the requirements of section C.4.3 of HI 40.6–2021 (including the applicable provisions of CSA C390–10, IEEE 112–2017, IEEE 114–2010–A, as referenced in section C.4.3 of HI 40.6), and motor power input shall be determined according to section 40.6.3.2.3 of HI 40.6–2021 and meet the requirements in Table 40.6.3.2.3 of HI 40.6–2021.

C. *Test Conditions.* The requirements regarding test conditions presented in section I.C of this appendix apply to this section V. In addition, when testing pumps using a calibrated motor, the conditions in section C.4.3.1 of HI 40.6–2021, including the applicable provisions of CSA C390–10, IEEE 112–2017, IEEE 114–2010–A, as referenced in section C.4.3.1 of HI 40.6–2021 shall be met.

D. *Testing BEP for the Pump.* Determine the best efficiency point (BEP) of the pump as follows:

D.1. Adjust the flow by throttling the pump without changing the speed of rotation of the pump and conduct the test at a minimum of the following seven flow points: 40, 60, 75, 90, 100, 110, and 120 percent of the expected BEP flow rate of the pump at the nominal speed of rotation, as specified in section 40.6.5.5.1 of HI 40.6–2021, including the applicable provisions of HI 9.6.1–2017 as referenced in section 40.6.5.5.1 of HI 40.6–2021.

D.2. Determine the BEP flow rate as the flow rate at the operating point of maximum pump efficiency on the pump efficiency curve, as determined in accordance with section 40.6.6.3 of HI 40.6–2021, where the pump efficiency is the ratio of the pump power output divided by the pump power input, as specified in Table 40.6.2 of HI 40.6–2021, disregarding the calculations provided in section 40.6.6.2.

* * * * *

E.1.1 Determine the pump power input at 75, 100, and 110 percent of the BEP flow rate by employing a least squares regression to determine a linear relationship between the pump power input at the nominal speed of rotation of the pump and the measured flow rate at the following load points: 60, 75, 90, 100, 110, and 120 percent of the expected BEP flow rate. Use the linear relationship to determine the pump power input at the nominal speed of rotation for the load points of 75, 100, and 110 percent of the BEP flow rate.

* * * * *

E.1.2.1.1 For pumps sold with motors other than submersible motors, determine the represented nominal full load motor efficiency as described in section V.E.1.2.1.1.1 of this appendix. For pumps sold with submersible motors, determine the default nominal full load submersible motor efficiency as described in section V.E.1.2.1.1.2 of this appendix.

E.1.2.1.1.1 For pumps sold with motors other than submersible motors, the represented nominal full load motor efficiency is that of the motor with which the given pump model is being tested, as determined in accordance with the DOE test procedure for electric motors at § 431.16 or, for SVIL, the DOE test procedure for small electric motors at § 431.444, or the DOE test procedure for SNEMs in subpart B to this part, as applicable (including for motors less than 0.25 hp), and if available, applicable representation procedures in 10 CFR part 429 and this part.

E.1.2.1.1.2 For pumps sold with submersible motors, prior to the compliance date of any energy conservation standards for submersible motors in subpart B of this part, the default nominal full load submersible motor efficiency is that listed in table 2 of this appendix, with the number of poles relevant to the speed at which the pump is being tested (see section I.C.1 of this appendix) and the motor horsepower of the pump being tested, or if a test procedure for submersible motors is provided in subpart B to this part, the represented nominal full load motor efficiency of the motor with which the given pump model is being tested, as determined in accordance with the applicable test procedure in subpart B to this part and applicable representation procedures in 10 CFR part 429 and this part, may be used instead. Starting on the compliance date of any energy conservation standards for submersible motors in subpart B of this part, the default nominal full load submersible motor efficiency may no longer be used. Instead, the represented nominal full load motor efficiency of the motor with which the given pump model is being tested, as determined in accordance with the applicable test procedure in subpart B of this part and applicable representation procedures in 10 CFR part 429 and this part, must be used.

* * * * *

VI. Testing-Based Approach for Pumps Sold With Motors and Controls

A. *Scope.* This section VI applies only to pumps sold with electric motors, including single-phase induction motors, and continuous or non-continuous controls, as well as to pumps sold with inverter-only synchronous electric motors that are regulated by DOE's test procedure and/or energy conservation standards in subpart B of this part (with or without controls). For the purposes of this section VI, all references to "driver input power" in this section VI or HI 40.6–2021 refer to the input power to the continuous or non-continuous controls.

B. *Measurement Equipment.* The requirements regarding measurement equipment presented in section I.B of this appendix apply to this section VI. In addition, when testing pumps using a calibrated motor, electrical measurement equipment shall meet the requirements of section C.4.3 of HI 40.6–2021 (including the applicable provisions of CSA C390–10, IEEE 112–2017, IEEE 114–2010–A, as referenced in section C.4.3 of HI 40.6), and motor power input shall be determined according to section 40.6.3.2.3 of HI 40.6–2021 and meet the requirements in Table 40.6.3.2.3 of HI 40.6–2021.

C. *Test Conditions.* The requirements regarding test conditions presented in section I.C of this appendix apply to this section VI. In addition, when testing pumps using a calibrated motor, the conditions in section C.4.3.1 of HI 40.6–2021, including the applicable provisions of CSA C390–10, IEEE 112–2017, IEEE 114–2010–A, as referenced in section C.4.3.1 of HI 40.6, shall be met.

D. *Testing BEP for the Pump.* Determine the best efficiency point (BEP) of the pump as follows:

D.1. Adjust the flow by throttling the pump without changing the speed of rotation of the pump and conduct the test at a minimum of the following seven flow points: 40, 60, 75, 90, 100, 110, and 120 percent of the expected BEP flow rate of the pump at the nominal speed of rotation, as specified in section 40.6.5.5.1 of HI 40.6–2021, including the applicable provisions of HI 9.6.1–2017 as referenced in section 40.6.5.5.1 of HI 40.6–2021.

D.2. Determine the BEP flow rate as the flow rate at the operating point of maximum pump efficiency on the pump efficiency curve, as determined in accordance with section 40.6.6.3 of HI 40.6–2021, where the pump efficiency is the ratio of the pump power output divided by the pump power input, as specified in Table 40.6.2 of HI 40.6–2021, disregarding the calculations provided in section 40.6.6.2.

* * * * *

VII. Calculation-Based Approach for Pumps Sold With Motors and Controls

A. *Scope.* This section VII can only be used in lieu of the test method in section VI of this appendix to calculate the index for pumps listed in sections VII.A.1, VII.A.2, VII.A.3, and VII.A.4 of this appendix.

A.1. Pumps sold with motors regulated by DOE's energy conservation standards for polyphase NEMA Design B electric motors at § 431.25(g) and continuous controls,

A.2. Pumps sold with inverter-only synchronous electric motors regulated by DOE's test procedure and/or energy conservation standards in subpart B of this part,

A.3. SVIL pumps sold with small electric motors regulated by DOE's energy conservation standards at § 431.446 or with SNEMs regulated by DOE's test procedure and/or energy conservation standards in subpart B of this part (but including motors of such varieties that are less than 0.25 hp) and continuous controls,

A.4. Pumps sold with submersible motors and continuous controls, and

A.5. Pumps sold with motors not listed in sections VII.A.1, VII.A.2, VII.A.3, and VII.A.4 of this appendix and pumps sold without continuous controls, including pumps sold with non-continuous controls, cannot use this section and must apply the test method in section VI of this appendix.

B. *Measurement Equipment.* The requirements regarding measurement equipment presented in section I.B of this appendix apply to this section VII. In addition, when testing pumps using a calibrated motor, electrical measurement equipment shall meet the requirements of section C.4.3 of HI 40.6–2021 (including the applicable provisions of CSA C390–10, IEEE 112–2017, IEEE 114–2010–A, as referenced in section C.4.3 of HI 40.6), and motor power input shall be determined according to section 40.6.3.2.3 of HI 40.6–2021 and meet the requirements in Table 40.6.3.2.3 of HI 40.6–2021.

C. *Test Conditions.* The requirements regarding test conditions presented in section I.C of this appendix apply to this section VII. In addition, when testing pumps using a calibrated motor, the conditions in section C.4.3.1 of HI 40.6–2021, including the applicable provisions of CSA C390–10, IEEE 112–2017, IEEE 114–2010–A, as referenced in section C.4.3.1 of HI 40.6–2021 shall be met.

D. *Testing BEP for the Pump.* Determine the best efficiency point (BEP) of the pump as follows:

D.1. Adjust the flow by throttling the pump without changing the speed of rotation of the pump and conduct the test at a minimum of the following seven flow points: 40, 60, 75, 90, 100, 110, and 120 percent of the expected BEP flow rate of the pump at the nominal speed of rotation, as specified in HI 40.6–2021, except section 40.6.5.3, and appendix B, including the applicable provisions of HI 9.6.1–2017, HI 9.6.6–2016, HI 9.8–2018, HI 14.1–14.2–2019, the HI Engineering Data Book, ASME MFC–3M–2004, ASME MFC–5M–1985, ASME MFC–8M–2001, ASME MFC–12M–2006, ASME MFC–16–2014, ASME MFC–22–2007, AWWA E103–2015, CSA C390–10, IEEE 112–2017, IEEE 114–2010–A, ISO 1438:2017, ISO 2186:2007, ISO 2715:2017, ISO 3354:2008, ISO 3966:2020, ISO 5167–1:2003, ISO 5198:1987, ISO 6416:2017, and ISO 20456:2017, as referenced in HI 40.6–2021.

D.2. Determine the BEP flow rate as the flow rate at the operating point of maximum pump efficiency on the pump efficiency curve, as determined in accordance with section 40.6.6.3 of HI 40.6–2021, where the pump efficiency is the ratio of the pump power output divided by the pump power input, as specified in Table 40.6.2 of HI 40.6–2021, disregarding the calculations provided in section 40.6.6.2.

* * * * *

E.1.2 * * *

* * * * *

L_{full} = motor losses at full load or, for inverter-only synchronous electric motors, motor + inverter losses at full load, as determined in accordance with section VII.E.1.2.1 of this appendix (hp),

* * * * *

E.1.2.1 Determine the full load motor losses using the appropriate motor efficiency value and horsepower as shown in the following equation:

$$L_{full} = \frac{MotorHP}{\left[\eta_{motor,full}/100\right]} - MotorHP$$

Where:

L_{full} = motor losses at full load (hp), or for inverter-only synchronous electric motors, motor + inverter losses at full load,

MotorHP = the horsepower of the motor with which the pump model is being tested (hp), and

$\eta_{motor,full}$ = the represented nominal full load motor efficiency (*i.e.,* nameplate/DOE-certified value) or the represented nominal full load motor + inverter efficiency or the default nominal full load submersible motor efficiency as determined in accordance with section VII.E.1.2.1.1 of this appendix (%).

E.1.2.1.1 For pumps sold with motors other than inverter-only synchronous electric motors or submersible motors, determine the represented nominal full load motor efficiency as described in section VII.E.1.2.1.1.1 of this appendix. For pumps sold with inverter-only synchronous electric motors, determine the represented nominal full load motor + inverter efficiency as described in section VII.E.1.2.1.1.2 of this appendix. For pumps sold with submersible motors, determine the default nominal full load submersible motor efficiency as described in section VII.E.1.2.1.1.3 of this appendix.

E.1.2.1.1.1 For pumps sold with motors other than inverter-only synchronous electric motors or submersible motors, the represented nominal full load motor efficiency is that of the motor with which the given pump model is being tested, as determined in accordance with the DOE test procedure for electric motors at § 431.16 or, for SVIL, the DOE test procedure for small electric motors at § 431.444 or the DOE test procedure for SNEMs in subpart B of this part, as applicable (including for motors less than 0.25 hp), and, if available, applicable representation procedures in 10 CFR part 429 and this part.

E.1.2.1.1.2 For pumps sold with inverter-only synchronous electric motors, the represented nominal full load motor + inverter efficiency is that of the motor with which the given pump model is being tested, as determined in accordance with the DOE test procedure for inverter-only synchronous electric motors in subpart B of this part, and, if available, applicable representation procedures in 10 CFR part 429 and this part.

E.1.2.1.1.3 For pumps sold with submersible motors, prior to the compliance date of any energy conservation standards for submersible motors in subpart B of this part, the default nominal full load submersible motor efficiency is that listed in table 2 of this appendix, with the number of poles relevant to the speed at which the pump is being tested (see section I.C.1 of this appendix) and the motor horsepower of the pump being tested, or if a test procedure for submersible motors is provided in subpart B of this part, the represented nominal full load motor efficiency of the motor with which the given pump model is being tested, as determined in accordance with the applicable test procedure in subpart B of this part and applicable representation procedures in 10 CFR part 429 and this part, may be used instead. Starting on the compliance date of any energy conservation standards for submersible motors in subpart B of this part, the default nominal full load submersible motor efficiency may no longer be used and instead the represented nominal full load motor efficiency of the motor with which the given pump model is being tested, as determined in accordance with the applicable test procedure in subpart B of this part and applicable representation procedures in 10 CFR part 429 and this part, must be used instead.

E.1.2.2 For load points corresponding to 25, 50, 75, and 100 percent of the BEP flow rate, determine the part load loss factor at each load point as follows:

$$z_i = a \times \left(\frac{P_i}{MotorHP}\right)^2 + b \times \left(\frac{P_i}{MotorHP}\right) + c$$

Where:

z_i = the motor and control part load loss factor at load point i,

a,b,c = coefficients listed in either Table 4 of this appendix for induction motors or Table 5 of this appendix for inverter-only synchronous electric motors, based on the horsepower of the motor with which the pump is being tested,

P_i = the pump power input to the bare pump at load point i, as determined in accordance with section VII.E.1.1 of this appendix (hp),

MotorHP = the horsepower of the motor with which the pump is being tested (hp),

i = load point corresponding to 25, 50, 75, or 100 percent of BEP flow rate, and

$\frac{P_i}{MotorHP} \leq 1.000$. If $\frac{P_i}{MotorHP} > 1.000$, then set $\frac{P_i}{MotorHP} = 1.000$ in the equation in section VII.E.1.2.2 of this appendix to calculate the part load loss factor at load point i.

TABLE 2—DEFAULT NOMINAL FULL LOAD SUBMERSIBLE MOTOR EFFICIENCY BY MOTOR HORSEPOWER AND POLE

Motor horsepower (hp)	Default nominal full load submersible motor efficiency		
	2 poles	4 poles	6 poles
1	55	68	64
1.5	66	70	72
2	68	70	74
3	70	75.5	75.5
5	74	75.5	75.5
7.5	68	74	72
10	70	74	72
15	72	75.5	74
20	72	77	74
25	74	78.5	77
30	77	80	78.5
40	78.5	81.5	81.5
50	80	82.5	81.5
60	81.5	84	82.5
75	81.5	85.5	82.5
100	81.5	84	82.5
125	84	84	82.5
150	84	85.5	85.5
200	85.5	86.5	85.5
250	86.5	86.5	85.5

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TABLE 4—INDUCTION MOTOR AND CONTROL PART LOAD LOSS FACTOR EQUATION COEFFICIENTS FOR SECTION VII.E.1.2.2 OF THIS APPENDIX A

Motor horsepower (hp)	Coefficients for induction motor and control part load loss factor (zi)		
	a	b	c
≤5	−0.4658	1.4965	0.5303
>5 and ≤20	−1.3198	2.9551	0.1052
>20 and ≤50	−1.5122	3.0777	0.1847
>50 and ≤100	−0.6629	2.1452	0.1952
>100	−0.7583	2.4538	0.2233

TABLE 5—INVERTER-ONLY SYNCHRONOUS ELECTRIC MOTOR AND CONTROL PART LOAD LOSS FACTOR EQUATION COEFFICIENTS FOR SECTION VII.E.1.2.2 OF THIS APPENDIX A

Motor horsepower (hp)	Coefficients for induction motor and control part load loss factor (zi)		
	a	b	c
≤5	−0.0898	1.0251	0.0667
>5 and ≤20	−0.1591	1.1683	−0.0085
>20 and ≤50	−0.4071	1.4028	0.0055
>50 and ≤100	−0.3341	1.3377	−0.0023
>100	−0.0749	1.0864	−0.0096

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