DEPARTMENT OF ENERGY

10 CFR Parts 429 and 431

[EERE–2016–BT–TP–0033]

RIN 1904–AD77

Energy Conservation Program: Test Procedure for Circulator Pumps

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

ACTION: Final rule.

SUMMARY: The U.S. Department of Energy (''DOE'') is establishing definitions, a test procedure, sampling and rating requirements, and enforcement provisions for circulator pumps. Currently, circulator pumps are not subject to DOE test procedures or energy conservation standards. DOE is adopting a test procedure for measuring the circulator energy index for circulator pumps. The test method references the relevant industry test standard. The definitions and test procedures are based on the recommendations of the Circulator Pump Working Group, which was established under the Appliance Standards Rulemaking Federal Advisory Committee.

DATES: The effective date of this rule is October 19, 2022. Compliance with the final rule will be mandatory for representations of head, flow rate, driver power input, circulator energy rating, and circulator energy index made on or after March 20, 2023. The incorporation by reference of certain publications listed in the rule is approved by the Director of the Federal Register on October 19, 2022.

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

A link to the docket web page can be found at *www.regulations.gov/docket/EERE-2016-BT-STD-0004*. 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 10 CFR part 431:

HI 40.6–2021, ''Methods for Rotodynamic Pump Efficiency Testing''.

HI 41.5–2022 ''Hydraulic Institute Program Guideline for Circulator Pump Energy Rating Program''.

Copies of HI 40.6–2021 and HI 41.5–2022 can be obtained from the Hydraulic Institute (''HI'') at 6 Campus Drive, First Floor North, Parsippany, NJ 07054–4406, (973) 267–9700, or by going to *www.pumps.org.*

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

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I. Authority and Background

Pumps are included in the list of ''covered equipment'' for which DOE is authorized to establish and amend energy conservation standards and test procedures. (42 U.S.C. 6311(1)(A)) Circulator pumps, which are the subject of this final rule, are a category of pumps. Circulator pumps generally are designed to circulate water in commercial and residential applications. Circulator pumps do not include dedicated-purpose pool pumps, for which test procedures and energy conservation standards are established in title 10 of the Code of Federal Regulations (''CFR'') part 431 subpart Y. DOE has not previously established test procedures or energy conservation standards applicable to circulator pumps. The following sections discuss DOE's authority to establish test procedures for circulator pumps and relevant background information regarding DOE's consideration of test procedures for this equipment.

A. Authority

The Energy Policy and Conservation Act, as amended (''EPCA''),[1] authorizes DOE to regulate the energy efficiency of a number of consumer products and certain industrial equipment. (42 U.S.C. 6291–6317) Title III, Part C [2] of EPCA, added by Public Law 96–619, Title IV, section 441(a) (42 U.S.C. 6311–6317 as codified) 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 specifically include definitions (42 U.S.C. 6311), test procedures (42 U.S.C. 6314), labeling provisions (42 U.S.C. 6315), energy conservation standards (42 U.S.C. 6313), and the authority to require information and reports from manufacturers (42 U.S.C. 6316; 42 U.S.C. 6296).

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

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

Under 42 U.S.C. 6314, EPCA sets forth the criteria and procedures DOE must follow when prescribing or amending test procedures for covered products. 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 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))

Before prescribing any final test procedures, 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)).

DOE is publishing this final rule in accordance with the statutory authority in EPCA.

B. Background

As stated previously in this document, EPCA includes ''pumps'' among the industrial equipment listed as ''covered equipment'' for the purpose of Part A–1, although EPCA does not define the term ''pump.'' (42 U.S.C. 6311(1)(A)) In a final rule published January 25, 2016, DOE established a definition for ''pump,'' associated definitions, and test procedures for certain pumps. 81 FR 4086 (''January 2016 TP final rule''). ''Pump'' is defined as 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. 81 FR 4086, 4147; 10 CFR 431.462. Circulator pumps fall within the scope of this definition.

While DOE has defined ''pump'' broadly, the test procedure established in the January 2016 TP final rule is applicable only to certain categories of clean water pumps,[3] specifically those that are end suction close-coupled (''ESCC''); end suction frame mounted/own bearings (''ESFM''); in-line (''IL''); radially split, multi-stage, vertical, in-line casing diffuser (''RSV''); and submersible turbine (''ST'') pumps with the following characteristics:

- Flow rate of 25 gallons per minute (''gpm'') or greater at best efficiency point (''BEP'') at full impeller diameter;
- 459 feet of head maximum at BEP at full impeller diameter and the number of stages specified for testing;
- design temperature range from 14 to 248 °F;
- 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;
- 6-inch or smaller bowl diameter for ST pumps;
- A specific speed less than or equal to 5,000, when calculated using U.S. customary units, for ESCC and ESFM pumps;
- Except for: 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 any relevant military specifications. [4]

10 CFR 431.464(a)(1); 81 FR 4086, 4148. The pump categories subject to the current test procedures are referred to as ''general pumps'' in this document. As stated, circulator pumps are not general pumps and therefore, are not subject to the current pumps test procedure.

DOE also published a final rule establishing energy conservation standards applicable to certain classes of general pumps. 81 FR 4368 (Jan. 26, 2016) (''January 2016 ECS final rule''); *see also,* 10 CFR 431.465.

The January 2016 TP final rule and the January 2016 ECS final rule implemented the recommendations of the Commercial and Industrial Pump Working Group (''CIPWG'') established through the Appliance Standards Rulemaking Federal Advisory Committee (''ASRAC'') to negotiate standards and a test procedure for

[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 B was redesignated Part A.

[3] A ''clean water pump'' is 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.

[4] E.g., 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). Military specifications and standards are available at *https://everyspec.com/MIL-SPECS.*

general pumps. (Docket No. EERE–2013–BT–NOC–0039) The CIPWG approved a term sheet containing recommendations to DOE on appropriate standard levels for general pumps, as well as recommendations addressing issues related to the metric and test procedure for general pumps (''CIPWG recommendations''). (Docket No. EERE–2013–BT–NOC–0039, No. 92) Subsequently, ASRAC approved the CIPWG recommendations. The CIPWG recommendations included initiation of a separate rulemaking for circulator pumps. (Docket No. EERE–2013–BT–NOC–0039, No. 92, Recommendation #5A at p. 2)

On February 3, 2016, DOE issued a notice of intent to establish the circulator pumps working group to negotiate a notice of proposed rulemaking (''NOPR'') for energy conservation standards and a test procedure for circulator pumps, if possible, and to announce the first public meeting. 81 FR 5658. The members of the Circulator Pump Working Group (''CPWG'') were selected to ensure a broad and balanced array of interested parties and expertise, including representatives from efficiency advocacy organizations and manufacturers. Additionally, one member from ASRAC and one DOE representative were part of the CPWG. 81 FR 5658, 5660. Table I.1 lists the 15 members of the CPWG and their affiliations.

TABLE I.1—ASRAC CIRCULATOR PUMP WORKING GROUP MEMBERS AND AFFILIATIONS

Member	Affiliation
Charles White	Plumbing-Heating-Cooling Contractors Association.
Gabor Lechner	Armstrong Pumps, Inc.
Gary Fernstrom	California Investor-Owned Utilities.
Joanna Mauer	Appliance Standards Awareness Project.
Joe Hagerman	U.S. Department of Energy.
Laura Petrillo-Groh	Air-Conditioning, Heating, and Refrigeration Institute.
Lauren Urbanek	Natural Resources Defense Council.
Mark Chaffee	TACO, Inc.
Mark Handzel	Xylem Inc.
Peter Gaydon	Hydraulic Institute.
Richard Gussert	Grundfos Americas Corporation.
David Bortolon	Wilo Inc.
Russell Pate	Rheem Manufacturing Company.
Don Lanser	Nidec Motor Corporation.
Tom Eckman	Northwest Power and Conservation Council (ASRAC member).

The CPWG commenced negotiations at an open meeting on March 29, 2016, and held six additional meetings to discuss scope, metrics, and the test procedure. The CPWG concluded its negotiations for test procedure topics on September 7, 2016, with a consensus vote to approve a term sheet containing recommendations to DOE on scope, definitions, metric, and the basis of the test procedure (''September 2016 CPWG Recommendations''). The September 2016 CPWG Recommendations are available in the CPWG docket. (Docket No. EERE–2016–BT–STD–0004, No. 58)

The CPWG continued to meet to address potential energy conservation standards for circulator pumps. Those meetings began on November 3–4, 2016, and concluded on November 30, 2016, with approval of a second term sheet (''November 2016 CPWG Recommendations'') containing CPWG recommendations related to energy conservation standards, applicable test procedure, labeling and certification requirements for circulator pumps. (Docket No. EERE–2016–BT–STD–0004, No. 98) ASRAC subsequently voted unanimously to approve the September and November 2016 CPWG Recommendations during a December 2016 meeting. (Docket No. EERE–2013–BT–NOC–0005, No. 91 at p. 2) [5]

In a letter dated June 9, 2017, HI expressed its support for the process that DOE initiated regarding circulator pumps and encouraged the publishing of a NOPR and a final rule by the end of 2017. (Docket No. EERE–2016–BT–STD–0004, HI, No.103 at p. 1) In response to an early assessment review request for information (''RFI'') published on September 28, 2020 regarding the existing test procedures for general pumps (85 FR 60734, ''September 2020 Early Assessment RFI''), HI commented that it continues to support the recommendations from the CPWG. (Docket No. EERE–2020–BT–TP–0032, HI, No. 6 at p. 1) NEEA also referenced the September 2016 CPWG Recommendations and recommended that DOE adopt test procedures for circulator pumps in the pumps rulemaking or a separate rulemaking. (Docket No. EERE–2020–BT–TP–0032, NEEA, No. 8 at p. 8)

On May 7, 2021, DOE published a RFI related to test procedures and energy conservation standards for circulator pumps and small vertical in-line pumps. 86 FR 24516 (''May 2021 RFI''). Subsequently, DOE published a notice of NOPR for the test procedure on December 20, 2021, presenting DOE's proposals to establish a circulator pump test procedure and requesting comment. (the ''December 2021 NOPR'') 86 FR 72096. DOE held a public webinar related to the December 2021 NOPR on February 2, 2022.

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

[5] All references in this document to the approved recommendations included in 2016 Term Sheets are noted with the recommendation number and a citation to the appropriate document in the CPWG docket (*e.g.,* Docket No. EERE–2016–BT–STD–0004, No. #, Recommendation #X at p. Y). References to discussions or suggestions of the CPWG not found in the 2016 Term Sheets include a citation to meeting transcripts and the commenter, if applicable (*e.g.,* Docket No. EERE–2016–BT–STD–0004, [Organization], No. X at p. Y).

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

Commenter(s)	Reference in this final rule	Docket number	Commenter type
New York State Energy Research and Development Authority.	NYSERDA	EERE–2016–BT–TP–0033–0006	State.
Grundfos Americas Corporation	Grundfos	EERE–2016–BT–TP–0033–0007	Manufacturer.
Appliance Standards Awareness Project, American Council for an Energy-Efficient Economy, Natural Resources Defense Council.	Joint Advocates	EERE–2016–BT–TP–0033–0008	Efficiency Organizations.
Hydraulic Institute	HI	EERE–2016–BT–TP–0033–0009	Trade Association.
Pacific Gas and Electric Company, San Diego Gas and Electric, and Southern California Edison.	CA IOUs	EERE–2016–BT–TP–0033–0010	Utilities.
Northwest Energy Efficiency Alliance	NEEA	EERE–2016–BT–TP–0033–0011	Efficiency Organization.

DOE also received a comment from Kobel that was supportive but did not address the substance of the proposals. (Docket No. EERE–2016–BT–TP–0033–0005) A parenthetical reference at the end of a comment quotation or paraphrase provides the location of the item in the public record.[6]

II. Synopsis of the Final Rule

In this final rule, DOE is establishing a test procedure in subpart Y to 10 CFR part 431 that includes methods to (1) measure the performance of the covered equipment, and (2) use the measured results to calculate a circulator energy index (''CEI'') to represent the weighted average electric input power to the driver over a specified load profile, normalized with respect to a circulator pump serving the same hydraulic load that has a specified minimum performance level.[7] The test procedure and metric are similar in concept to the test procedure and metric established in subpart Y to 10 CFR part 431 for general pumps.

DOE's test method for circulator pumps includes measurements of head, flow rate, and driver power input, all of which are required to calculate CEI, as well as other quantities to characterize the rated circulator pump performance (*e.g.,* pump power output (hydraulic horsepower), speed, wire-to-water efficiency). For consistent and uniform measurement of these values, DOE is incorporating the test methods established in HI 40.6–2021, ''Methods for Rotodynamic Pump Efficiency Testing,'' with certain exceptions. In order to specify methods to use the measured results to calculate the Circulator Energy Rating (''CER'') for different circulator varieties, DOE is also incorporating certain sections of HI 41.5–2022, ''Hydraulic Institute Program Guideline for Circulator Pump Energy Rating Program.''

DOE reviewed the relevant sections of HI 40.6–2021 and HI 41.5–2022 and determined that those sections will produce test results that reflect the energy efficiency, energy use, or estimated operating costs of a circulator pump during a representative average use cycle. (42 U.S.C. 6314(a)(2)) DOE also reviewed the burdens associated with conducting the circulator pump test procedure adopted in this final rule and based on the results of such analysis, found that the test procedure would not be unduly burdensome to conduct. (42 U.S.C. 6314(a)(2)) DOE's analysis of the burdens associated with the test procedure is presented in section III.H.1 of this document.

This final rule also establishes requirements regarding the sampling plan and representations for circulator pumps at 10 CFR part 429 subpart B. The sampling plan requirements are similar to those established for general pumps. DOE also adopts provisions regarding allowable representations of energy consumption, energy efficiency, and other relevant metrics manufacturers may make regarding circulator pump performance (as discussed in section III.G of this document).

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**. Manufacturers are not required to test according to the DOE test procedure until such time as compliance is required with energy conservation standards for circulator pumps, should DOE establish such standards. Manufacturers choosing to make voluntary representations would be required to test the subject circulator pump according to the established test procedure, and any such representations would have to fairly disclose the results of such testing.

III. Discussion

In this test procedure final rule, DOE establishes test procedures and related definitions for circulator pumps in subpart Y of 10 CFR part 431, amends 10 CFR 429.59 to establish sampling plans for this equipment, and establishes enforcement provisions for this equipment in 10 CFR 429.110 and 10 CFR 429.134. The requirements and amendments are summarized in Table III.1.

[6] The parenthetical reference provides a reference for information located in the docket of DOE's rulemaking to develop test procedures for circulator pumps. (Docket No. EERE–2016–BT–TP–0033, which is maintained at *www.regulations.gov*). The references are arranged as follows: (commenter name, comment docket ID number, page of that document).

[7] The performance of a comparable pump that has a specified minimum performance level is referred to as the circulator energy rating.

TABLE III.1—SUMMARY OF TOPICS IN THIS TEST PROCEDURE FINAL RULE, THEIR LOCATION WITHIN THE CODE OF FEDERAL REGULATIONS, AND THE APPLICABLE PREAMBLE DISCUSSION

Topic	Location in CFR	Summary of requirements	Applicable preamble discussion
Definitions	10 CFR 431.462	Defines circulator pump as well as varieties of circulator pumps and circulator pump controls.	Sections III.B.2, III.B.3, III.B.4, III.B.5, III.B.7, and III.D.1.
Test Procedure	10 CFR 431.464 & Appendix D.	Establishes CEI as the metric for circulator pumps, incorporate by reference HI 40.6–2021, and provides additional instructions for determining the CEI (and other applicable performance characteristics) for circulator pumps.	Sections III.C, III.D, and III.E.
Sampling Plan	10 CFR 429.59	Specifies the minimum number of circulator pumps to be tested to rate a basic model and determination of representative values.	Section III.F.1.
Enforcement Provisions	10 CFR 429.110 & 10 CFR 429.134.	Establishes a method for determining compliance of circulator pump basic models.	Section III.F.2.

The following sections discuss DOE's specific regulations regarding circulator pumps. Section III.B presents definitions for categorizing and testing of circulator pumps. Sections III.C, III.D, III.E, and III.F discuss the metric, test procedure, and certification and enforcement provisions for tested circulator pump models. Section III.G discusses representations of energy use and energy efficiency for circulator pumps.

A. General Comments

In response to the December 2021 NOPR, several commenters expressed general statements related to the proposed test procedure. NYSERDA stated that circulator pumps have a large energy savings potential, as they are commonly used in multifamily and commercial buildings to reduce hot water demand time for occupants, and a test procedure that accurately measures their energy use is vital to measuring code impacts and meeting New York's greenhouse gas reduction goals. NYSERDA added that the CPWG developed a thorough set of recommendations, including definitions, outline of scope, and proposed test procedure, that DOE should implement. (NYSERDA, No. 6 at p. 1) Joint Advocates supported the CPWG recommendations along with the changes proposed in the December 2021 NOPR, consistent with HI 41.5–2021, which were based on stakeholder feedback in response to the May 2021 RFI. (Joint Advocates, No. 8 at p. 1) CA IOUs supported the proposed test procedure for the CEI metric. (CA IOUs, No. 10 at p. 1) And NEEA supported DOE's progress towards establishing a test procedure and standard for circulator pumps, stating that most major manufacturers have been prepared to meet a DOE standard since the CPWG concluded in 2016. (NEEA, No. 11 at p. 1) ASAP stated that they support the CPWG recommendations as well as the proposed modification based on stakeholder comments. (ASAP, No. 4 at p. 5)

HI stated that HI and its member companies producing circulators have continued the work of the CPWG since 2016, by publishing HI 41.5–2021. HI explained that the industry-led program has been implemented by manufacturers with energy efficient circulators labeled per the HI 41.5 program and listed on the program website. (HI, No. 9 at p. 1)

As discussed in the following sections, DOE is adopting a test procedure generally consistent with the procedure proposed in the December 2021 NOPR, and generally consistent with the recommendations of the CPWG.

B. Scope and Definitions

As discussed, in the January 2016 TP final rule, DOE adopted a definition for ''pump,'' as well as definitions for other pump component- and configuration-related definitions. 81 FR 4086, 4090–4094 (Jan. 25, 2016); *see also* 10 CFR 431.462. DOE recognized circulator pumps as a category of pumps, but DOE did not define ''circulator pump.'' 81 FR 4086, 4097.

In this final rule, DOE is establishing a definition of circulator pump, associated definitions for categories of circulator pumps, as well as related definitions for control varieties of circulator pumps (see sections III.B.2, III.B.3, III.B.4, III.B.5 and III.D.1 of this final rule). These definitions are necessary to establish the scope of applicability of the circulator pump test procedure. The scope of the test procedure is discussed in section III.B.6 of this document.

1. CPWG Recommendations

The September 2016 Circulator Pump Recommendations addressed the scope of a circulator pumps rulemaking. Specifically, the CPWG recommended that the scope of a circulator pumps test procedure and energy conservation standards cover clean water pumps (as defined at 10 CFR 431.462) distributed in commerce with or without a volute [8] and that are one of the following categories: wet rotor circulator pumps, dry rotor close-coupled circulator pumps, and dry rotor mechanically-coupled circulator pumps. The CPWG also recommended that the scope exclude submersible pumps and header pumps. 86 FR 24516, 24520; (Docket No. EERE–2016–BT–STD–0004, No. 58, Recommendations #1A, 2A and 2B at pp. 1–2) The CPWG also recommended several definitions relevant to scope, see discussion in sections III.B.3 through III.B.5. 86 FR 24516, 24520; (Docket No. EERE–2016–STD–0004, No. 58, Recommendation #2B, 3A, and 3B at pp. 2–3)

DOE notes that generally these definitions recommended by the CPWG rely on terms previously defined in the January 2016 TP final rule, including ''close-coupled pump,'' ''mechanically-coupled pump,'' ''dry rotor pump,'' ''single axis flow pump,'' and ''rotodynamic pump.'' 81 FR 4086, 4146–4147; 10 CFR 431.462. In addition, the recommended definition for submersible pump is the same as that already defined in a 2017 test procedure final rule for dedicated-purpose pool pumps (''DPPP'') (''August 2017 DPPP TP final rule''). 82 FR 36858, 36922 (August 7, 2017); 10 CFR 431.462.

DOE discusses the definitions of wet rotor circulator pump; dry rotor, two-

[8] Volutes are also sometimes referred to as a ''housing'' or ''casing.''

piece circulator pump; dry rotor, three-piece circulator pump; and horizontal motor in section III.B.3, header pump in section III.B.4, and submersible pump in section III.B.6 of this final rule.

2. Definition of Circulator Pump

In the December 2021 NOPR, DOE proposed a definition of circulator pump at 10 CFR 431.462 consistent with the definition recommended by the CPWG and informed by the standard American National Standards Institute (''ANSI'')/HI 1.1–1.2–2014 standard (''ANSI/HI 1.1–1.2–2014''), ''Rotodynamic Centrifugal Pumps for Nomenclature and Definitions.'' 86 FR 72096, 72101–72102. Specifically, DOE proposed the following definition for circulator pump:

Circulator pump is a pump that is either a wet rotor circulator pump; a dry rotor, two-piece circulator pump; or a dry rotor, three-piece circulator pump. A circulator pump may be distributed in commerce with or without a volute.

Id. at 86 FR 72102.

DOE requested comment on the proposed definition for circulator pump. *Id.* In response to the December 2021 NOPR, HI, Grundfos, NEEA, and NYSERDA agreed with the proposed definition of circulator pumps. (HI, No. 9 at p. 3; Grundfos, No. 7 at p. 1; NEEA, No. 11 at p. 2; NYSERDA, No. 6 at p. 1)

For the reasons discussed in the December 2021 NOPR and in the preceding paragraphs, in this final rule, DOE adopts the definition of circulator pump as proposed in the December 2021 NOPR.

The definitions of the pump categories that comprise the scope of ''circulator pump'' are addressed in the following section.

3. Definition of Circulator Pump Varieties

In the December 2021 NOPR, DOE proposed to adopt definitions for wet rotor circulator pump; dry rotor, two-piece circulator pump; and dry rotor, three-piece circulator pump at 10 CFR 431.462 as recommended by the CPWG and supported by stakeholder comments in response to the May 2021 RFI. 86 FR 72096, 72102. The proposed definitions are as follows:

Wet rotor circulator pump means a single stage, rotodynamic, close-coupled, wet rotor pump. Examples include, but are not limited to, pumps generally referred to in industry as CP1.

Dry rotor, two-piece circulator pump means a single stage, rotodynamic, single-axis flow, close-coupled, dry rotor pump that:

(1) Has a rated hydraulic power less than or equal to five horsepower at best efficiency point at full impeller diameter,

(2) Is distributed in commerce with a horizontal motor, and

(3) Discharges the pumped liquid through a volute in a plane perpendicular to the shaft. Examples include, but are not limited to, pumps generally referred to in industry as CP2.

Dry rotor, three-piece circulator pump means a single stage, rotodynamic, single-axis flow, mechanically-coupled, dry rotor pump that:

(1) Has a hydraulic power less than or equal to five horsepower at best efficiency point at full impeller diameter,

(2) Is distributed in commerce with a horizontal motor, and

(3) Discharges the pumped liquid through a volute in a plane perpendicular to the shaft. Examples include, but are not limited to, pumps generally referred to in industry as CP3.

Id. at 86 FR 72139.

In the December 2021 NOPR, DOE also proposed a definition for horizontal motor, consistent with the intent of the CPWG:

Horizontal motor means a motor, for which the motor shaft position when functioning under operating conditions specified in manufacturer literature, includes a horizontal position.

Id. at 86 FR 72102.

DOE tentatively concluded that the proposed modification to the horizontal motor definition would provide additional specificity but would not in practice change the pumps currently excluded from the IL pump definition (and now proposed to be included in the circulator pump definition) through use of the term. *Id.*

DOE requested comment on the proposed definition for horizontal motor, including whether it met the intent of the CPWG recommendation or whether it would include other motors not intended to be captured in the definition. *Id.*

NYSERDA supported the definitions of wet rotor circulator pump; dry rotor, two-piece circulator pump; dry rotor, three-piece circulator pump; and horizontal motor, as recommended by the CPWG. (NYSERDA, No. 6 at pp. 1–2) HI and Grundfos agreed with the proposed definition of horizontal motor and stated that it meets the intent of the CPWG. (HI, No. 9 at p. 3; Grundfos, No. 7 at p. 1) NEEA agreed also with the proposed definition of horizontal motor and stated the definition was consistent with the intent of CPWG. (NEEA, No. 11 at p. 2)

For the reasons discussed in the December 2021 NOPR and in the preceding paragraphs, in this final rule, DOE adopts the definitions of wet rotor circulator pump; dry rotor, two-piece circulator pump; dry rotor, three-piece circulator pump; and horizontal motor as proposed in the December 2021 NOPR.

4. Definition of Circulator-Less-Volute and Header Pump

In the December 2021 NOPR, DOE discussed that some circulator pumps are distributed in commerce as a complete assembly with a motor, impeller, and volute, while other circulator pumps are distributed in commerce with a motor and impeller, but without a volute (herein referred to as ''circulators-less-volute''). Some circulators-less-volute are solely intended to be installed in other equipment, such as a boiler, using a cast piece in the other piece of equipment as the volute, while others can be installed as a replacement for a failed circulator pump in an existing system or newly installed with a paired volute in the field. 86 FR 72096, 72102; (Docket No. EERE–2016–BT–STD–0004, No. 47 at pp. 371–372; Docket No. EERE–2016–BT–STD–0004, No. 70 at p. 99) The CPWG recommended excluding circulator pumps that are distributed in commerce exclusively to be incorporated into other OEM equipment, such as boilers or pool heaters. 86 FR 72096, 72103; (Docket No. EERE–2016–BT–STD–0004, No. 74 at pp. 413–416)

As stated in the December 2021 NOPR, the CPWG suggested referring to circulator-less-volute that are intended solely for installation in another piece of equipment and do not have a paired volute that is distributed in commerce as ''header pumps,'' and recommended defining header pump as pump that consists of a circulator-less-volute intended to be installed in an [original equipment manufacturer] ''OEM'' piece of equipment that serves as the volute. 86 FR 72096, 72103; (Docket No. EERE–2016–BT–STD–0004, No. 74 at pp. 384–386; No. 58 Recommendation #2B at p. 2)

The CPWG recommended that for header pumps distributed in commerce with regulated equipment, DOE should consider modifying the test procedure and metric for such regulated equipment during the next round of applicable rulemakings to account for the energy use of header pumps in a modified metric. For header pumps distributed in commerce with non-regulated equipment, the CPWG recommended that DOE should consider

test procedures and standards for such pumps or equipment at a later date. (Docket No. EERE–2016–BT–STD–0004, No. 58 Non-Binding Recommendation to the Secretary #2 at p. 10); 86 FR 72096, 72103.

In the December 2021 NOPR, DOE tentatively agreed that a circulator-less-volute designed solely for use as a component in a separate piece of equipment should be distinguished from a circulator-less-volute generally. To provide a distinction between a circulator-less-volute and a header pump, DOE proposed to add additional detail within the definition of header pump recommended by the CPWG and to add a definition of circulator-less-volute to be mutually exclusive from the definition of a header pump. These definitions proposed by DOE are as follows:

Header pump means a circulator pump distributed in commerce without a volute and for which a paired volute is not distributed in commerce. Whether a paired volute is distributed in commerce will be determined based on published data, marketing literature, and other publicly available information.

Circulator-less-volute means a circulator pump distributed in commerce without a volute and for which a paired volute is also distributed in commerce. Whether a paired volute is distributed in commerce will be determined based on published data, marketing literature, and other publicly available information.

86 FR 72096, 72103.

DOE requested comment on the proposed definitions of header pump and circulator-less-volute. *Id.* DOE also tentatively concluded that requiring testing of header pumps using a reference volute, as required in EU Regulation No 622/2012, may result in a rating that is not representative of its energy use in the equipment for which it is designed, and that assessing header pump energy use within broader equipment categories in which they are embedded, such as boilers, may be more appropriate. As such, DOE did not propose to include header pumps in the scope of the test procedure, nor did it propose a test method for them. *Id.*

In response to the December 2021 NOPR, NYSERDA supported the definition of header pump as recommended by the CPWG. (NYSERDA, No. 6 at p. 2) HI and NEEA agreed with the proposed definitions of header pump and circulator-less-volute. (HI, No. 9 at p. 3; NEEA, No. 11 at p. 2)

Grundfos agreed with the proposed definition of circulator-less-volute but stated that header pumps should be included in this definition and covered by the circulator-less-volute testing requirements. (Grundfos, No. 7 at p. 1) Additionally, Grundfos noted that the CPWG's basis for excluding header pumps was because an OEM specific volute was not available for testing. Grundfos commented that header pumps are generally the same as standard circulator-less-volutes in the market and that representative volutes already exist or can be created by manufacturers. Grundfos stated that DOE should require that header pumps be tested like circulators-less-volute, except that the manufacturer determines the volute to be used and make this volute available for testing on the open market so that all interested parties can purchase and test the pump in the same manner it was certified. Grundfos noted that allowing header pumps to exist on the market without testing creates a loophole that can be exploited to avoid meeting the test standard and efficiency standard requirements. (Grundfos, No. 7 at p. 4)

While Grundfos has suggested a method for testing header pumps, DOE observes that the suggested method would increase burden on manufacturers by requiring creation of volutes that may not be used in commerce (given that header pumps are intended solely for installation in another piece of equipment) and requiring them to be available for testing on the open market. Additionally, by requiring testing with volutes for which the application is only for equipment testing, the suggested method would not be representative of an average use. Grundfos did not address DOE's tentative determination regarding lack of representativeness of testing header pumps with reference volutes. As such, in this final rule, DOE adopts the definitions of header pump and circulator-less-volute as proposed in the December 2021 NOPR and is not including header pumps within the scope of the test procedure nor adopting a test method for header pumps.

5. Definition of On-Demand Circulator Pumps

In the December 2021 NOPR, DOE stated that on-demand circulator pumps are designed to maintain hot water supply within a temperature range by activating in response to a signal, such as user presence. 86 FR 72096, 72104. Discussion during CPWG meetings suggested that the purpose of recommending a definition for on-demand circulator pumps would be to allow for the possibility of considering them as a separate equipment class with a different standard level, while still applying the metric and test procedure to them. (Docket No. EERE–2016–BT–STD–0004–0069, p. 199)

The CPWG discussed that on-demand controls do not reduce the speed of the pump, but rather reduce the hours of use. Pumps with on-demand controls could also have speed controls, which the recommended metric would capture. (Docket No. EERE–2016–BT–STD–0004–0069, pp. 172–173) In addition, CPWG members discussed that the extent to which time-based controls are used is unknown (*Id.* at p. 176), and that rather than attempting to capture it in the metric, utility programs could consider prescriptive rebates associated with these controls. (*Id.* at p. 178) In addition, CPWG members suggested that legionella concerns would limit the application of on-demand controls.[9] (*Id.* at pp. 195–196)

DOE notes that neither HI 41.5–2021 nor HI 41.5–2022 address on-demand circulator pumps. DOE proposed to define on-demand circulator pump at 10 CFR 431.462 consistent with the definition recommended by the CPWG, as follows:

On-demand circulator pump means a circulator pump that is distributed in commerce with an integral control that:

- Initiates water circulation based on receiving a signal from the action of a user [of a fixture or appliance] or sensing the presence of a user of a fixture and cannot initiate water circulation based on other inputs, such as water temperature or a pre-set schedule.
- Automatically terminates water circulation once hot water has reached the pump or desired fixture.
- Does not allow the pump to operate when the temperature in the pipe exceeds 104 °F or for more than 5 minutes continuously.

86 FR 72096, 72104.

DOE did not propose to exclude on-demand circulator pumps from the scope of the test procedure or to develop a credit for such controls in the December 2021 NOPR. DOE noted that if on-demand circulator pumps are equipped with other controls that reduce speed, they may be tested according to the relevant test methods rather than using the no controls test. *Id.* DOE stated that it would consider whether standards were appropriate for this equipment in a future energy conservation standards rulemaking. *Id.*

DOE requested comment on its proposal to include on-demand circulator pumps within the scope of

[9] As discussed in the transcript, situations where water is stagnant and the temperature drops can result in growth of legionella.

this test procedure. DOE also requested data and information that would justify a CEI credit for on-demand circulator pumps. 86 FR 72096, 72104.

Joint Advocates supported inclusion of on-demand controls but noted that the energy savings benefits of reduced run time would not be directly captured by the test procedure. Joint Advocates explained that on-demand controls have the potential to reduce energy consumption in water recirculation applications. Joint Advocates encouraged DOE to consider options to promote the adoption of on-demand controls that reduce energy consumption by reducing circulator pump run-time. (Joint Advocates, No. 8 at p. 3)

CA IOUs supported DOE's proposed definition of the on-demand circulator pump product class, in particular that a product must be exclusively an on-demand circulator and should not support additional control modes typical of other circulator products (*e.g.,* constant pressure), or support bypass functionality, ensuring that users receive consistent run-hour reduction benefits relative to conventional products. (CA IOUs, No. 10 at p. 2) CA IOUs stated they aim to encourage widespread market adoption in the domestic hot water sector, in part by maintaining the cost benefit to consumers of this product. CA IOUs included an analysis of potential costs and benefits to a consumer when applying a 1.0 CEI requirement, which would imply an electrically commutated motor (''ECM''). CA IOUs stated that, based on their analysis, cost is the largest influencing factor of consumer payback, followed by runtime hours, with CEI as the least influential factor.[10] Based on this, CA IOUs encouraged DOE to develop a methodology for on-demand circulator products that does not require the ECM level unless lifecycle cost effectiveness can be demonstrated. (CA IOUs, No. 10 at pp. 3–5). CA IOUs stated that baseline operating hours of a domestic hot water circulator product is 6,400 hours per year and the on-demand product is instead 92, a ratio of 0.014. CA IOUs encouraged DOE to develop a CEI score for circulator products that demonstrates the substantial energy savings available and allows for field representative lifecycle cost-benefit calculations. (CA IOUs, No. 10 at p. 5)

NEEA recommended that DOE require testing circulator pumps at full speed but provide a CEI credit for circulator pumps intended for domestic hot water recirculation equipped with run-hour controls. NEEA stated that eliminating unnecessary operation at no cost of convenience or performance to customers, is the most significant method to reduce circulator energy consumption. NEAA added that ignoring this factor misses an important opportunity for energy conservation and fails to communicate energy savings to the market. NEEA commented that a CEI credit is the most effective strategy to convey this factor to consumers. (NEEA, No. 11 at pp. 1–2)

Additionally, NEEA stated that efficient run hour controls include temperature (*i.e.,* aquastat), on-demand, learning, or a combination of timer and temperature run-hour controls. NEEA noted that the Regional Technical Forum's circulator measure workbook contains calculations about the potential energy savings from run-hour controls on domestic hot water circulators, and that according to this analysis, run-hour controls reduce energy consumption by 50 percent to 99 percent. NEEA stated that the CEI credit should accurately reflect the energy savings reduction from each control type. However, NEEA commented that savings from learning-based controls are less well-proven in the field, and that there is concern that timer-based controls can be overridden or set to a high number of hours to avoid homeowner complaints. But NEEA noted also that their research indicates that timer-controls are relatively consistently applied. (NEEA, No. 11 at p. 4) NEEA suggested that there should be different CEI credits for different control types, especially on-demand and temperature-based, due to differences between commercial and residential applications. (NEEA, No. 11 at pp. 4–5)

NEEA recommended that rating equipment with applicable run hours controls should be optional so as to represent an opportunity rather than a burden, especially for manufacturers of equipment with on-demand controls that cannot operate without them, to potentially comply with future standards without redesigning the motor. NEEA stated that circulators that can only be operated with on-demand controls represent a small portion of the market but are very efficient due to extremely low run hours and increasing the efficiency of the pump and motor would likely not be cost effective. NEEA stated that an appropriate CEI credit could allow such equipment to remain on the market at a cost-competitive price point, which may increase their adoption and lead to more overall pump and hot water savings. (NEEA, No. 11 at p. 5)

NEEA stated that in order for the CEI credit to not represent a loophole in the standard, DOE must calibrate the credit to ensure it provides a comparable and meaningful metric compared to the hydronic heating controls currently proposed in the test procedure, and require rating with the most consumptive control available, such that the mere availability of run-hour controls (or other efficient controls) do not circumvent the desired efficiency of the standard. NEEA suggested that DOE consider the relative run hours of hydronic heating versus domestic hot water installations, as temperature-based run-hour controls may run a similar number of hours as hydronic heating controls and a significant credit may not be warranted. (*Id.*)

NEEA noted that the CEI credit concept was not discussed in the CPWG nor approved in the term sheet, and that an appropriate credit and certification system may take time to develop and implement. NEEA stated that, while DOE could make a reasonable proposal now, the addition of special treatment for run-hours-controls-equipped circulators could be considered in the future with more opportunity for discussion and input. In this case, NEEA recommended that on demand circulators not be exempted and be covered by the applicable test procedure and any future standard to provide consistency for manufacturers and the market. (NEEA, No. 11 at p. 5)

HI agreed with the proposed definition of on-demand circulator pump and inclusion of on-demand circulating pump within the scope of the test procedure. However, HI stated that domestic hot water circulators come with several intermittent control methods, including temperature and timer, that all provide reduced energy consumption versus a circulator under continuous operation. HI stated that as DOE only identified on-demand controls in the December 2021 NOPR, DOE should not consider credits for them. HI stated that in future rulemakings DOE should consider creating a category and test procedure calculations for intermittent controlled domestic hot water circulator pumps that define an average use case for this new category of pumps, including operating hours and load points. (HI, No. 9 at p. 3) Grundfos stated that inclusion of on-demand circulator pumps is warranted but commented similarly to HI regarding the other control methods that were not included, recommending that these categories should be included in a separate rulemaking. (Grundfos, No. 7 at p. 1)

[10] CA IOUs also included a discussion regarding potential economics for consumers with electric water heaters versus natural gas water heaters.

After reviewing and considering all the comments on on-demand circulator pumps, DOE is adopting a definition for on-demand circulator pumps and a scope of applicability for the test procedure that includes on-demand circulator pumps, as proposed. DOE is not adopting a CEI credit for on-demand circulators in this rulemaking. Such a credit was not discussed by the CPWG, nor proposed in the NOPR. As noted by the commenters, development of further information as to the prevalence, variety, and operation of on-demand controls is likely needed. Accordingly, DOE is not addressing a CEI credit for on-demand circulator pumps in this final rule. In response to the comments from CA IOUs and NEEA, DOE will consider the appropriate scope and product categories for standards for on-demand circulators in a separate energy conservation rulemaking.

6. Applicability of Test Procedure Based on Pump Configurations

In the December 2021 NOPR, DOE proposed that the test procedure would be applicable to circulator pumps that are clean water pumps, including circulators-less-volute and on-demand circulator pumps, and excluding header pumps and submersible pumps (as recommended by the CPWG). DOE requested comment on the proposed scope. 86 FR 72096, 72105.

NEEA agreed with the proposed scope of applicability. (NEEA, No. 11 at p. 2) NYSERDA supported the proposed test procedure scope, specifically as limited to clean water pumps, consistent with the scope of general pumps. (NYSERDA, No. 6 at p. 2) HI agreed with the proposed scope of applicability to exclude header pumps and submersible pumps but include circulator-less-volute pumps. (HI, No. 9 at p. 4) Joint Advocates supported exclusion of header pumps. (Joint Advocates, No. 8 at p. 1)

Grundfos agreed that submersible pumps should be excluded but stated that header pumps should be included. (Grundfos, No. 7 at p. 1)

As discussed in section III.B.4 of this document, DOE continues to have concerns about the representativeness of including header pumps in the scope of the test procedure and, therefore, is not including them in scope.

For the reasons discussed in the December 2021 NOPR and in the preceding paragraphs, in this final rule, DOE is adopting the scope as proposed in the December 2021 NOPR.

7. Basic Model

In the course of regulating consumer products and commercial and industrial equipment, DOE has developed the concept of a ''basic model'' to determine the specific product or equipment configuration(s) to which the regulations would apply. For the purposes of applying the proposed circulator pump regulations, DOE proposed to rely on the definition of ''basic model'' as currently defined at 10 CFR 431.462. 86 FR 72096, 72105. DOE stated that application of the current definition of ''basic model'' would allow manufacturers of circulator pumps to group similar models within a basic model to minimize testing burden, while ensuring that key variables that differentiate circulator pump energy performance or utility are maintained as separate basic models. *Id.* As proposed, manufacturers would be required to test only a representative number of units of a basic model in lieu of testing every model they manufacture. *Id.* As proposed, individual models of circulator pumps would be permitted to be grouped under a single basic model, so long as all grouped models have the same representative energy performance, which is representative of the least efficient or most consumptive unit. *Id.*

Specifically, for pumps, DOE's existing definition of basic model is as follows:

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 10 CFR 431.465(b), 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, 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 to subpart Y of this part); 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 subpart Y of this part).

10 CFR 431.462.

In the December 2021 NOPR, DOE stated that only the general provisions of the basic model definition would be applicable to circulator pumps and no additional provisions specific to circulator pumps would be necessary. 86 FR 72096, 72106. DOE requested comment on the proposed applicability of the definition of ''basic model'' at 10 CFR 431.462 to circulator pumps and any characteristics unique to circulator pumps that may necessitate modifications to that definition. *Id.*

HI and Grundfos agreed that the main paragraph of the basic model definition is accurate for circulator pumps, but stated that DOE should explicitly exclude parts 1, 2, and 3 of the definition. (HI, No. 9 at p. 4; Grundfos, No. 7 at p. 2)

As discussed in the December 2021 NOPR, provisions (1)–(3) of the basic model definition would not apply to circulator pumps based on the nature of how circulator pumps are designed and distributed in commerce. 86 FR 72096, 72106. Therefore, DOE does not need to exclude these provisions explicitly and instead applies the existing definition of ''basic model'' at 10 CFR 431.462 to circulator pumps, consistent with the application of that definition to dedicated-purpose pool pumps, for which provisions (1)–(3) would also not be applicable due to lack of variation in stages and impeller trims within a pump model.

C. Rating Metric

In the December 2021 NOPR, DOE proposed to adopt the CEI metric as the performance-based metric for representing the energy performance of circulator pumps, as defined in equation (1), and consistent with Section 41.5.3.2 of HI 41.5–2021. 86 FR 72096, 72107. DOE noted that while HI 41.5–2021 defines the denominator as CER_{REF}, DOE believed that the terminology CER_{STD} is more reflective of the Federal energy conservation standards. *Id.* Any standards considered for any circulator pumps for which the CEI is applicable would use this metric as a basis for the standard level.

$$CEI = \left[\frac{\mathrm{CER}}{CER_{STD}}\right] \quad \textbf{(1)}$$

Where:

CER = circulator energy rating (hp); and

CER_{STD} = circulator energy rating for a minimally compliant circulator pump serving the same hydraulic load.

Id.

In the December 2021 NOPR, DOE stated that the CPWG specified a method for determining the denominator of the metric with procedures to determine the minimally compliant overall efficiency at the various test points based on the hydraulic performance of the rated circulator pump. 86 FR 72096, 72106; (Docket No. EERE–2016–BT–STD–0004, No. 98 Recommendations #1 and 2A–D at pp. 1–4). As discussed, the denominator would represent the energy efficiency of a circulator pump that is minimally compliant with the applicable energy conservation standard, should DOE establish such a standard. Were DOE to conduct a rulemaking to propose energy conservation standards for circulator pumps, DOE would discuss in detail the derivation of the denominator, as well as an analysis as required by EPCA to evaluate any such standard level to determine the level designed to achieve the maximum improvement in energy efficiency that is technologically feasible and economically justified, as required under EPCA.[11] DOE noted that the recommended method for determining the denominator relies on the hydraulic horsepower of the rated circulator pump, which was also discussed in the December 2021 NOPR. 86 FR 72096, 72106–72107.

DOE requested comment on its proposal to adopt CEI as the metric to characterize the energy use of certain circulator pumps and on the proposed equation for CEI. *Id.* at 86 FR 72107.

HI, Grundfos, NEEA, and NYSERDA supported adoption of CEI. (HI, No. 9 at p. 5; Grundfos, No. 7 at p. 2; NEEA, No. 11 at p. 2; NYSERDA, No. 6 at p. 2) NYSERDA noted that CEI is consistent with HI 41.5–2021, developed by CPWG members based on the approved CPWG term sheet, and supported by a variety of stakeholders. (NYSERDA, No. 6 at p. 2) DOE notes that HI 41.5–2022 has the same definition of CEI as HI 41.5–2021.

For the reasons discussed in the December 2021 NOPR and in the preceding paragraphs, in this final rule, DOE adopts CEI as the metric to characterize the energy use of circulator pumps and the equation for CEI as proposed in the December 2021 NOPR.

D. Test Methods for Different Circulator Pump Categories and Control Varieties

In the December 2021 NOPR, DOE stated that many circulator pumps are sold with a variable speed drive and controls (*i.e.,* logic or user interface) with various control strategies that reduce the required power input at a given flow rate to save energy. The primary varieties of control recommended by the CPWG include manual speed controls, pressure controls, temperature controls, and external input signal controls. (Docket No. EERE–2016–BT–STD–0004, No. 58 Recommendations #4 at p. 4) For the test procedure to produce results that reflect variations in energy consumption associated with the various control strategies that could be implemented in a circulator pump, the CPWG recommended that DOE establish different test methods for each control variety in the circulator test procedure. 86 FR 72096, 72107; (Docket No. EERE–2016–BT–STD–0004, No. 58 Recommendations #6A and #6B at pp. 4–6).

Section III.D.1 discusses DOE's definitions for each of these circulator pump control varieties.

Section III.D.2 discusses the reference system curve that serves as a basis for rating each variety of circulator pump controls.

Sections III.D.3 through III.D.7 discuss the specific test provisions for pressure controls, temperature controls, manual speed controls, external input signal controls, and no controls,[12] respectively.

In response to the December 2021 NOPR, NEEA stated that they agreed with the proposed procedures for specific circulator types and control methods. (NEEA, No.11 at p. 2) Joint Advocates stated that they support the use of unique test point weights for different control types. (Joint Advocates, No. 8 at p. 1)

In the December 2021 NOPR, DOE considered incorporating HI 41.5–2021, ''Hydraulic Institute Program Guideline for Circulator Pump Energy Rating Program,'' which provides additional instructions for testing circulator pumps to determine an Energy Rating value for different circulator pump control varieties. DOE tentatively determined not to directly incorporate HI 41.5–2021. Unlike HI 40.6–2021, which is an industry test standard, HI 41.5–2021 is a guideline for participation in an industry program and includes many provisions not relevant to DOE. However, DOE preliminarily determined that its proposed test methods and calculations that supplement the proposed incorporation by reference of HI 40.6–2021, as discussed in sections III.D and III.E.2.c of this document, were consistent with HI 41.5–2021. 86 FR 72096, 72099.

In response to the December 2021 NOPR, HI requested that DOE incorporate by reference appropriate sections of HI 41.5–2021, instead of restating the requirements in the test procedure, noting support from additional stakeholders in response to the May 2021 RFI. (HI, No. 9 at p. 1) HI stated that this will reduce testing burden by eliminating confusion between DOE's test procedure and HI's standard and will significantly simplify and shorten the regulatory text language in appendix D. HI stated that many of DOE's requests for comment in the December 2021 NOPR were fully covered by HI 41.5, and slight changes by DOE could cause confusion in the market while not being beneficial to energy efficiency. (HI, No. 9 at pp. 1–2). HI did not recommend that DOE incorporate by reference HI 41.5 in full, but rather that DOE incorporate a table summarizing the appropriate Section of HI 41.5–2021 for each control method, and by referencing the appropriate Section of HI 41.5–2021 in each applicable section of the regulatory text. (HI, No. 9 at pp. 2–3).

Grundfos stated that DOE should incorporate HI 41.5–2021, Table 41.5.3 into appendix D, similar to Table 1 in appendix A, to clarify what testing is required based on the control method(s) of a circulator pump and to directly reference HI 41.5–2021 for testing

[11] For more information on any energy conservation standard rulemaking for circulator pumps, see Docket No. EERE–2016–BT–STD–0004.

[12] In this document, circulator pumps with ''no controls'' are also inclusive of other potential control varieties that are not one of the specifically identified control varieties. *See* section III.D.7 of this document.

procedures instead of recreating the language within the test procedure itself. (Grundfos, No .7 at p. 7)

NEEA also disagreed that DOE is not able to adopt HI 41.5–2021 directly. NEEA stated that while HI 41.5–2021 is a rating guide for HI's Energy Rating program for circulators, it also contains the necessary test provisions for circulators and is identical to the test procedure DOE proposed. As such, NEEA found this proposal in the December 2021 NOPR to be confusing and burdensome for manufacturers and the market, as manufacturers have invested in testing and rating circulators according to HI 41.5–2021 and labeling equipment accordingly. NEEA noted that if there are minor difference between DOE's proposal and HI 41.5–2021, retesting might be required to ensure compliance without substantively affecting the efficiency of the equipment or the overall test result. NEEA stated that it would be more simple and less confusing to have just one test procedure for CEI. NEEA recommended that DOE reference the appropriate sections in HI 41.5–2021, rather than writing each section out in full. (NEEA, No. 11 at pp. 2–3) NEEA's suggestions for references are consistent with those provided by HI.

Following publication of the December 2021 NOPR, HI released a new version of HI 41.5, HI 41.5–2022 ''Hydraulic Institute Program Guideline for Circulator Pump Energy Rating Program''. In this version of the industry guideline, HI corrected errors in certain test methods, provided additional specificity regarding certain provisions, and removed provisions specific to the HI Energy Rating program. These changes are discussed in the following subsections. Having considered comments suggesting that adding additional regulatory text would be confusing and burdensome, and due to the changes made in HI 41.5–2022, DOE is incorporating by reference HI 41.5–2022, adopting only sections specific to the test methods for control modes as requested by stakeholders. This limitation of the reference addresses DOE's concerns about the inclusion of provisions not relevant to DOE.

In the December 2021 NOPR, DOE proposed that manufacturers could select the control variety used for testing if the circulator pump model is distributed in commerce with multiple control varieties, which DOE expected would typically be the least consumptive control mode. However, DOE proposed that manufacturers may select multiple control varieties with which to test their circulator pumps and noted that DOE would address certification requirements in any future energy conservation standard rulemaking.[13] DOE requested comment on this proposal. 86 FR 72096, 72108.

Joint Advocates stated that when given the option to choose a control variety for rating, it is expected that most manufacturers would choose the least consumptive control curve, so in practicality there would be little difference between the ''manufacturer-selected'' and the ''least-consumptive'' control methods. Joint Advocates stated that requiring additional reporting of ratings representing the ''most-consumptive'' control method may encourage adoption of energy efficient options and would better inform purchases. (Joint Advocates, No. 8 at p. 3)

Joint Advocates and CA IOUs noted that the HI labeling program requires testing of the most and least consumptive control modes. (Joint Advocates, No. 8 at p. 3; CA IOUs, No. 10 at p. 1) CA IOUs added that manufacturers are intended to compete primarily on the least consumptive control mode, that most manufacturers are participating, and that therefore manufacturers will have test data in hand for both most and least consumptive control modes. (CA IOUs, No. 10 at pp. 1–2)

CA IOUs agreed with DOE's reasoning that the least consumptive control mode is where the products are most easily differentiated from each other and is representative of the circulator product performance in the field under a variety of scenarios. CA IOUs noted that there would be no need for DOE to specify least consumptive prescriptively and supported the proposal that manufacturers select the control mode to be tested. (CA IOUs, No. 10 at p. 2)

CA IOUs recommend that DOE require reporting of the most consumptive product performance values and reporting of the control type used for certification rating (*i.e.,* least consumptive). CA IOUs noted that the most consumptive control mode data is a direct indication of product mechanical performance at the CEI rating load points, unlike the least consumptive mode which also assesses the control system's performance. (*Id.*) CA IOUs also noted that the control scheme used can have a considerable influence on the results of the CEI rating at the least consumptive control method, so the CA IOUS recommended that control scheme used as part of rating should be reported in a supplemental information field. CA IOUs recommended that adaptive pressure controls have a unique control classification as part of the rating. (*Id.*)

NEEA recommended that DOE require testing in the most consumptive control strategy, likely full speed, and set the performance standard at efficiency level (''EL'') 1.5 (*i.e.,* a nominally lower efficiency level than the EL2 recommended by the CPWG). NEEA stated that the intent of a DOE standard and the CPWG recommendation is to raise the performance of all circulators in commerce to a minimum threshold, which should be one to be powered by electrically commutated (''EC'') motors. NEEA stated that the proposed test procedure requires circulators to be capable of reaching the required efficiency level but allows equipment to operate below the rated efficiency when installed. NEEA stated that this approach is not an appropriate regulatory mechanism nor is it representative of how circulators are operated in the market. Therefore, NEEA recommended testing in the most consumptive control strategy. (NEEA, No. 11 at p. 2) NEEA added that non-guaranteed performance would discourage utility circulator energy conservation programs. (NEEA, No. 11 at p. 7) NEEA stated that a DOE standard based on the most consumptive control setting creates a baseline above which utilities can incentivize increased performance, such as using the least consumptive control setting. (NEEA, No. 11 at p. 9)

NEEA stated that it believed the CPWG intent was for all circulator pumps sold in commerce to be equipped with either an EC motor or advanced controls. NEEA stated that by using least consumptive as the standard, installers would have the option to choose between controls that meet DOE's standard and controls that do not. NEEA stated that it did not believe that the least consumptive setting available is representative of how circulators with multiple control strategies will be installed, and that at this time information on what is representative is not available (NEEA, No. 11 at p. 6)

NEEA commented that not all EC motors meet EL 2 (the level recommended by the CPWG), and as such EL 1.5 might be appropriate when paired with a most consumptive requirement (which would tend to produce lower ratings for a given circulator pump model). NEEA stated that if DOE allows manufacturers to choose the control setting, then EL2 is appropriate. (NEEA, No. 11 at p. 7) NEEA stated that testing in the most consumptive setting and using EL 1.5 as

[13] For more information on any energy conservation standard rulemaking for circulator pumps, see Docket No. EERE–2016–BT–STD–0004.

the standard allows DOE to increase the standard in future circulator rulemakings, which would be difficult based on least consumptive settings. (NEEA, No .11 at p. 9)

NEEA also recommended that DOE allow manufacturers to test in another control setting of their choosing to represent the range of efficiency available in a product to the market, and that the CEI of the most consumptive control strategy and any other CEI be reported to DOE and included on the circulator nameplate. (NEEA, No. 11 at p. 6) NEEA stated that multiple ratings would support the market in adopting energy efficient options and technologies beyond the minimum threshold set by the standard. NEEA noted that manufacturers already support testing in most consumptive control setting through the HI Energy Rating program. (NEEA, No. 11 at p. 8)

HI stated that, for DOE compliance, the manufacturer should be able to select any control mode that results in a compliant rating. (HI, No. 9 at p. 4) Grundfos agreed that the manufacturer should be allowed to select the control method tested. However, Grundfos stated that reporting of the control method used, and the actual parameters of the testing need to be addressed in detail in the circulator efficiency standard. Grundfos gave as an example, where a user can adjust setpoints for maximizing their system, this should be detailed in reporting to DOE, so repeatability of testing is possible. (Grundfos, No. 7 at p. 2)

DOE is adopting provisions in section 2.2 of appendix D to allow manufacturers to use the DOE test procedure to test any control variety available on a given circulator pump model, as proposed in the December 2021 NOPR. In response to NEEA's recommendation that DOE require testing in the most consumptive control strategy, DOE notes that circulator pumps may be sold with multiple control varieties, and DOE has determined that consumers may benefit from having access to CEI ratings at full speed and with various control options. Whether compliance with any standard established, should energy conservation standards be established, would be based on a specific control mode (or no controls), or whether certain information related to the control mode used for testing would be required as part of certification, would be addressed in an energy conservation standard rulemaking.

1. Definitions Related to Circulator Pump Control Varieties

In the December 2021 NOPR, DOE proposed to define external input signal control, manual speed control, pressure control, and temperature control as recommended by the CPWG and consistent with HI 41.5–2021:

- *Manual speed control* means a control (variable speed drive and user interface) that adjusts the speed of a driver based on manual user input.
- *Pressure control* means a control (variable speed drive and integrated logic) that automatically adjusts the speed of the driver in response to pressure.
- *Temperature control* means a control (variable speed drive and integrated logic) that automatically adjusts the speed of the driver continuously over the driver operating speed range in response to temperature.
- *External input signal control* means a variable speed drive that adjusts the speed of the driver in response to an input signal from an external logic and/or user interface.

86 FR 72096, 72108–72109.

DOE also proposed to define adaptive pressure control as follows:

> *Adaptive pressure control* means a pressure control that continuously senses the head requirements in the system in which it is installed and adjusts the control curve of the pump accordingly.
>
> DOE requested comment on this definition. 86 FR 72096, 72109.

In response, HI suggested modifications to the proposed definition and stated that adaptive pressure control pumps do not always operate continuously. HI proposed the following definition:

Adaptive pressure control means a pressure control that senses the head requirements in the system in which it is installed and adjusts the pump control curve accordingly.

(HI, No. 9 at p. 4)

Grundfos agreed with the suggested modification detailed by HI. (Grundfos, No. 7 at p. 2)

In this final rule, for the reasons discussed in the December 2021 NOPR, DOE adopts the definitions for external input signal control, manual speed control, pressure control, and temperature control as proposed in the December 2021 NOPR. For the reasons discussed in the NOPR, and in order to capture controls that do not always operate continuously, as identified by HI and Grundfos, DOE is adopting the definition for adaptive pressure control as recommended by HI and Grundfos.

2. Reference System Curve

In the December 2021 NOPR, DOE stated that all recommended test methods for circulator pump control varieties, which involve variable speed control of the circulator pump, specify test points with respect to a representative system curve. 86 FR 72096, 72109. That is, for circulator pumps with manual speed controls, pressure controls, temperature controls, or external input signal controls, a reference system curve is implemented to be representative of the speed reduction that is possible in a typical system to provide representative results. *Id.* For circulator pumps with no controls, no reference system is required as measurements are taken at various test points along a pump curve at maximum speed only. *Id.*

Such a reference system curve describes the relationship between the head and the flow at each test point in a typical system. Additionally, a reference system curve that is representative of a typical system in which circulator pumps are installed may also allow for the differentiation of control varieties to be reflected in the resulting ratings. DOE proposed to incorporate a quadratic reference system curve as recommended by the CPWG and consistent with HI 41.5–2021, which includes this reference curve in each of the individual control test methods (sections 41.5.3.4.2 #3d, 41.5.3.4.3 #2, 41.5.3.4.4.1 #2, 41.5.3.4.4.2 #2, and 41.5.3.4.5 #2d). *Id.* The proposed reference system curve intersects the BEP and has a static offset of 20 percent of BEP head, as shown in equation (2).

$$H = \left[0.8 * \left(\frac{Q}{Q_{100\%}}\right)^2 + 0.2\right] * \mathrm{H}_{100\%} \quad \textbf{(2)}$$

Where:

H = the pump total head (ft),
Q = the flow rate (gpm),
$Q_{100\%}$ = flow rate at 100 percent of BEP flow (gpm), and
$H_{100\%}$ = pump total head at 100 percent of BEP flow (ft).

86 FR 72096, 72109–72110.

DOE received no comments on the proposed reference system curve. As noted in section II, DOE is incorporating by reference sections of HI 41.5–2022 for each control mode test method, which include the reference curve equation, and is the same as HI–41.5–2021. As such, DOE is adopting the proposed reference curve through reference to HI 41.5–2022 and is not establishing an additional section in its test procedure specifying the reference curve as applicable to all test methods.

As such, DOE adopts the curve as described in Equation 2 and proposed in the December 2021 NOPR. Pressure Control.

In the December 2021 NOPR, DOE proposed a test method for circulator pumps with pressure controls consistent with the method included in HI 41.5–2021 and deviating from that proposed by the CPWG. 86 FR 72096, 72111–72112. Specifically, DOE proposed that circulator pumps with pressure controls be tested at test points of 25, 50, 75, and 100 percent of BEP flow based on a manufacturer-selected control curve that is available to the end user, must produce a head equal to or greater than 25 percent of BEP head at a minimum of one test point, and must achieve 100 percent BEP flow of the reference curve. *Id.* at 86 FR 72112. DOE proposed that such the test points may be obtained based on automatic speed adjustment, manual speed adjustment, or simulated pressure signal, or a combination of these adjustments, including throttling. *Id.* Additionally, DOE proposed that the CEI for circulator pumps with pressure controls be calculated with the unique weights and test points as shown in equation (3):

$$CER = \sum_{i} \omega_i \left(P_{in,i} \right) \quad \textbf{(3)}$$

Where:

CER = circulator pump energy rating (hp);
w_i = weight of 0.05, 0.40, 0.40, and 0.15 at test points of 25, 50, 75, and 100 percent of BEP flow, respectively;
$P_{in,i}$ = power input to the driver at each test point i (hp); and
i = test point(s), defined as 25, 50, 75, and 100 percent of the flow at BEP.

Id. at 86 FR 72110.

Additionally, in a deviation from CPWG recommendations and based on stakeholder comments on the May 2021 RFI and the contents of HI 41.5–2021, DOE stated that it agreed with commenters that it is important for the test method to capture the variety of pressure controls on the market, and that correction back to the reference curve would prevent any unfair advantage among the variety of controls on the market. *Id.* at 86 FR 72112. DOE requested comment on the proposed test method for circulator pumps with pressure controls. *Id.*

Joint Advocates supported the proposed update, consistent with HI 41.5–2021, relating to pressure control system test points, stating that they understand that many programmed control curves were not testable under the older methodology because the control systems of some circulator pumps may operate at head pressures below the reference curve provided in HI 41.5–2018. Referring to the proposed update and the contents of HI 41.5–2021, Joint Advocates added that they understand that the power correction back to the reference curve assumes a constant pump efficiency, is valid, and does not give an arbitrary advantage to products using this assumption. (Joint Advocates, No. 8 at p. 2) Grundfos stated that DOE should not recreate language from HI 41.5 and instead point to HI 41.5.3.4.2 for testing circulator pumps with pressure controls. (Grundfos, No. 7 at p. 2)

In the December 2021 NOPR, DOE stated that it was aware of some circulator pumps that are equipped with user-adjustable pressure controls such that the maximum and minimum head values on the control curve can be set to specifically match the system into which the pump is being installed. 86 FR 72096, 72112. DOE's interpretation of HI 41.5–2021 was that these types of controls are not addressed in the industry standard. To test such controls, DOE proposed that the maximum and minimum head values on user-adjustable pressure controls may be adjusted, if possible, to coincide with a maximum head value at the pump's BEP and a minimum head value equivalent to 20 percent of the BEP head value (consistent with the static offset of the proposed reference system curve). *Id.* If only the maximum or minimum head value can be adjusted, DOE proposed that only the adjustable setting would be adjusted. In either case, DOE also proposed that the settings can be adjusted for testing only if they are adjustable by the user. *Id.* DOE stated that this proposed methodology would result in the most representative performance of such adjustable controls by preventing the testing of specifically tuned control options that would not be representative of likely field performance. *Id.* DOE noted that further adjustment to attain 100 percent of BEP head would be required. *Id.*

In summary, for adjustable pressure controls with user-adjustable maximum and/or minimum head values, DOE proposed to allow one-time manual adjustment of the maximum and/or minimum control curve head values, as applicable, to coincide with a maximum head value at the pump's BEP and a minimum head value equivalent to 20 percent of the BEP head value with all subsequent test points taken along the adjusted control curve. DOE requested comment on whether specific test provisions for circulator pumps equipped with user-adjustable pressure controls are needed, and if so, on the proposed provisions for such pumps. *Id.*

Joint Advocates supported DOE's approach to testing user-adjustable controls, noting that DOE's interpretation of HI 41.5–2021 is that these controls are not addressed in the industry standard. Joint Advocates stated that, importantly, DOE's proposal states that settings can only be adjusted for testing if they are adjustable by the user, which would prevent testing of specifically tuned control options that are not representative. (Joint Advocates, No. 8 at pp. 2–3)

HI and Grundfos stated that circulator pumps with user-adjustable pressure controls are addressed in HI 41.5–2021 in section 41.5.3.4.2 and should be tested accordingly. (HI, No. 9 at pp. 4–5; Grundfos, No. 7 at p. 2) HI noted that no special provisions or alternative test

methods are needed. (HI, No. 9 at p. 5) Grundfos added that DOE should properly collect this adjustment data through reporting for repeatable testing. (Grundfos, No. 7 at p. 2)

Upon review of HI 41.5–2021, DOE finds that its proposals in the December 2021 NOPR related to adjustable pressure controls are a more specific implementation of the requirements for pressure controls in section 41.5.3.4.2 #3. Specifically, user-adjustable controls allow the user to create a control curve, and the control curve created by adjusting the maximum and/or minimum head values must be available to the end user, produce a head equal to or greater than 25 percent of BEP head at a minimum of one test point, and achieve 100 percent BEP flow of the reference curve. While DOE's proposal has more specificity that could increase repeatability, DOE notes that all of DOE's proposed test methods for the various speed control varieties, as well as the methods in HI 41.5–2022, allow some discretion by the manufacturer with regard to exactly which settings to use. As such, DOE is not adopting its proposal specific to user-adjustable controls, and, in response to Grundfos, DOE will address certification reporting requirements related to control curve settings in a separate rulemaking.

In the December 2021 NOPR, DOE stated that adaptive pressure controls are installed in similar applications as pressure controls but can also be effective at reducing the head and flow provided in single-zone systems to adjust for typical pump oversizing. Also, due to the ability of adaptive pressure controls to measure and automatically adjust to the system requirements over time, adaptive pressure controls can result in optimized performance and energy use as compared to pressure-based controls. 86 FR 72096, 72112.

Consistent with HI 41.5–2021, for adaptive pressure controls, DOE proposed to test at each test point at the minimum thresholds for head noted in the manufacturer literature or the head values specified along the reference system curve, whichever is greater. In addition, although not included in HI 41.5–2021, DOE also proposed that if the pump does not have a manual control mode available, the speed would be adjusted based on the pressure control mode with the lowest head at each load point, and if the selected pressure control results in a head value below the reference system curve, the pump would be throttled to achieve a head value at or above the reference system curve. 86 FR 72096, 72114.

DOE requested comment on the proposed test methods for circulator pumps with adaptive pressure controls, and, in particular, on the proposed provisions not included in HI 41.5–2021, including for pumps without a manual control mode, whether throttling should be allowed to achieve head above the reference system curve, or instead head should be allowed below the reference system curve and adjusted back to the curve, as with other non-adaptive pressure controls. DOE also requested comment on the HI 41.5–2021 provision for manual adjustment to achieve 100 percent BEP flow and head point at max speed, which is not included for other pressure controls. *Id.*

Joint Advocates supported the proposed test methodology for adaptive pressure controls as a reasonable approach, while encouraging DOE in the future to gather field data related to real-world operating points. (Joint Advocates, No. 8 at p. 2)

HI and Grundfos stated that HI 41.5–2021 treats adaptive pressure controls with the same methodology as all pressure controls, and that section 41.5.3.4.2 #4 is a subset of the pressure testing methodology and not a standalone test methodology. (HI, No. 9 at p. 5; Grundfos, No. 7 at p. 2) HI added that it would be rare that the circulator BEP would be outside of the adaptive controls operating area, so the difference between throttling and adjusting back to the curve would not be an issue, unless the BEP is outside the control area. HI stated that a pump without manual speed adjustment would still allow use of a throttling equivalent (as noted in section 41.5.3.4.2 #2b) to get back to the BEP flow, which can then be corrected back to BEP on the reference curve. (HI, No. 9 at p. 5)

In response to HI and Grundfos, DOE notes that HI 41.5–2021 contained discrepancies with regard to the methodology in section 41.5.3.4.2 #4 (adaptive pressure controls) compared to #2 and #3 (all pressure controls). Specifically, #4 only allows manual speed adjustment, while #2 also allows throttling and simulated pressure signal. In addition, #4 requires head values to be above the reference curve, while #3 does not require this. In the recent publication of HI 41.5–2022, HI included several updated to section 41.5.3.4.2 that address DOE's proposals related to adaptive pressure controls, specifically removing the identified discrepancies, so that #4 now provides additional testing provisions for adaptive pressure controls, but not conflicting provisions. This update indicates that the provision requiring adaptive pressure controls to achieve head values at or above the reference curve was erroneous.

In addition, HI 41.5–2022 has moved the contents of section 41.5.3.4.2 #5, which discussed the choice and reporting of factory control curves specific to the HI Energy Rating Program, but not necessary for conduct of the test method, to a separate section of the guideline. As such, DOE will reference the entire section.

For these reasons, DOE is adopting the test method for pressure speed controls by referencing HI 41.5–2022 section 41.5.3.4.2. As noted, this test method contains some differences from the test method proposed by DOE in that it does not include specific provisions for user-adjustable controls, which DOE has determined are not necessary, and that it has revised the test method for adaptive pressure controls to be more consistent with the test method for pressure controls in general, while providing necessary additional specifications. The overall test method for pressure controls in HI 41.5–2022 section 41.5.3.4.2 in general is consistent with that proposed in the December 2021 NOPR. DOE has determined that the revised test method for adaptive pressure controls will produce representative results for such equipment and would not be unduly burdensome to conduct.

3. Temperature Control

Temperature controls are controls that automatically adjust the speed of the variable speed drive in the pump continuously over the operating speed range to respond to a change in temperature of the operating fluid in the system. Typically, temperature controls are designed to achieve a fixed temperature differential between the supply and return lines and adjust the flow rate through the system by adjusting the speed to achieve the specified temperature differential. Similar to pressure controls, temperature controls are also designed primarily for hydronic heating applications. However, temperature controls may be installed in single- or multi-zone systems and will optimize the circulator pump's operating speed to provide the necessary flow rate based on the heat load in each zone. Unlike pressure controls, there are no minimum head requirements inherent to the temperature control, so temperature controls have the potential to use the least amount energy to serve a given load. 86 FR 72096, 72114.

The CPWG recommended that for circulator pumps distributed in commerce with temperature controls, PER_{CIRC} should be calculated in the

same way and with the same weights as for pressure controls, as shown in equation (4). (Docket No. EERE–2016–BT–STD–0004, No. 58 Recommendation #6A at pp. 4–5)

In the December 2021 NOPR, DOE tentatively determined that the CPWG recommendation for temperature controls would allow for temperature controls to be tested in a way that captures the potential energy savings from this control variety without being overly burdensome for manufacturers to conduct. Therefore, DOE proposed to adopt the recommendations of the CPWG to test temperature controls based on manual speed adjustment or with simulated temperature signal to activate the temperature-based control to achieve the test point flow rates with a head at or above the reference system curve. Additionally, DOE proposed to use the weights and test points shown in equation (4) of the December 2021 NOPR (equation (3) in this final rule) for circulator pumps distributed in commerce with temperature controls. DOE requested comment on the proposed test methods, test points, and weights for circulator pumps with temperature controls. 86 FR 72096, 72115.

Joint Advocates supported testing of temperature controls as recommended by the CPWG. (Joint Advocates, No. 8 at p. 1) HI agreed with the proposed testing of temperature controls but noted that the terminology in the equations should be updated to reflect CEI and CER. (HI, No. 9 at p. 6) Grundfos agreed with the temperature control testing but stated that DOE should directly reference HI 41.5.3.4.3 instead of recreating this language within the test procedure. (Grundfos, No. 7 at p. 3)

In response to HI, DOE notes that the regulatory text proposed in section V.C of appendix D reflected CER terminology. 86 FR 72096, 72144. This proposed regulatory text, which DOE based on the test procedure from HI 41.5–2021, is consistent with the content of HI 41.5–2022. DOE adopts the test method for temperature controls as proposed, but instead of including regulatory text, DOE is referencing HI 41.5–2022 section 41.5.3.4.3, as requested by stakeholders. This section is consistent with the regulatory text proposed in the NOPR, and as such does not representative a substantive change.

4. Manual Speed Control

In the December 2021 NOPR, DOE proposed to test circulator pumps with manual speed controls consistent with the provisions in Section 41.5.3.4.5 of HI 41.5–2021, as follows: (1) the tested control must produce head equal to or greater than 25 percent of BEP head at a minimum of one test point (HI 41.5–2021 section 41.5.3.4.5 #2a), and (2) the control curve setting being evaluated must achieve 100 percent BEP flow of the reference curve (HI 41.5–2021 section 41.5.3.4.5 #2b). DOE also proposed that the CER be calculated as the weighted average of $P_{in,max}$ and $P_{in,reduced}$, as shown in equations (5), (6), and (7):

$$CER = z_{max}\left(P_{in_{max}}\right) + z_{reduced}\left(P_{in_{reduced}}\right) \quad \textbf{(5)}$$

Where:

CER = circulator pump energy rating (hp);
z_{max} = speed factor weight of 0.75;
$z_{reduced}$ = speed factor weight of 0.25; and
P_{in_max} = weighted average input power at maximum rotating speed of the circulator (hp), as specified in equation (6);
$P_{in\_reduced}$ = weighted average input power at reduced rotating speed of the circulator (hp), as specified in equation (7).

$$P_{in_{max}} = \sum_{i} \omega_{i_{max}}\left(P_{in,i_{max}}\right) \quad \textbf{(6)}$$

Where:

P_{in_max} = weighted average input power at maximum speed of the circulator (hp);
w_{i_max} = 0.25;
P_{in,i_max} = power input to the driver at maximum rotating speed of the circulator pump at each test point i (hp); and
i = test point(s), defined as 25, 50, 75, and 100 percent of the flow at BEP.

$$P_{in_{reduced}} = \sum_{i} \omega_{i_{reduced}}\left(P_{in,i_{reduced}}\right) \quad \textbf{(7)}$$

Where:

$P_{in\_reduced}$ = weighted average input power at reduced speeds of the circulator (hp);
$w_{i\_reduced}$ = 0.3333;
$P_{in,i\_reduced}$ = power input to the driver at reduced rotating speed of the circulator pump at each test point i (hp); and
i = test point(s), defined as 25, 50, and 75 percent of the flow at BEP of max speed.

86 FR 72096, 72115–72116.

Additionally, in a deviation from CPWG recommendations and based on stakeholder comments on the May 2021 RFI and the contents of HI 41.5–2021, DOE did not propose that all test points

on a control curve must exist above the reference curve. DOE noted that HI 41.5–2021 section 41.5.3.4.5 #3 still retained that provision, which DOE assumed to be an error based on HI's comments and recommendations in response to the May 2021 RFI. 86 FR 72096, 72116.

DOE tentatively determined that the proposed test methods for manual speed control circulator pumps are appropriate and representative, as they account for the likelihood that a circulator pump with manual speed controls will be installed and operated at maximum speed, but also accounts for the potential energy savings associated with reduced speed operation. 86 FR 72096, 72116. DOE requested comment on the proposed test method and the unique test points, weights, and speed factors for circulator pumps distributed in commerce with manual speed controls. *Id.* at 86 FR 72117.

Grundfos continued to state, as it did in response to the May 2021 RFI, that manual speed control should not be a separate test method, as the devices are typically operated 75 percent of the time at full speed, and a manufacturer could benefit by adding alternate speeds that are never used. Grundfos suggested that if manual speed testing is maintained, a CEI value should be required for each setting available to consumers so that consumers can understand the true efficiency. (Grundfos, No. 7 at p. 3)

As discussed in the December 2021 NOPR, the CPWG addressed the issues raised by Grundfos in discussing how the test points at maximum speed were designed to represent the performance at maximum speed and account for operation at maximum speed the majority of the time, while the test points at reduced speed allowed some ''credit'' for being able to reduce speed. 86 FR 72096, 72116; (Docket No. EERE–2016–BT–STD–0004, No. 70 at p. 201–202) The CPWG concluded that about 75 percent of the time, circulator pumps with manual speed controls are operated at maximum speed, as reflected in its recommended procedure. (Docket No. EERE–2016–BT–STD–0004, No. 71 at p. 377) For these reasons, DOE proposed to include manual speed control as a test method in the circulator pump test procedure. 86 FR 72096, 72116. Grundfos did not add additional information in their comment in response to the December 2021 NOPR, and as such DOE is adopting a test method for circulator pumps with manual speed control in this final rule. DOE will address Grundfos' suggestion for CEI ratings for multiple settings in a separate certification rulemaking.

Joint Advocates supported testing manual controls with test point weightings as recommended by the CPWG and using updated testing methodology consistent with HI 41.5–2021, for the same reasons discussed for pressure controls. (Joint Advocates, No. 8 at p. 1–2) HI supported the proposed testing for manual controls but noted that the terminology in the equations should be updated to reflect CEI and CER. (HI, No. 9 at p. 6) Grundfos stated that DOE should directly reference HI 41.5.3.4.5, instead of recreating this language within the test procedure. (Grundfos, No. 7 at p. 3)

In the December 2021 NOPR, DOE noted that HI 41.5–2021 section 41.5.3.4.5 #3 includes a provision for head to be at or above the reference curve, as originally recommended by the CPWG, which DOE assumed to be an error based on HI's comments and recommendations in response to the May 2020 RFI. DOE also noted that the introductory text of HI 41.5–2021 section 41.5.3.4.5 specifies that the test method applies to manual speed control, which can be operated without an external input signal, but DOE stated it believed this provision is superfluous as manual speed controls by definition do not require an external input signal. 86 FR 72096, 72116–72117. DOE did not include these provisions in its proposed test method for manual speed control. DOE did not receive comments specifically related to these issues, but in the recent publication of HI 41.5–2022, the provisions that DOE assumed to be erroneous have been removed. In response to HI's comments, the proposed regulatory text regarding the manual speed control test method did reflect CEI and CER; HI 41.5–2022 also reflects this terminology.

DOE also notes that in the proposed regulatory text for manual speed controls, DOE proposed that the control curve must be available to the end user. 86 FR 72096, 72142. This provision was not specified in HI 41.5–2021 but has been added to HI 41.5–2022. DOE has determined that this requirement will improve the representativeness of CEI ratings for circulator pumps with manual speed controls as it will prevent manufacturers from rating with speeds that cannot be used in the field. The remainder of the provisions in HI 41.5–2022 section 41.5.3.4.5 are consistent with DOE's proposals and with HI 41.5–2021.

For these reasons, DOE adopts the test method for manual speed control as proposed in the NOPR but is referencing HI 41.5–2022 section 41.5.3.4.5 instead of including regulatory text. This section is consistent with the regulatory text proposed in the NOPR, and as such does not representative a substantive change.

5. External Input Signal Control

In the December 2021 NOPR, DOE proposed to specify a test method for circulator pumps sold only with external input signal control and that cannot operate without an external input signal. 86 FR 72096, 72118. Specifically, DOE proposed to test along the reference system curve to achieve the test point flow rates with a head at or above the reference curve, and that CEI would be calculated as shown in equation (2) of the December 2021 NOPR (equation (1) in this final rule). *Id.* DOE also proposed that the speed of the pump could be adjusted using either manual speed adjustment or with a simulated external signal to achieve the specified flow rates. *Id.* at 86 FR 72141.

DOE also proposed to test circulator pumps sold with external input signal controls along with other controls, or which can be operated without an external input signal control, both: (1) along the maximum speed circulator pump curve to achieve the test point flow rates for the max speed input power values and (2) with speed adjustment that will achieve a head at or above the reference system curve at the test point flow rates for the reduced speed input power values. DOE proposed that in either case, either manual speed adjustment or simulated external input signal can be used to achieve the relevant flow rates. DOE did not propose that the speed adjustment include the ''lowest speed setting'' that results in a head value at or above the reference system curve, as recommended by the CPWG; however, DOE addressed this issue in its enforcement provision proposals. Finally, DOE proposed that the CEI should be calculated as the weighted average of $P_{in,max}$ and $P_{in,reduced}$, as shown in equations (8), (9), and (10).

$$CER = z_{max}(P_{in_{max}}) + z_{reduced}(P_{in_{reduced}})$$

(8)

Where:

CER = circulator pump energy rating (hp);
z_{max} = speed factor weight of 0.30;
P_{in_max} = weighted average input power at maximum rotating speed of the circulator pump (hp);
$z_{reduced}$ = speed factor weight of 0.70; and
$P_{in\_reduced}$ = weighted average input power at reduced rotating speed of the circulator (hp).

$$P_{in_{max}} = \sum_{i} \omega_{i_{max}}\left(P_{in,i_{max}}\right)$$

(9)

Where:

P_{in_max} = weighted average input power at maximum speed of the circulator (hp);
w_{i_max} = 0.25;
P_{in,i_max} = power input to the driver at maximum rotating speed of the circulator pump at each test point i (hp); and
i = test point(s), defined as 25, 50, 75, and 100 percent of the flow at BEP.

$$P_{in_{reduced}} = \sum_{i} \omega_{i_{reduced}}\left(P_{in,i_{reduced}}\right)$$

(10)

Where:

$P_{in\_reduced}$ = weighted average input power at reduced speeds of the circulator pump (hp);
$w_{i\_reduced}$ = 0.3333;
$P_{in,i\_reduced}$ = power input to the driver at reduced rotating speed of the circulator pump at each test point i (hp); and
i = test point(s), defined as 25, 50, and 75 percent of the flow at BEP of max speed and head values at or above the reference curve.

86 FR 72096, 72117–72118.

DOE requested comment on the proposed test method and the unique test points, weights, and speed factors for circulator pumps distributed in commerce with external input signal controls. 86 FR 72096, 72118. In particular, DOE requested comment on whether manual speed adjustment and/or simulated external input signal are appropriate for testing circulator pumps with external input signal only, as well as circulator pumps with external input signal in addition to other control varieties. *Id.* DOE also sought comment on whether it is necessary to reference the ''lowest speed setting'' when determining the appropriate test points. *Id.* Finally, DOE sought comment on whether the test points and weights for circulator pumps distributed in commerce with external input signal control in addition to other control varieties are appropriately reflective of their energy consumption in the field relative to other control varieties. *Id.*

In response, Grundfos stated that delta T and temperature control test methods should be combined.[14] Grundfos noted that the speed of the pump is the primary function determining efficiency, that both test methods control the pumps speed, as in both cases they simulate inputs to conduct testing and attempt to model the reference curve with those inputs, and therefore separate test requirements are not necessary. (Grundfos, No. 7 at p. 3).

DOE assumes that Grundfos is recommending that the test methods for temperature controls and external input signal controls be combined, as they suggested in response to the May 2021 RFI. (Grundfos, No. 113 at p. 4) As discussed in the December 2021 NOPR, the CPWG considered the category of external input signal controls as separate from temperature controls. Specifically, the CPWG noted that unlike pressure and temperature controls, for external input signal controls, the logic that defines how the circulator pump operating speed is selected in response to some measured variable (*e.g.,* temperature, pressure, or boiler fire rate) is not integral to the circulator as distributed in commerce. Instead, it is part of another control system, such as a building management system or a boiler control system. (Docket No. EERE–2016–BT–STD–0004, No. 72 at p. 83–84); 86 FR 72096, 72115.

DOE also noted that the test method recommended by the CPWG and in HI 41.5–2021 for circulator pumps with external input signal controls only and that cannot operate without an external signal control is the same as the test method for circulator pumps with temperature control. 86 FR 72096, 72115. However, the CPWG recommended, and HI 41.5–2021 included, a different test method for external input signal controls with other control varieties or that can be operated without external input signal control. *Id.* The CPWG asserted that if external input signal control is one of multiple options available on a circulator pump, or the pump is able to operate without an external input signal, it is less likely that the external input signal control option is going to be utilized since it requires external logic and equipment in order to operate properly. (Docket No. EERE–2016–BT–STD–0004, No. 72 at pp. 216–218, 229); 86 FR 72096, 72117. The CPWG recommended testing

[14] Delta T and temperature controls refer to the same type of control. As discussed in the next paragraph, DOE believes this is an error.

circulator pumps with external input signal controls similar to manual speed controls. (Docket No. EERE–2016–BT–STD–0004, No. 47 at p. 480); 86 FR 72096, 72117.

For these reasons, DOE proposed separate test methods for temperature controls, external input signal controls only (identical to the test method for temperature controls), and external input signal controls with other control varieties. 86 FR 72096, 72115.

In its response to the December 2021 NOPR, Grundfos has not introduced additional information beyond that provided in its May 2021 RFI comments that would contribute to DOE amending the test methods as proposed. (See Grundfos, No. 7 at p. 3)

HI agreed with the proposal in the NOPR, which they stated is incorporated within the appropriate testing sections of HI 41.5–2021. (HI, No. 9 at p. 6) Grundfos stated that DOE should directly reference HI 41.5–2021 sections 41.5.3.4.4.1 for external control only and 41.5.3.4.4.2 for external control with other control methods, instead of recreating the language within the test procedure. (Grundfos, No. 7 at p. 3)

HI stated that additional clarification for ''lowest speed setting'' is not necessary. (HI, No. 9 at p. 6) Grundfos also stated that adding ''lowest speed setting'' to the testing requirements is not required for repeatability and would put test points at or near the minus 5 percent region of flow. Grundfos stated that DOE testing should attempt to achieve a head/flow as close to the reference curve/test point as possible. (Grundfos, No. 7 at p. 3)

In the December 2021 NOPR, DOE noted that HI 41.5–2021 contained some discrepancies between the two external input signal control methods regarding testing with manual speed adjustment and/or simulated external input signal. 86 FR 72096, 72118. DOE proposed to allow both manual speed adjustment and simulated external input signal for both test methods. *Id* at 86 FR 72141.

No commenters responded to DOE's request regarding whether manual speed adjustment and/or simulated external input signal are appropriate for testing circulator pumps with external input signal only, as well as circulator pumps with external input signal in addition to other control varieties. However, in the recent publication of HI 41.5–2022, HI amended the test method to both allow manual speed adjustment and simulated external input signal, regardless of whether external input signal control is the only control mode, as proposed by DOE. The remainder of the provisions regarding external input signal controls are the same in HI 41.5–2022 as in HI 41.5–2021, and also consistent with DOE's proposals.

In response to the comments from HI and Grundfos, DOE is not adopting a reference to the ''lowest speed'' setting in the test method for external input control, consistent with the December 2021 NOPR proposal and HI 41.5–2022. DOE addresses enforcement testing in section III.F.2 of this document.

In this final rule, DOE is adopting the test methods for external input signal controls by referencing HI 41.5–2022 sections 41.5.3.4.4.1 and 41.5.3.4.4.2, rather than including regulatory text. The test methods in those sections of HI 41.5–2022 are consistent with that proposed by DOE and as such this does not represent a substantive change.

6. No Controls or Full Speed Test

In the December 2021 NOPR, consistent with the recommendations of the CPWG, DOE proposed to test circulator pumps without external input signal, manual, pressure, or temperature controls along the maximum speed circulator pump curve to achieve the test point flow rates. DOE agreed that since these circulator pumps with no controls are single-speed controls and only have a single speed, testing at maximum speed is representative of the typical operation of circulator pumps with no controls. Additionally, DOE proposed to use equation (11):

$$CER = \sum_{i} \omega_i \left(P_{in,i} \right) \quad \textbf{(11)}$$

Where:

CER = circulator pump energy rating (hp);

$w_i = 0.25$;

$P_{in,i}$ = power input to the driver at each test point i (hp); and

i = test point(s), defined as 25, 50, 75, and 100 percent of the flow at BEP.

86 FR 72096, 72119.

To provide regulatory clarity about which pumps must be rated using the ''no controls'' test method, but also accommodate the option for any pump to be rated using the ''no controls'' test method, DOE proposed to refer to this test method in the regulatory text as the test method for circulator pumps without external signal, manual, pressure, or temperature controls (*i.e.,* full speed test). DOE also proposed additional language in the scope section regarding this clarification. *Id.*

DOE requested comment on the proposed test method for circulator pumps distributed in commerce with no controls. *Id.*

HI agreed with the proposal for pumps with no controls and stated that DOE should incorporate by reference section 41.5.3.4.1 for ''Full speed or without pressure, temperature, external input signal or manual speed control.'' (HI, No. 9 at p. 6) Grundfos also agreed with the proposed test method and stated that DOE should reference HI 41.5–2021 section 41.5.3.4.1, use language consistent with HI 41.5, and name this test method ''Full speed.'' (Grundfos, No. 7 at p. 3)

For the reasons discussed in the December 2021 NOPR and in the preceding paragraphs, DOE is adopting the proposed test method for circulator pumps without external input signal, manual, pressure, or temperature controls (full speed test) in this final rule. In response to HI and Grundfos, DOE is re-ordering the title of this test method to: ''Testing and Calculation of CER for Full Speed Test and for Circulator Pumps without External Input Signal, Manual, Pressure, or Temperature Controls.'' In addition, instead of including regulatory text, DOE is referencing HI 41.5–2022 section 41.5.3.4.1, which is identical to HI 41.5–2021 section 41.5.3.4.1, as requested by stakeholders. This section contains the same content as the NOPR proposal and does not represent a substantive change.

E. Determination of Circulator Pump Performance

In the December 2021 NOPR, DOE stated that as part of the September 2016 CPWG Recommendations, the CPWG recommended that all test points be tested on a wire-to-water basis, in accordance with HI 40.6–2014, with minor modifications. The CPWG also

recommended that if an updated version of HI 40.6 is published prior to publication of the test procedure final rule, DOE should review and incorporate the updated version. (Docket No. EERE–2016–BT–STD–0004, No. 58, Recommendation #10 at p. 8–9); 86 FR 24516, 24526. The CPWG also recommended several modifications related to frequency of data collection, BEP speed, electrical measurement equipment, relevant parameters at specific load points, power supply characteristics, and rounding of values for calculating and reporting purposes. (Docket No. EERE–2016–BT–STD–0004, No. 58 Recommendation #10 at pp. 8–9). 86 FR 72096, 72119.

DOE noted that two updated versions of HI 40.6—HI 40.6–2016 and HI 40.6–2021—had been published since the CPWG meetings concluded. DOE proposed to incorporate by reference HI 40.6–2021, for measuring the performance of circulator pumps, noting the changes made from the previous version of HI 40.6–2014. DOE also stated that it was necessary to make several exceptions, modifications, and additions to this test procedure to ensure accuracy and repeatability of test measurements and that the test method produces results that reflect energy efficiency or energy use during a representative average use cycle without being unduly burdensome to conduct Additionally, DOE proposed specific procedures for calculating the CEI and rounding of values to ensure that the resultant ratings are determined in a consistent manner. 86 FR 72096, 72119. DOE discusses these proposals and their resulting requirements in the following subsections.

Section III.E.1 discusses HI 40.6–2021, the industry standard, which DOE is incorporating by reference, for measuring the performance of circulator pumps. DOE has determined that it is necessary to make several exceptions, modifications, and additions to this test procedure to ensure accuracy and repeatability of test measurements (sections III.E.2.a through III.E.2.c of this document) and that the test method produces results that reflect energy efficiency or energy use during a representative average use cycle without being unduly burdensome to conduct. Additionally, DOE adopts specific procedures for calculating the CEI and rounding of values to ensure that the resultant ratings are determined in a consistent manner (section III.E.2.d of this document).

1. Incorporation by Reference of HI 40.6–2021

In the December 2021 NOPR, DOE stated that it had reviewed HI 40.6–2021 and determined that the test methods contained within HI 40.6–2021 are generally consistent with HI 40.6–2014 and are sufficiently specific and reasonably designed to produce test results to determine a CEI that is representative of an average use cycle of applicable circulator pumps. Specifically, Table 40.6.2 of HI 40.6–2021, like HI 40.6–2014, defines and explains how to calculate driver power input,[15] volume per unit time,[16] pump total head,[17] and other relevant quantities, which are essential to determining the metric. 86 FR 72096, 72120.

HI 40.6–2021 also contains appropriate specifications regarding the scope of pumps covered by the test method, standard rating conditions, equipment specifications, uncertainty calculations, and tolerances. The electrical measurement specification and associated equipment specifications in Section C.4.3 of HI 40.6–2021 contain the relevant measurement specifications for certain non-energy metrics (*i.e.,* true root mean square ''RMS'' current, true RMS voltage, and real power) that manufacturers may choose to make representations about for each rated circulator pump. These specifications also describe the relevant measurements used in the calculation of true power factor (''PF'') at each applicable load point for each circulator pump control variety, a non-energy metric manufacturers may wish to use to make representations. In addition, HI 40.6–2021 contains a new appendix E with specific test instructions for circulator pumps. DOE noted that Section 41.5.3.1 of HI 41.5–2021 references Appendix E of HI 40.6–2021 as the test standard that governs measurements of all test points in the standard. DOE reviewed HI 40.6–2021 with respect to the minor modifications listed by the CPWG in Recommendation #10. DOE found that recommendations regarding frequency of data collection are included in section 40.6.5.5.1, and recommendations regarding electrical measurement equipment and power supply characteristics are included in section C.3.4.1 and Table 40.6.3.2.3. The recommendation regarding BEP speed—specifically, to test at max speed with no adjustment to nominal—is addressed in Appendix E of HI 40.6–2021, which excludes sections 40.6.5.5.2, 40.6.6.1, and 40.6.6.1.1, dealing with the specified speed of rotation and translation to that specified speed. The recommendations for relevant parameters at specific load points have been addressed in Appendix E of HI 40.6–2021 as well as HI 41.5–2021, with some modifications. *Id.*

After considering stakeholder comments on the May 2021 RFI, DOE proposed to incorporate HI 40.6–2021, inclusive of Appendix E, into the proposed appendix D to subpart Y, with the exceptions, modifications, and additions described elsewhere in the December 2021 NOPR. DOE requested comment on its proposal. 86 FR 72096, 72121.

HI agreed with incorporating HI 40.6–2021 by reference. In Appendix E of HI 40.6–2021, HI noted exception and modifications for testing of circulator pumps. (HI, No. 9 at p. 6) Grundfos agreed with incorporating HI 40.6–2021 as stated in the December 2021 NOPR. (Grundfos, No. 7 at p. 4)

For the reasons discussed in the December 2021 NOPR and in the preceding paragraphs, DOE is incorporating by referencing HI 40.6–2021, inclusive of Appendix E, into appendix D to subpart Y, with the exceptions, modifications, and additions described elsewhere in the document.

2. Exceptions, Modifications and Additions to HI 40.6–2021

In the December 2021 NOPR, DOE stated that, in general, DOE finds the test methods contained within HI 40.6–2021 are sufficiently specific and reasonably designed to produce test results to determine a CEI that is representative of average use cycle of applicable circulator pumps. However, only certain sections of HI 40.6–2021 are applicable to the proposed circulator pump test procedure. 86 FR 72096, 72121. In addition, DOE proposed certain exceptions, modifications, and additions to ensure test results are sufficiently repeatable and reproducible, addressed in the subsequent sections III.E.2.a through III.E.2.d of this document.

[15] The term ''driver or control power input'' in HI 40.6–2021 is defined as ''the power input to the driver or control;'' in the NOPR, DOE refers to ''driver power input'' as the power to either the motor or the controls, if present.

[16] The term ''volume per unit time'' in HI 40.6–2021 is defined as ''. . . the volume rate of flow in any given section . . . Also referred to as *flow, flow rate,* and *rate of flow.*''

[17] The term ''pump total head'' is defined in HI 40.6–2021 as ''the algebraic difference between the outlet total head and the inlet total head'' and is used synonymously with the term ''head'' in this document.

a. Applicability and Clarification of Certain Sections of HI 40.6–2021

In the December 2021 NOPR, DOE stated that although it is proposing to incorporate by reference HI 40.6–2021 as the basis for its test procedure, some sections of the standard are not applicable to the circulator pump test procedure, while other sections require additional specification regarding their applicability when conducting the circulator pump test procedure. *Id.*

DOE did not propose to adopt through reference section 40.6.4.1, ''Vertically suspended pumps,'' and section 40.6.4.2, ''Submersible pumps,'' of HI 40.6–2021 in the circulator pump test procedure because circulator pumps are IL pumps and are not vertical turbine or submersible pumps. As such, the test provisions applicable to vertical turbine and submersible pumps described in Section 40.6.4.1 and section 40.6.4.2 of HI 40.6–2021 would not apply to the circulator pump test procedure. *Id.*

Additionally, Section 40.6.5.5.2 of HI 40.6–2021, ''Speed of rotation during test,'' requires that the speed of rotation to establish flow rate, pump total head, and power input be within the range of 80 percent to 120 percent of the rated speed. However, in the proposed circulator pump test procedure, rated or nominal speeds are not relevant, as DOE did not propose that speed be measured as part of the test procedure. Similarly, section 40.6.6.1, ''Translation of test results to the specified speed of rotation,'' describes the method by which tested data can be translated to the rated speed of rotation for subsequent calculations and reporting purposes. As DOE did not propose that speed be measured as part of this circulator pump test procedure, translation of tested results based on speed is not necessary. As a result, DOE did not propose to adopt Sections 40.6.5.5.2 and 40.6.6.1 (including 40.6.6.1.1) of HI 40.6–2021. This is consistent with the exclusions for circulator pump testing in Appendix E of HI 40.6–2021. *Id.*

DOE also did not propose to adopt Section 40.6.5.3, ''Test report,'' which provides requirements regarding reporting of test results and Appendix B, ''Reporting of test results,'' that refers to DOE's existing reporting requirements at 10 CFR 429.59 for general pumps, both of which are not required for testing and rating circulator pumps in accordance with DOE's procedure. Specifically, the updated Appendix B references specific reporting requirements established in the general pumps test procedure, of which not all specifications are applicable to circulator pumps. DOE noted that it would propose specific certification and reporting requirements for circulator pumps as part of a separate rulemaking, should such standards be proposed.[18] *Id.*

Finally, DOE did not propose to adopt Appendix G, ''DOE compared to HI 40.6 nomenclature,'' which refers to nomenclature used by DOE in the general pumps test procedure (appendix A to subpart Y of 10 CFR part 431) and is not in all cases consistent with the terminology used in the proposed circulator pump test procedure. *Id.*

In summary, for the reasons stated previously, DOE did not propose to adopt Sections 40.6.4.1, 40.6.4.2, 40.6.5.3, 40.6.5.5.2, 40.6.6.1, 40.6.6.1.1, Appendix B, and Appendix G of HI 40.6–2021 as part of the DOE test procedure for circulator pumps. *Id.*

In addition, DOE noted that Appendix E of HI 40.6–2021 includes modifications to testing in sections 40.6.5.5.1 and 40.6.6.3. DOE proposed to reference HI 40.6–2021 inclusive of Appendix E and the modifications therein. *Id.*

DOE requested comments on these proposals. *Id.*

Grundfos stated that excluding sections 40.6.4.1, 40.6.4.2, 40.6.5.3, 40.6.5.5.2, 40.6.6.1, 40.6.6.1.1, Appendix B, and Appendix G of HI 40.6–2021is warranted. (Grundfos, No. 7 at p. 4) HI stated that circulator pump definitions are separate from submersible or vertically suspended; therefore, a specific exclusion of Sections 40.6.4.1 and 40.6.4.2 is not needed. HI stated that Appendix E already excludes Section 40.6.5.5.2, 40.6.6.1, and 40.6.6.1.1, so DOE does not need to exclude them. HI agreed that Section 40.6.5.3, Appendix B, and Appendix G of HI 40.6–2021 can be excluded. (HI, No. 9 at p. 7)

In response to HI, DOE understands that within HI 40.6–2021 section 40.6.4, there are separate subsections for vertically suspended pumps (40.6.4.1), submersible pumps (40.6.4.2), and all other pump types (40.6.4.3), the latter of which references all other pump types identified by ANSI/HI 14.1–14.2, ''Rotodynamic Pumps for Nomenclature and Definitions,'' which is the successor to the previously discussed ANSI/HI 1.1–1.2–2014. DOE expects this is why HI stated that specific exclusion of sections 40.6.4.1 and 40.6.4.2 is not required. However, to provide clarity without having to reference additional industry standards, DOE is adopting only those specific sections of HI 40.6–2021 applicable to the test procedure for circulator pumps in scope of the DOE test procedure (see section A.0.1 in appendix D as established in this final rule), as proposed in the December 2021 NOPR. DOE is also excluding sections 40.6.5.5.2, 40.6.6.1, and 40.6.6.1.1, to improve the clarity of the DOE test procedure even though Appendix E of HI 40.6–2021 already excludes them. DOE is also adopting exclusions of section 40.6.5.3, Appendix B, and Appendix G as proposed in the December 2021 NOPR and supported by HI and Grundfos.

b. Testing Twin Head Circulator Pumps and Circulators-Less-Volute

In the December 2021 NOPR, DOE stated that a twin head circulator pump is a type of circulator pump that contains two impeller assemblies, mounted in two volutes that share a single inlet and discharge in a common casing. DOE proposed to test twin head circulator pumps as recommended by the CPWG and consistent with Section 41.5.3 of HI 41.5–2021. Specifically, DOE proposed that to test twin head circulator pumps, one of the two impeller assemblies should be incorporated into an adequate, single impeller volute and casing. An adequate, 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 essentially identical to their corresponding characteristics for a single impeller in the twin head circulator pump volute and casing. DOE requested comments on its proposal. 86 FR 72096, 72121–72122.

HI agreed with the proposed test procedure for twin head pumps, which is consistent with the test procedure outlined in HI 41.5.3 (paragraph 5). (HI, No. 9 at p. 7) Grundfos agreed with the test method, stating that it is the same method applied to general pumps and using that test method ensures consistency in the regulation. (Grundfos, No. 7 at p. 4)

As discussed in the December 2021 NOPR and consistent with comment, in this final rule, DOE is adopting the test procedure for twin head circulator pump as proposed in the December 2021 NOPR.

In the December 2021 NOPR, DOE stated that a circulator-less-volute is a circulator pump with a complete motor that is sold without a volute, but for which a paired volute is available in commerce from a manufacturer. DOE proposed that the circulator-less-volute would be paired with specific volute(s)

[18] For more information on any energy conservation standard rulemaking for circulator pumps see Docket No. EERE–2016–BT–STD–0004.

with which the circulator-less-volute is offered for sale or advertised to be paired with, and that the combination would be subject to the proposed applicable DOE test procedure for that circulator-less-volute model. DOE proposed that the CEI for each volute and circulator-less-volute pairing be determined separately. Additionally, DOE proposed to allow manufacturers of circulator pumps to group similar volute and circulator-less-volute pairings within a given basic model rating to minimize testing burden, while still ensuring that the CEI rating is representative of minimum efficiency or maximum energy consumption of the group. DOE stated that circulator-less-volute manufacturers could opt to make representations of the CEI of each individual circulator-less-volute and volute combination or could elect to make CEI representations regarding a circulator-less-volute combined with several individual volutes and rate the group with the same representative CEI value, which would be representative of the least efficient model. DOE requested comment on its proposals. 86 FR 72096, 72122.

HI agreed with DOE's proposed test procedure for circulators-less-volute. (HI, No. 9 at p. 7) Grundfos agreed with the test procedure for circulator-less-volute but stated that header pumps should be included in this test procedure. (Grundfos, No. 7 at p. 4) As discussed in section III.B.4, Grundfos stated that DOE should require that header pumps be tested like circulators-less-volute, except that the manufacturer determines the volute to be used and make this volute available for testing on the open market so that all interested parties can purchase and test the pump in the same manner it was certified. (*Id.*)

As discussed in section III.B.4 and III.B.6 of this document, DOE is not including header pumps within the scope of the test procedure as it has determined that the recommended test method would increase burden and would not produce representative results. Therefore, for the reasons discussed in the December 2021 NOPR, DOE is adopting the test procedure for circulators-less-volute as proposed in the December 2021 NOPR.

c. Determination of Circulator Pump Driver Power Input at Specified Flow Rates

In the December 2021 NOPR, DOE proposed to adopt the provisions in appendix E of HI 40.6–2021 for determining circulator pump driver power input at specified flow rates, noting that these differ from the CPWG recommendations, but are more appropriate because having test points lower than the lowest point of required driver power allows a linear regression to be constructed that includes all the driver power input points. The provisions include:

- Section 40.6.5.5.1 Test procedure—A minimum of nine test points shall be taken for all performance tests. Points are to be selected at approximately 10 percent, 25 percent, 40 percent, 60 percent, 75 percent, 90 percent, 100 percent, 110 percent, and 120 percent of the flow rate at the expected BEP of the circulator pump.
- Section 40.6.6.3 Performance curve—Determine the pump total head versus flow rate curve only based on a polynomial of the 6th order.
- Section 40.6.6.3 Performance curve—Determine the driver power input at 25 percent, 50 percent, 75 percent, and 100 percent of BEP based on a 3rd order polynomial curve of best fit of the tested values (as specified in section 40.6.5.5.1) at 10 percent, 25 percent, 40 percent, 60 percent, 75 percent, 90 percent, 100 percent, 110 percent, and 120 percent of expected BEP flow rate.

DOE requested comments on this proposal. 86 FR 72096, 72122–72123.

HI and Grundfos agreed with DOE's proposal to incorporate Appendix E of HI 40.6–2021 for determining the circulator pump driver power input at flow rates. (HI, No. 9 at p. 7; Grundfos, No. 7 at p. 4) For the reasons discussed in the December 2021 NOPR and in the preceding paragraphs, in this final rule, DOE is incorporating Appendix E of HI 40.6–2021 into the test procedure for circulator pumps as proposed.

In the December 2021 NOPR, DOE also noted that the procedure specified in section 40.6.6.3 and Appendix E of HI 40.6–2021 is applicable for test points gathered at maximum speed, but the other test points proposed for circulator pumps with pressure controls, temperature controls, manual speed controls, and external input signal controls are not specified in HI 40.6–2016. For circulator pumps with pressure controls, temperature controls, manual speed controls, and external input signal controls, the general test procedure consists of ''sweeping'' the maximum speed curve (*i.e.,* taking measurements at flow intervals along the head/flow curve associated with maximum pump speed) to determine BEP, adjusting the pump to the determined BEP at maximum speed, and then adjusting the speed of the pump according to the applicable control or reference system curve to achieve the specified load points at 25, 50, 75 percent of BEP flow at reduced speed. As such, for these test points, unlike the test points at maximum speed derived from the data collected to determine BEP, manufacturers would adjust the operation of the pump to specifically achieve the load points at 25, 50, 75, and 100 percent of BEP flow, as applicable. Due to experimental uncertainty, the specific test points measured in the test protocol may not be exactly at 25, 50, 75, or 100 percent of the BEP flow load points specified in the test procedure and, thus, the relevant power input measurements must be adjusted to reflect the power input at the specific load points specified in the test procedure. DOE noted that HI 40.6–2021 does not specify the tolerances around which the specified flow values must be achieved or how to adjust the test points to the specified load points, accounting for such experimental tolerance. 86 FR 72096, 72123.

In the December 2021 NOPR, DOE stated that HI 41.5–2021 includes provisions different from those recommended by the CPWG. Specifically, all tested flow values must be within ±5 percent of the target flow load points as specified by the reference system curve in HI 41.5–2021. (HI 41.5–2021 section 41.5.3.4.2 #3c, 41.5.3.4.3, 41.5.3.4.4.1–2, 41.5.3.45) HI stated that this target range limits the pump efficiency ranges allowed for a given test point and minimizes variation in CEI values for a given test. In addition, any head values that are above the reference system curve (including within 10 percent) are not adjusted. HI stated that this eliminates a discontinuity in CEI values when transitioning between corrected and uncorrected values and allows for better representation of pump CEI. Finally, for pressure control and manual speed control, tested head is allowed to be below the reference curve and corrected back to the reference curve. HI stated that this eliminates the need for all control curves to exist above the reference curve allowing for a better representation of control curves used in the market and for the circulator pump CEI values to better represent a pump's capabilities. (HI, No. 112 at p. 2) These provisions are found throughout each of the individual control variety test methods in HI 41.5; a summary is available in 41.5.1. DOE proposed to incorporate the provisions in HI 41.5–2021. 86 FR 72096, 72123.

DOE noted also that the proposed load points are specified with a discrete flow value (*i.e.,* 25, 50, 75, and/or 100 percent of BEP flow) and, for temperature control and external input signal controls, a minimum head value

(*i.e.,* at or above the reference system curve). Therefore, as proposed the flow values must be achieved within ±5 percent and, for temperature controls and external input signal controls, the tested head values must not be more than 10 percent below the reference system curve. Any test point with a flow value that is more than ±5 percent away from the specified value or, for temperature controls and external input signal controls, a head value is more than 10 percent below the reference system curve would be invalid and, therefore, must be retested. 86 FR 72096, 72124.

DOE proposed to adjust the tested driver input power values for all relevant test points for circulator pumps with temperature and external input signal controls using the methods adopted in the January 2016 TP final rule and discussed by the CPWG. Specifically, DOE proposed that if the tested flow values are within ±5 percent of the flow load point specified by the reference system curve and the head values are within ±10 percent of the head load points specified by the reference system curve, the tested driver input power values would be proportionally adjusted to the specified flow and head points, as shown in equation (12):

$$P_{R,i} = \left(\frac{H_{R,i}}{H_{T,j}}\right)\left(\frac{Q_{R,i}}{Q_{T,j}}\right)P_{T,j} \quad \textbf{(12)}$$

Where:

$P_{R,i}$ = the driver power input (hp);
$H_{R,i}$ = the specified head at load point i based on the reference system curve (ft);
$H_{T,j}$ = the tested head at load point j (ft);
$Q_{R,i}$ = the specified flow rate at load point i based on the reference system curve (gpm);
$Q_{T,j}$ = the tested flow rate at load point j (gpm); and
$P_{T,j}$ = the tested driver power input at load point j (hp).

86 FR 72096, 72124.

DOE also proposed that for pressure controls and manual speed controls, if the tested flow values are within ±5 percent of the flow load point specified by the reference system curve and the tested head values are below the head load points specified by the reference system curve, the tested driver power input values would be proportionally adjusted to the specified flow and heat points as shown in equation (12). *Id.*

Finally, DOE proposed, consistent with the recommendations of the CPWG and the modifications in HI 41.5–2021, that for temperature controls and external input signal controls, if the tested head values are above the reference system curve by more than 10 percent, or for pressure controls and manual speed controls, if the tested head values are above the reference system curve at all, only the flow values would be proportionally adjusted to the specified value, as shown in equation (13):

$$P_{R,i} = \left(\frac{Q_{R,i}}{Q_{T,j}}\right)P_{T,j} \quad \textbf{(13)}$$

Where:

$P_{R,i}$ = the driver power input (hp);
$Q_{R,i}$ = the specified flow rate at load point i based on the reference system curve (gpm);
$Q_{T,j}$ = the tested flow rate at load point j (gpm); and
$P_{T,j}$ = the tested driver power input at load point j (hp).

DOE requested comment on these proposals. 86 FR 72096, 72124.

HI stated that the power corrections in HI 41.5 are as HI intends, specifically for pressure and manual speed controls, the power corrections noted in HI 41.5–2021 section 41.5.3.4.2.3.d and Equation 41.5.3.4.2b for pressure speed control and section 41.5.3.4.5.2.d and Equation 41.5.3.4.5b for manual speed control. HI recommended that DOE should incorporate these sections by reference. (HI, No. 9 at p. 7) Grundfos also stated that only the head term is ignored when correcting power above the reference curve, and that it agreed with the ±5 flow tolerance. (Grundfos, No. 7 at p. 5)

HI stated that, with regard to temperature and external input signal controls, the power corrections noted in HI 41.5–2021 in section 41.4.3.4.3.2 and Equation 41.5.3.4.3b for temperature controls and sections 41.5.3.4.4.1.2 and 41.5.3.4.4.2.2 and Equations 41.5.3.4.4.1b and 41.5.3.4.4.2b for external input signal controls are as intended. HI recommended that DOE should incorporate these sections by reference. (HI, No. 9 at p. 8) Grundfos reiterated that only the head term is ignored when correcting power above the reference curve, and that it agreed with the ±5 flow tolerance. (Grundfos, No. 7 at p. 5)

For the reasons discuss above and in the December 2021 NOPR, DOE is adopting the flow and head tolerances and proportional adjustments as proposed in the December 2021 NOPR. However, as discussed in section II, DOE is adopting through reference specific sections of HI 41.5–2022, each of which includes provisions for these adjustments. The language in HI 41.5–2022 differs from that in the regulatory text in the December 2021 NOPR, by using only one equation and clarifying the applicable use of the equation in different scenarios in text rather than including two separate equations applicable to the different scenarios as DOE did. However, the substance of the language in HI 41.5–2022 is consistent with that of the regulatory text in the December 2021 NOPR; as such this does not represent a substantive change. In addition, HI specifically requested DOE reference the relevant sections of HI 41.5–2021 (to which HI 41.5–2022 is identical), and no stakeholders expressed that the relevant language in HI 41.5 was unclear.

With regards to the test points to which the tolerance and adjustment methods are applicable, DOE noted in the December 2021 NOPR that the CPWG recommended that ''all'' test points for circulator pumps with pressure controls, temperature controls, manual speed controls, or external input signal controls apply the specified tolerances and adjustment methods. (Docket No. EERE–2016–BT–STD–0004, No. 58 Recommendation #10 at pp. 8–9) However, DOE stated that it believed that the curve fitting method for determining driver power input at the specified load points at maximum speed is more applicable and less burdensome for many of the maximum speed test points than requiring retesting along the maximum speed curve to achieve those test points within ±10 percent. Specifically, for manual speed controls and external input signal controls in addition to other control varieties, the proposed test methods and CEI calculation methods require load points be determined at 25, 50, 75, and 100 percent of BEP flow along the maximum speed curve, as well as at 25, 50, and 75 percent of BEP flow at reduced speeds. For the test points at reduced speed, DOE stated that it believed, as recommended by the CPWG, that the proposed tolerances and proportional adjustment would be applicable. However, for the test points at 25, 50, and 75 percent of maximum speed, DOE stated that it believed that it would be less burdensome and more consistent with the proposed testing of circulator pumps with no controls to determine such test points via curve fitting of the BEP test data at maximum speed. DOE stated that this is consistent with Sections 41.5.3.4.4.2 and 41.5.3.4.5 of HI 41.5–2021. With regard to the test point at 100 percent of BEP flow and maximum speed, DOE noted that, in order to test such circulator pump models, the circulator pump must be adjusted to a test point at 100 percent of BEP flow and maximum speed before reducing the speed in accordance with the control logic to achieve the reduced speed values. As such, DOE stated that using the tested value at 100 percent of BEP flow and maximum speed as opposed to the value determined via curve fitting would be more accurate and would not increase the burden of the testing. DOE noted that this proposal is inconsistent with HI 41.5–2021, which includes the 100 percent point as part of the points determined by curve fitting, rather than as a measured test point. DOE requested comment on this deviation. 86 FR 72096, 72124–72125. Table III.2 summarizes the proposed applicability of the different adjustment methods to the various test points for each circulator pump variety.

TABLE III.2—SUMMARY OF APPLICABLE ADJUSTMENT METHOD FOR DIFFERENT TEST POINTS FOR ALL CONTROL VARIETIES

Control variety	Test points that would be determined via curve fitting	Test points that must be achieved within any specified tolerance and would be determined via proportional adjustment
Pressure Controls	None	All (25, 50 ,75, and 100 percent of BEP flow).
Temperature Controls	None	All (25, 50 ,75, and 100 percent of BEP flow).
Manual Speed Controls	25, 50, and 75 percent of BEP flow at maximum speed.	25, 50, and 75 percent of BEP flow at reduced speed and 100 percent of BEP flow at maximum speed.
External Input Signal Controls	25, 50, and 75 percent of BEP flow at maximum speed.	25, 50, and 75 percent of BEP flow at reduced speed and 100 percent of BEP flow at maximum speed.

DOE requested comment on the proposed applicability of the tolerance and proportional adjustment method to the various test points, as compared to the curve fitting method, based on circulator pump control variety. DOE particularly requested comment on which category is most appropriate for the 100 percent of BEP flow point. *Id.* at 86 FR 72125.

HI stated that it understood that DOE proposed to test the 100 percent BEP for manual speed controls and external input signal controls the same way as for pressure and temperature controls to determine the input power term at maximum speed in the CER equation, which requires adjusting the tested power proportional to the BEP originally determined from the curve fit. HI commented that the curve fitted 100 percent BEP point is the anchor point for the reduced speed load points and should be used without requiring retesting for manual and external input speed control. HI stated that DOE's proposal would not increase accuracy but would require retesting a point already measured. HI stated that DOE should incorporate by reference the language in sections HI 41.5.3.4.5 for manual speed control and 41.5.3.4.4 for external input signal control to maintain consistency with what industry has already implemented. (HI, No. 9 at p. 8)

Grundfos stated that maintaining the curve fitting method is preferable to minimize testing burden even if minor deviations are present using this method. Grundfos added that if DOE decides that curve fitting error needs to be addressed, allowing a piece-wise curve fitting would solve this issue. Grundfos added that this curve fitting error happens at all test points, not just at 100 percent BEP. (Grundfos, No. 7 at p. 5)

DOE agrees with HI and Grundfos that deviating from HI 41.5–2021 to require the 100 percent BEP flow point be obtained by achieving the test point within tolerance rather than by curve-fitting would introduce burden not warranted for the expected gain. These provisions appear in the updated version of the industry guideline, in HI 41.5–2022 sections 41.5.3.4.5 and 41.5.3.4.4, which DOE is adopting through reference. As such, DOE is adopting provisions for manual speed controls and external input signal controls that determine the 100 percent BEP flow point through curve fitting.

3. Calculation and Rounding Modifications and Additions

In the December 2021 NOPR, DOE noted that HI 40.6–2014 did not specify how to round values for calculation and reporting purposes. DOE recognized that the manner in which values are rounded can affect the resulting CEI and that CEI values should be reported with the same number of significant digits. Therefore, to improve the consistency of calculations and to ensure accuracy, the CPWG recommended that that all calculations be performed with the raw measured data, and that the resultant CER (then called PER_{CIRC})and CEI (then called PEI_{CIRC}) be rounded to 3 significant figures. (Docket No. EERE–2016–BT–STD–0004, No. 58 Recommendation #10 at p. 8) DOE noted that neither HI 40.6–2021 nor HI 41.5–2021 include any rounding provisions. 86 FR 72096, 72125.

DOE stated that it agreed with the CPWG regarding its recommendation to perform all calculations with the raw measured data and to round the resultant CER, CEI, and other relevant measurements and calculations in a standardized manner. In the established provisions for general pumps, the CEI analog (''PEI'') is rounded to the nearest hundredths place (*i.e.,* 0.01). See section I.D.3 of appendix A to subpart Y of part 431. To be consistent with the general pumps provisions, DOE proposed to round CER to three significant figures and to round CEI to the nearest hundredths place. Additionally, DOE proposed to calculate relevant non-energy metrics using the raw measured data and to round to the following: BEP flow at maximum speed and BEP head at maximum speed values to three significant figures; real power, true RMS current, and true RMS voltage values to the tenths place (*i.e.,* 0.1); and rated hydraulic horsepower and true power factor values to the hundredths place unless otherwise specified. DOE requested comment on these proposals. *Id.* at 86 FR 72125–72126.

HI agreed with using raw data for all calculations. HI stated that it is common practice for manufacturers to use power analyzers to measure the real power input and that individual values of RMS voltage, RMS current, and true power factor are not always available. HI added that collection of test data to 3 significant digits could be a problem depending on instrumentation display, its resolution, and the measured value. (HI, No. 9 at p. 9)

HI agreed with the CPWG recommendation that any non-energy metrics, like RMS current, RMS voltage, real power, and power factor, should be voluntary to report. (HI, No. 9 at p. 9) HI stated that, for voluntary purposes to DOE, sufficient rounding guidelines are as follows:

- Flow at maximum speed (Three significant digits, but limited to the tenths place for decimal values. *e.g.,* 101, 10.1, 1.1)
- BEP head at maximum speed (Three significant digits, but limited to the tenths place for decimal values. *e.g.,* 101, 10.1, 1.1)
- Real power (Three significant digits, but limited to four decimal places. *e.g.,* 0.0111)
- True RMS current (Three significant digits, but limited to the tenths place for decimal values. *e.g.,* 101, 10.1, 1.1)
- True RMS voltage (Tenths)
- Hydraulic horsepower (Three significant digits, but limited to four decimal places. *e.g.,* 0.0111)
- True power factor (Hundredths place)

(*Id.*)

HI added that the rounding guidelines should not apply to manufacturer representations of this data in commerce (*e.g.,* websites, literature). (*Id.*)

Grundfos agreed that the calculations should be done using raw measured data and agreed with the recommendations from HI on rounding. (Grundfos, No. 7 at p. 5)

In response to HI's and Grundfos' comments in support of the CPWG's recommendation to use unrounded values in intermediate test procedure calculations, DOE is adopting in the December 2021 NOPR proposal to use the raw measured data in this final rule. Specifically, DOE is requiring use of raw measured data to perform test procedure calculations.

In response to HI's support of rounding provisions only as related to voluntary reporting to DOE and not to manufacturer representations, DOE has determined that as it has not yet proposed or finalized certification reporting requirements for circulator pumps, it is only appropriate to finalize rounding proposals related to parameters necessary for determination of scope (*i.e.,* rated hydraulic horsepower) and calculation of CEI (*i.e.,* CER, BEP flow, and BEP head). As DOE has not yet determined whether it is necessary to report real power, RMS voltage, RMS current, and true power factor, and given HI's statement regarding potential limitations in instrumentation for these values, DOE finds that it would be premature to finalize rounding proposals related to these provisions at this time. DOE may consider certification reporting requirements in a separate rulemaking.

Specifically to CEI and CER, DOE received no comments or data contrary to adoption of the December 2021 NOPR proposal. Therefore, DOE is adopting in this final rule the December 2021 NOPR's proposal to require rounding of (1) CEI to the hundredths decimal place; and (2) CER to three significant figures. Rounding CER to three significant figures is consistent with the CPWG's recommendation and rounding CEI to the hundredths place is consistent with the requirements for general pumps. *See* section I.D.3 of appendix A to subpart Y of part 431.

Regarding rated hydraulic horsepower, HI and Grundfos suggested more precision than DOE proposed requiring in December 2021 NOPR's proposal. Whereas the December 2021 NOPR proposed to require rounding of rated hydraulic horsepower to the hundredths decimal place,[19] as stated previously HI (and Grundfos in support of HI's comment) commented in support of rounding to three significant figures, not to exceed four decimal places. (HI, No. 9 at p. 9; Grundfos, No. 7 at p. 5)

Review of publicly available marketing literature indicates availability of units of power draw at least as small as 14W.[20] Depending on the relative efficiencies of both the motor and wet end, DOE estimates the rated hydraulic horsepower of such a motor may round to zero if expressed to two decimal places.

Further, because circulator pump motor output power is often marketed using fractions, identifying the correct value when converted to decimal notation would require at least the same number of significant figures. As the denominators of circulator pump motor output power reach at least three digits, at least three significant figures are required to identify rated hydraulic power with sufficient precision. However, in review of the market, DOE did not observe circulator pump models, which would require more precision than the fourth decimal place to characterize.

Accordingly, in this final rule, DOE is adopting the rounding requirements suggested by HI and supported by Grundfos to round rated hydraulic power to less precise of the following two values: three significant figures; the fourth decimal place when expressed in units of horsepower.

4. Rated Hydraulic Horsepower

In the December 2021 NOPR, DOE noted that the proposed definitions of dry rotor, two-piece circulator pumps and dry rotor, three-piece circulator pumps each contain a clause that the pump must have a rated hydraulic power less than or equal to 5 hp at BEP at full impeller diameter. Accordingly, DOE proposed nomenclature to consistently refer to and categorize dry rotor circulator pumps based on the hydraulic horsepower they can produce at BEP and full impeller diameter, as measured in accordance with the proposed circulator pump test procedure. DOE noted that hydraulic horsepower (termed pump power output [21]) is defined in HI 40.6–2021

[19] For this discussion of rated hydraulic horsepower, decimal places are as expressed in units of horsepower.

[20] Xylem Inc. *Autocirc Instant Hot Water System Product Brochure.* Accessed: June 07, 2022. *https://www.xylem.com/siteassets/brand/bell-amp-gossett/resources/brochure/a-134.pdf.*

[21] The term ''pump power output'' in HI 40.6 is defined as ''the mechanical power transferred to the

Continued

and which DOE proposed to adopt through reference (*see* section III.E.1 of this document). HI 40.6–2021 also contains a test method for determining pump power output. However, HI 40.6–2021 includes methods for determining pump power output at any load point. To specify the pump power characteristic that DOE proposed to use to describe the size of dry rotor circulator pumps, DOE proposed to introduce a new term, the ''rated hydraulic horsepower,'' that is identified as the measured hydraulic horsepower at BEP and full impeller diameter for the rated pump. DOE requested comment on this proposal. 86 FR 72096, 72126.

HI agreed with the proposal to use rated hydraulic horsepower. (HI, No. 9 at p. 9) Grundfos agreed with the proposal but stated that DOE needs to consider that using rated hydraulic horsepower could modify the scope of products covered by the CPWG recommendations. Grundfos also noted that consideration should be made to ensure that setting this limit does not modify the scope such that wet runner [22] and dry runners [23] have different sizes covered by the regulation. (Grundfos, No. 7 at pp. 5–6)

In response to Grundfos, the definitions for the two varieties of dry rotor circulator pumps, as recommended by CPWG, as proposed in the NOPR, and as found in HI 41.5–2021, specify that such pumps must have hydraulic power less than or equal to five horsepower at best efficiency point at full impeller diameter. DOE's proposed test procedure in section 7 of appendix D requires determination of the rated hydraulic horsepower as the pump power output measured at BEP and full impeller diameter for the rated pump. This provision does not differ materially from the language in the dry rotor circulator pump definitions. As such, DOE has determined that the definition will not modify the scope of products covered by the CPWG recommendations. In addition, the proposed definition of wet rotor circulator pump does not have such a horsepower limitation provision because, unlike dry rotor circulator pumps, wet rotor circulator pumps are not found in larger horsepower that would otherwise be regulated as a commercial and industrial pump. For these reasons, DOE is adopting the provision for rated hydraulic horsepower as proposed in the December 2021 NOPR.

F. Sampling Plan and Enforcement Provisions for Circulator Pumps

In the December 2021 NOPR, DOE proposed that, for determining the representative values (*i.e.,* both the proposed energy- and non-energy-related metrics) for each basic model, manufacturers must use a statistical sampling plan of tested data, consistent with the sampling plan for pumps that is currently specified at 10 CFR 429.59. In addition, DOE proposed specific enforcement procedures that DOE would follow when testing equipment to verify compliance of any circulator pump basic model should energy conservation standards be established. 86 FR 72096, 72126. The following sections III.F.1 and III.F.2 of this document discuss DOE's sampling plan and enforcement provisions for circulator pumps.

1. Sampling Plan

In the December 2021 NOPR, DOE stated that it provides, in subpart B to 10 CFR part 429, sampling plans for covered equipment. *Id.* at 86 FR 72126. The purpose of a statistical sampling plan is to provide a method to determine representative values of energy- and non-energy-related metrics, for each basic model. In the January 2016 TP final rule, DOE adopted sampling provisions applicable to pumps that were similar to those used for other commercial and industrial equipment. 81 FR 4086, 4135–4136 (Jan. 25, 2016). *See also* 10 CFR 429.59.

In the December 2021 NOPR, DOE proposed to adopt statistical sampling plans for circulator pumps similar to that adopted for pumps. That is, DOE proposed to amend 10 CFR 429.59 to require that, for each basic model of pump (including circulator pumps), a sample of sufficient size must be randomly selected and tested to ensure that any representative value of CEI or other measure of energy consumption of a basic model for which customers would favor lower values is greater than or equal to the higher [24] of the following two values:

(1) The mean of the sample,
where:

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

and $\bar{x}$ is the sample mean, n is the number of samples, and x_i is the maximum of the i^{th} sample;

Or,

(2) The upper 95 percent confidence limit (UCL) of the true mean divided by 1.05,

where:

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

and $\bar{x}$ is the sample mean, s is the sample standard deviation, n is the number of samples, and $t_{0.95}$ is the t statistic for a 95 percent one-tailed confidence interval with $n-1$ degrees of freedom (from appendix A of subpart B of 10 CFR part 429).

86 FR 72096, 72126; *see also* 86 FR 72096, 72137–72138.

DOE stated that for purposes of certification testing, the determination that a basic model complies with the applicable energy conservation standard would be based on testing conducted using the proposed 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(a)–(b). DOE proposed to apply this same minimum sample size requirement to circulator pumps. Thus, if a statistical sampling plan is used, DOE proposed that a sample of sufficient size be selected to ensure compliance and that at least two units must be tested to determine the representative values of applicable metrics for each basic model. DOE noted 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* at 86 FR 72126.

DOE noted that the proposed sampling provisions would be applicable to all energy-related metrics for which each manufacturer elected to make representations. DOE stated that, similar to other pumps, an upper confidence limit (''UCL'') of 0.95 divided by a de-rating factor of 1.05 would also be applicable to circulator pumps, based on the variability inherent in the test procedure and manufacturing variability among units within a given model. Specifically, DOE noted that the proposed circulator pump test procedure is based on the same

liquid as it passes through the pump, also known as pump hydraulic power.'' It is used synonymously with ''hydraulic horsepower'' in this document. However, where hydraulic horsepower is used to reference the size of a dry rotor circulator pump, it refers to the rated hydraulic horsepower.

[22] Also known as wet rotor circulator pumps.

[23] Also known as dry rotor circulator pumps.

[24] In the preamble of the December 2021 NOPR, this was erroneously written as ''lower of'', while it was correctly written as ''higher of'' in the regulatory text. *See* 86 FR 72096, 72126; 86 FR 72096, 72137–72138.

fundamental test standard (*i.e.,* HI 40.6–2021), with identical equipment accuracy requirements and test tolerances. In addition, DOE stated that circulator pumps would realize similar performance variability to other commercial and industrial equipment, such as general pumps and dedicated-purpose pool pumps, based on a statistical analysis conducted by DOE discussed in section III.F.2 of this document. *Id.* at 86 FR 72126.

DOE also stated that in addition to CEI, the rated hydraulic horsepower would be an important characteristic for determining the applicability of the proposed test procedure to a given circulator pump model. Specifically, rated hydraulic horsepower would determine the scope of applicability of the proposed test procedure for dry-rotor close-coupled circulator pump and dry-rotor mechanically-coupled circulator pump. DOE proposed that the representative value of rated hydraulic horsepower be determined as the average of all the tested units that serve as the basis for the rated efficiency for that basic model. Similarly, DOE also proposed that true RMS current, true RMS voltage, true power factor, input power, and the flow and head at BEP at each load point be determined based on the average of the test results, for each metric, from all the tested units that serve as the basis for the rating for that basic model. *Id.* at 86 FR 72126–72127.

Finally, consistent with provisions for other commercial and industrial equipment, DOE noted the applicability of certain requirements regarding retention of certain information related to the testing and certification of circulator pumps, which are detailed under 10 CFR 429.71. Generally, manufacturers must establish, maintain, and retain certification and test information, including underlying test data for all certification testing for 2 years from the date on which the circulator pump model is discontinued in commerce. *Id.* at 86 FR 72127.

DOE requested comment on the proposed statistical sampling procedures and certification requirements for circulator pumps. *Id.*

HI commented on what it stated was contradictory language within the NOPR with regard to statistical sampling procedures. HI stated that it agreed with the proposed language to 10 CFR 429.59 at 86 FR 72137, which states in part: ''Any representation of the constant load pump energy index (PEICL), variable load pump energy index (PEIVL), circulator energy index (CEI), or other measure of energy consumption of a basic model for which consumers would favor lower values shall be greater than or equal to the higher of: . . .'', while HI stated that the language in the preamble text at 86 FR 72126 incorrectly used ''lower''. (HI, No. 9 at p. 10) Grundfos agreed with the proposed statistical sampling procedures and certification requirements. (Grundfos, No. 7 at p. 6) Grundfos also stated that the discussion recommendation diverges from the current requirement in 10 CFR 429.59 for selecting the highest of the Mean CEI and UCL/1.05 values. Grundfos stated that the current language in the regulation should also apply to circulators.[25] (Grundfos, No. 7 at p. 6)

DOE acknowledges the error in the preamble of the December 2021 NOPR and adopts the sampling plan as proposed in the regulatory text. With regard to the proposals related to representative values of rated hydraulic horsepower, true RMS current, true RMS voltage, true power factor, input power, and the flow and head at BEP at each load point, DOE has determined that as it has not yet proposed or finalized certification reporting requirements for circulator pumps, as discussed in section III.E.2.d of this document, it is only appropriate to finalize the proposals related to parameters necessary for determination of scope (*i.e.,* rated hydraulic horsepower) and calculation of CEI (*i.e.,* flow and head at BEP; input power limited to relevant load points). Instead of including specific provisions for true RMS current, true RMS voltage, true power factor, and input power at unspecified points, which would be premature, DOE is finalizing a provision that requires the representative value of any other reported value of a basic model of circulator pump to be determined based on the mean of that value for each tested unit. DOE will consider certification reporting requirements in a separate rulemaking.

With regard to the requirements in 10 CFR 429.71 as discussed in the December 2021 NOPR, DOE notes that the records retention requirements are applicable to certification reports and the data underlying certification reports. DOE reiterates that certification in accordance with the test procedure adopted in this final rule would not be required until such time as compliance were required with energy conservation standards for circulator pumps, should DOE establish such standards.

[25] DOE notes that Grundfos included this statement in response to a request for comment about enforcement provisions, but DOE believes it is actually in reference to the sampling plan. (*See* Grundfos, No. 7 at p. 6)

2. Enforcement Provisions

In the December 2021 NOPR, DOE stated that enforcement provisions govern the process DOE would follow when performing an assessment of basic model compliance with standards, as described under subpart C of 10 CFR part 429. Specifically, subpart C of 10 CFR 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. DOE proposed that the same general enforcement provisions contained in subpart C of 10 CFR part 429 would be applicable to circulator pumps. 86 FR 72096, 72127.

Related to enforcement testing of circulator pumps, as specified in 10 CFR 429.110(e)(1), DOE proposed that it would conduct the applicable circulator pump test procedure, once adopted, to determine the CEI for tested circulator pump models. DOE proposed circulator-pump specific enforcement testing provisions for 10 CFR 429.134.[26] Specifically, if a manufacturer did not certify a control setting, DOE would test the circulator pump model using the no controls test method if no controls were available, or if controls are available, DOE would test using the test method for any one of the available control varieties on board. DOE requested comment on how, absent information on the tested control method for a basic model, DOE should determine which test method to conduct. *Id.*

HI agreed with DOE's proposed methodology for determining which test method to conduct and recommended that DOE make the tested control method a mandatory entry in the data upload template. (HI, No. 9 at p. 10) Grundfos stated that DOE should rely on published literature on the product, and absent that information DOE should select any available control method for testing. (Grundfos, No. 7 at p. 6)

In response to HI, DOE will address the certification requirements and template in a separate rulemaking. In response to Grundfos, DOE has determined that it does not need to rely on manufacturer literature to identify an appropriate control method for testing; any control method available on board the circulator may be tested. As such, DOE is finalizing its proposal that if a manufacturer does not certify a control setting, DOE would test the circulator pump model using the no controls test method if no controls were available, or

[26] DOE intends to propose certification requirements in a separate energy conservation standards rulemaking.

if controls are available, DOE would test using the test method for any one of the available control varieties on board.

In the December 2021 NOPR, DOE noted that the CPWG recommended that for pressure controls, manufacturers choose the factory control logic to test, report the control setting used for rating, and report the method of control (automatic speed adjustment, manual speed adjustment, or simulated pressure signal adjustment). (Docket No. EERE–2016–BT–STD–0004, No. 58 Recommendation #9 at p. 7) However, DOE proposed that it would test using the specified control curve but would always use the automatic control option for testing of pressure controls, to ensure that any rated CEI is representative of commercially available performance, as distributed in commerce. In addition, for circulator pumps rated with adaptive pressure controls, DOE proposed to test the circulator pump using the manual control option that results in the lowest head values at each test point below maximum speed. This would ensure that, if the minimum head thresholds are not accessible via the commercially available control with which the pump is distributed in commerce, a representative CEI can still be obtained for the compliance of that circulator pump to be assessed. If a specified control curve is not available, DOE proposed to test using any control that meets the requirements specified in the pressure control test method. DOE stated that it would consider adopting more specific provisions in the final rule given feedback on the most appropriate selection criteria. 86 FR 72096, 72127.

For manual speed controls and external input signal controls, the CPWG recommended testing at the lowest speed setting that will achieve a head at or above the reference curve. (Docket No. EERE–2016–BT–STD–0004, No. 58 Recommendation #9 at p. 7–8) DOE noted that this requirement had been removed in HI 41.5–2021. For external input signal controls and temperature controls, DOE proposed that it would conduct enforcement testing with this provision. DOE stated that if manual speed control testing is allowed below the reference curve, this provision would not be applicable to certification testing. However, to provide certainty as to how DOE would conduct enforcement testing DOE proposed to specify that it would conduct testing using the speed setting closest to each of the head points specified by the reference system curve (above or below). 86 FR 72096, 72127.

DOE requested comment on the proposed product-specific enforcement testing provisions for circulator pumps, particularly with regard to the appropriate control curve for pressure controls (when not specified) and the appropriate speed settings for other control methods. *Id.*

HI stated that to clarify, DOE should test at the lowest head at or above the reference curve for 75, 50, and 25 percent of BEP flow that is within the manufacturer's literature. HI recommended that for the 100 percent BEP flow point, DOE should use the curve fitted 100 percent BEP point as the anchor point. (HI, No. 9 at p. 10)

Grundfos stated that DOE should clarify that adaptive pressure controls will be manually tested with the following parameters: (1) test the points below 100 percent flow as close to the reference curve as possible, still meeting the +−5% flow requirements, and (2) all test points will be conducted within the operating parameters of the identified adaptive control method (*e.g.,* H_min_set, Hmax, etc.) to ensure that the resultant CEI reflects test points achievable in the field. (Grundfos, No. 7 at p. 6)

Upon review, DOE has determined that additional product-specific enforcement provisions are not needed for circulator pumps. In HI 41.5–2022, industry has determined that it is not necessary to specify ''lowest speed'' as part of the test methods. In addition, HI 41.5–2022 section 41.5.5.3 requires manufacturers to report to HI the control type(s) the circulator pumps is rated with as well as, where applicable, the control curve setting used and numerical description of the control curve as a function of flow rate (gpm) and head (ft). As such, DOE has determined that it will be sufficient for DOE to test the circulator pump in accordance with the control curve description and equation with which the circulator pumps was rated.

As circulator pumps have relatively large shipments and are generally a high-volume piece of equipment, in the December 2021 NOPR, DOE proposed to use, when determining performance for a specific basic model, the enforcement testing sample size, calculations, and procedures laid out in appendix A to subpart C of 10 CFR part 429 for consumer products and certain high-volume commercial equipment. These procedures, in general, provide that DOE would test an initial sample of at least 4 units and determine the mean CEI value and standard error of the sample. DOE would then compare these values to the CEI standard level, once adopted, to determine the compliance of the basic model or if additional testing (up to a total of 21 units) is required to make a compliance determination with sufficient confidence. 86 FR 72096, 72127.

DOE noted that this proposal differs from the enforcement testing sample size and calculations for DOE adopted for general pumps in the January 2016 TP final rule. Specifically, in the January 2016 TP final rule, DOE adopted provisions at 10 CFR 429.110(e)(5) [27] stating that DOE would assess compliance of any pump basic models undergoing enforcement testing based on the arithmetic mean of up to four units. 81 FR 4086, 4121. In the August 2017 DPPP TP final rule, DOE also adopted the enforcement testing sample provisions in appendix A and clarified that the enforcement provisions adopted in the January 2016 TP final rule and specified at 10 CFR 429.110(e)(5) are only applicable to those pumps subject to the test procedure adopted in the January 2016 TP final rule. 82 FR 36858, 36910. In the December 2021 NOPR, DOE stated that circulator pumps should be treated similarly to DPPP because of the shipments and high volume of the equipment. 86 FR 72096, 72127–72128.

DOE requested comment on the proposal to apply to circulator pumps the enforcement testing sample size, calculations, and procedures laid out in appendix A to subpart C of 10 CFR part 429. *Id.* at 86 FR 72128.

HI stated that the standard methodology laid out in appendix A to subpart C of 10 CFR part 429 applies to products where the representative value of efficiency is larger for more efficient products. HI noted that CEI has lower values for more efficient products; therefore, appendix A is not applicable unless the determinations are inverted. (HI, No. 9 at p. 10) Grundfos also stated that appendix A applies to regulated products where the representative measure is higher for more efficient product and therefore does not apply to circulators. (Grundfos, No. 7 at p. 6)

In response to HI and Grundfos, DOE notes that while section (e) of appendix A applies to products where the representative value of efficiency is larger for more efficient products (*i.e.,* subject to an energy efficiency standard), section (f) applies to products that have lower values for more efficient products (*i.e.,* subject to an energy

[27] DOE notes that the 2016 general pumps TP final rule were originally adopted into 10 CFR 429.110(e)(1)(iv), but a recent rulemaking for battery chargers reorganized the enforcement provisions for various equipment, including pumps, to place the pump enforcement provisions in 10 CFR 429.110(e)(5). 81 FR 31827, 31841 (May 20, 2016).

consumption standard). As such, DOE is applying to circulator pumps the enforcement testing sample size, calculations, and procedures laid out in appendix A to subpart C of 10 CFR part 429 as proposed in the December 2021 NOPR.

In the December 2021 NOPR, DOE noted that the rated hydraulic horsepower would be necessary to determine the scope of applicability of the test procedure to certain circulator pump varieties (*i.e.,* dry-rotor close-coupled circulator pump and dry-rotor mechanically-coupled circulator pump). Therefore, DOE proposed specific procedures to determine the rated hydraulic horsepower of tested circulator pumps when verifying compliance. When determining compliance of any units tested for enforcement purposes, DOE proposed that, if the rated hydraulic horsepower determined through DOE's testing (either the measured rated hydraulic horsepower for a single unit sample or the average of the measured rated hydraulic horsepower values for a multiple unit sample) is within 5 percent of the certified value of rated hydraulic horsepower, then DOE would use the certified value of rated hydraulic horsepower as the basis for determining the scope of applicability for that circulator pump model. However, if DOE's tested value of hydraulic horsepower is not within 5 percent of the certified value of hydraulic horsepower, DOE would use the arithmetic mean of all the hydraulic horsepower values resulting from DOE's testing when determining the scope of applicability for the circulator pump model. DOE stated such an approach would result in more reproducible and equitable compliance determinations among DOE, manufacturers, and test labs. 86 FR 72096, 72128.

DOE sought comment upon the applicability of a 5 percent tolerance on rated hydraulic horsepower for each tested circulator pump model or if a higher or lower percentage variation would be justified. *Id.*

HI stated that based on the uncertainties listed in HI 40.6–2021, it agreed with DOE's proposal. (HI, No. 9 at p. 10) Grundfos also agreed with the proposal. (Grundfos, No. 7 at p. 6)

DOE notes that while the preamble to the December 2021 NOPR explained this proposal and solicited comment, the corresponding draft regulatory text for this provision was erroneously omitted in the December 2021 NOPR. Given stakeholder support for the proposal and for the reasons discussed previously and in the December 2021 NOPR, in this final rule, DOE adopts the product-specific enforcement provisions related to hydraulic horsepower for circulator pumps as described in the December 2021 NOPR preamble.

G. Representations of Energy Use and Energy Efficiency

In the December 2021 NOPR, DOE stated that manufacturers of circulator pumps within the scope of the proposed circulator pump test procedure, if finalized, would be required to use the test procedures proposed in this rulemaking when making representations about the energy efficiency or energy use of their equipment. 86 FR 72096, 72128. Specifically, 42 U.S.C. 6314(d) provides that ''no manufacturer . . . may make any representation . . . respecting the energy consumption of such equipment or cost of energy consumed by such equipment, unless such equipment has been tested in accordance with such test procedure and such representation fairly discloses the results of such testing.''

DOE stated that, if made final, the proposed test procedure would not require manufacturers to test the subject circulator pumps. However, beginning 180 days after publication of a final rule that adopts a test procedure for circulator pumps, any voluntary representations as to the energy efficiency or energy use of a subject circulator pump would be required to be based on the DOE test procedure. (42 U.S.C. 6314(d)); 86 FR 72096, 72128.

With respect to representations, generally, DOE stated that manufacturers often make representations (graphically or in numerical form) of energy use metrics, including overall (wire-to-water) efficiency, driver power input, and/or pump power output (hydraulic horsepower) and may make these representations at a variety of different load points or operating speeds. DOE proposed to allow manufacturers to continue making these representations. To ensure consistent and standardized representations across the pump industry and to ensure such representations are not in conflict with the reported CEI for any given circulator pump model, DOE proposed to establish testing procedures for these parameters that are part of the DOE test procedure and that while manufacturers would not be required to make representations regarding the performance of circulator pumps using these additional metrics, to the extent manufacturers wish to do so, they would be required to do so based on testing in accordance with the DOE test procedure. In addition, as noted in section III.C of this document, the CPWG-recommended method of determining $PER_{STD,}$ if adopted by DOE, would require tested hydraulic horsepower of the rated circulator pump at one or more specific load points. 86 FR 72096, 72128.

DOE noted that overall (wire-to-water) efficiency, driver power input, and/or pump power output (hydraulic horsepower) are already parameters that are described in HI 40.6–2021, which DOE proposed to incorporate by reference in the DOE test procedure. DOE stated that further specification is not necessary regarding the determination of these parameters. DOE noted that HI 40.6–2021 does not include explicit instructions for determining pump power output at specific load points; however, section E.3.2 specifies determination of the circulator pump total head versus flow rate curve based on a polynomial of the 6th order, and DOE assumed this curve would be used to calculate pump power output at any relevant load point. *Id.*

DOE requested comment on its proposal to adopt provisions for the measurement of several other circulator pump metrics, including overall (wire-to-water) efficiency, driver power input, and/or pump power output (hydraulic horsepower). *Id.* DOE also requested comment on its belief 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. 86 FR 72096, 72129.

HI agreed that the load point pump power output would be calculated based on the flow and head curve as identified in HI 40.6–2021 section E.3.2. (HI, No. 9 at p. 11) HI and Grundfos agreed that no further specification is necessary in HI 40.6–2021. (HI, No. 9 at p. 11; Grundfos, No .7 at p. 7)

HI stated that it is not realistic for circulator manufacturers to update literature for all circulators 180 days after the final rule is published. HI stated that specifically for products that will be discontinued after the compliance date, the test burden required would be orders of magnitude greater than the current test burden, and that the additional testing burden was not considered when DOE evaluated the impact on manufacturers. (HI, No. 9 at pp. 10–11) Grundfos also stated that the provisions, combined with a 180-day implementation, would be a large increase in burden for management of data and updating literature across all possible representations. Grundfos added that this provision does not address multi-market products (*e.g.,* US

an EU) where both regions will require representations of the same data using different test methods. (Grundfos, No. 7 at p. 6)

In response to HI and Grundfos, DOE has determined that in order to meet its stated goal in the December 2021 NOPR of ensuring representations of metrics other than CEI are not in conflict with the reported CEI for any given circulator pump model, it is only necessary to finalize provisions related to circulator pump metrics that are used in the determination of CEI, specifically flow and head at BEP and pump power output and driver power input at load points used in the determination of CEI, including the rated hydraulic horsepower. Instead of finalizing provisions specific to other metrics that may or may not be reported to DOE, which would be premature, DOE is limiting the adopted provision to state that any other reported performance parameters must be determined based on testing according to the DOE test procedure. This is consistent with the discussion in sections III.E.2.d and III.F.1 of this document with respect to rounding and representation provisions. DOE expects that by reducing the scope of the metrics to which the test procedure provisions apply, DOE has sufficiently mitigated the burden concerns expressed by HI and Grundfos. DOE will consider certification reporting requirements in a separate rulemaking. In addition, DOE notes that if manufacturers do not make voluntary representations of CEI prior to the compliance date of any relevant energy conservation standards, then the concerns about conflicts with CEI would not apply.

H. Test Procedure Costs and Harmonization

1. Test Procedure Costs and Impacts

This final rule establishes a test procedure for circulator pumps by incorporating by reference the test methods established in HI 40.6–2021, ''Methods for Rotodynamic Pump Efficiency Testing,'' with certain exceptions. Additionally, DOE is establishing representations, and enforcement provisions for circulator pumps that would be added to 10 CFR parts 429 and 431, respectively.

DOE is incorporating, by reference, the test methods established in HI 40.6–2021, ''Methods for Rotodynamic Pump Efficiency Testing,'' with certain exceptions. The test results are necessary for calculating the CEI to represent the energy consumption of the circulator pump, inclusive of a motor and any controls, and determine the minimum test sample (*i.e.,* number of units) and permitted method of determining represented values.

DOE has determined that the test procedure established in this final rule would not be unduly burdensome, given that DOE is referencing the prevailing industry test procedure. Furthermore, compliance with the test procedure in this final rule is not required until such a time DOE adopts energy efficiency standards for circulator pumps, or if a manufacturer chooses to make voluntary representations. Accordingly, DOE has determined that this final rule establishes DOE test procedures that are reasonably designed to produce test results, which reflect energy efficiency and energy use of circulator pumps during a representative average use cycle and would not be unduly burdensome for manufacturers to conduct.

In the December 2021 NOPR, DOE presented the maximum expected testing burden associated with testing equipment and procedure consistent with the requirements of the proposed test procedure should a manufacturer not already be testing to HI 40.6–2021. 86 FR 72096, 72129. DOE considered also the capital conversion costs and labor costs for a manufacturer to conduct testing in-house. Capital cost estimates are based on previous manufacturer interviews and stakeholder comments. The following sections detail those costs in specifics.

a. Estimated Capital Costs for Testing Circulator Pumps

In the maximum-burden case where a circulator pump manufacturer would be required to construct a test lab from scratch, manufacturers would be required to make capital outlays to acquire test equipment.

The first necessary item for testing a circulator pump is a water reservoir to hold the water that the pump circulates during testing. Manufacturers provided estimates to DOE on the cost of water reservoirs for a variety of sizes. The water reservoir sizes provided from manufacturers varied between 5 gallons and 1,500 gallons, as some manufacturers also use their water reservoirs to test larger pumps. Based on the information provided, DOE estimated in the December 2021 NOPR that the cost of a water reservoir to test circulator pumps to be approximately $9.30 per gallon. Because the circulator pumps are typically less than 5 hp in output, DOE used a 100-gallon water reservoir as a typical size and thus estimates the cost at approximately $930 for the water reservoir.[28] *Id.*

To complete the circulator pump test loop, assorted piping and valves would be necessary to circulate water from the reservoir to the pump and regulate the flow and head of the water. Multiple diameter pipes, valves, and associated fittings may be required to accommodate different size circulator pumps. The total costs for the values and piping will vary on pipe diameter as well as the actual testing laboratory configuration. In the December 2021 NOPR, DOE estimated a cost of $2,745 for the piping and valves necessary to test the circulator pumps within the scope of the proposed test procedure.[29] *Id.*

The proposed DOE test procedure also requires the power supply characteristics (*i.e.,* voltage, frequency, voltage unbalance, and total harmonic distortion) to be maintained within specific values. Specifically, the proposed power supply requirements must be within a certain percent of the rated voltage, frequency, and voltage unbalance. Also, the total harmonic distortion must be limited throughout the test. In some situations, manufacturers may be required to acquire power conditioning equipment to ensure the power supplied to the circulator pump motor or control is within the required tolerances. Based on the estimates DOE researched for power supplies as well as incorporated estimates provided by manufacturers of possible equipment costs, DOE estimated the cost for power conditioning equipment as $2,200.[30] *Id.*

The circulator pump test procedure in this final rule contains requirements regarding the characteristics and accuracy of the measurement necessary for determining relevant measured quantities. The primary measurement equipment includes flow measuring equipment, pressure measuring equipment, and electrical measuring equipment.

Test facilities would need equipment to measure the flow rate in gallons per minute to verify that the circulator pump is operating at the applicable load point. Manufacturers indicated that, for flow measurement equipment, they utilized magnetic flow measurement devices. These magnetic flow

[28] DOE based this cost estimate on information gathered from manufacturers during the 2016 CPWG meetings.

[29] DOE based this cost estimate on information gathered from manufacturers during the 2016 CPWG meetings.

[30] DOE based this cost estimate on information gathered from manufacturers during the 2016 CPWG meetings.

measurement devices vary in price based on the range of the device to accommodate different sizes of circulator pumps. DOE researched flow measurement devices, as well as referenced feedback from manufacturer interviews about the typical prices of various sizes of flow measurement devices. In the December 2021 NOPR, DOE estimated a typical flow measurement equipment capable of accommodating the full range of circulator pumps subject to this proposed test procedure to be $4,400.[31] *Id.* at 86 FR 72129–72130.

Pressure measurement equipment could include a manometer, bourdon tube, digital indicator, or a transducer. Manufacturers provided information as to which pressure measurement device they utilize and the approximate cost of such device. DOE's research indicated that most manufacturers utilize differential pressure transducers to measure pressure in the test setup. In the December 2021 NOPR, DOE estimated the average cost of the pressure measurement devices to be $1,650.[32] *Id.* at 86 FR 72130.

Finally, electrical measurement equipment is necessary to determine the input power to the circulator pump, as measured at the input to the motor or controls (if present). There are multiple devices that can measure power and energy values. However, DOE includes specific requirements regarding the accuracy and quantities measured for such power measuring equipment, as discussed in section III.E.1 of this document. In this case, only specific power analyzers and watt-amp-volt meters with the necessary accuracy can measure RMS voltage, RMS current, and real power up to at least the 40th harmonic of fundamental supply source frequency and having an accuracy level of ±2.0 percent of the measured value when measured at the fundamental supply source frequency. DOE researched equipment as well as inquired with manufacturers about the equipment used and related costs. DOE estimated the typical cost for the electrical measurement equipment to conduct this proposed test procedure is $4,400.[33] *Id.*

Additionally, temperature measurements would be necessary to perform the test procedure. To verify that the testing fluid (*i.e.,* clear water) is within the specified temperature range, testing facilities will also need to measure temperature. DOE estimated a cost of $220 for potential temperature measurement devices.[34] *Id.*

Finally, to ensure that all data are taken simultaneously and properly recorded, a data acquisition system might also be necessary. DOE researched data acquisition systems necessary for the test procedure and estimated the typical cost for a data acquisition system as $21,000.[35] *Id.*

In total, DOE estimated the cost of acquiring all the necessary equipment to perform the proposed circulator pump test procedure as approximately $37,600, if a manufacturer needed to purchase all the testing equipment described in this section. In the December 2021 NOPR, DOE requested comment on its understanding of the capital cost burden associated with its proposed test procedure. *Id.*

In response, HI stated that a capital investment range of $20,000–$37,600 for HI members with existing laboratories was sufficient. For manufacturers that would need to create a circulator pump-specific test laboratory, HI estimated conversion costs could exceed DOE's high-end estimate of $37,600. (HI, No. 9 at p. 11) Grundfos agreed with HI that opening a lab would exceed the high-end estimate and elaborated by explaining there are additional costs that are not related to test equipment. (Grundfos No. 7 at p. 7)

While DOE recognizes there would be costs to develop a test laboratory specific to circulator pumps, DOE notes that the majority of circulator pump manufacturers have indicated they already have existing testing capabilities to verify equipment performance, as well as certify performance for other applicable circulator pump programs.[36] In response to the December 2021 NOPR, HI stated that all members have implemented the capital investments necessary to have their labs certified under the HI Pump Test Laboratory Program and to properly test and rate circulators as part of the HI Energy Rating program. (HI, No. 9 at p. 11) Comments were not received regarding the specific test facility cost estimates.

DOE has determined that its estimated $37,600 capital cost as a maximum-case estimate is representative of the maximum burden a manufacturer could incur. However, DOE notes that is not representative of the likely eventual burden to most manufacturers.

b. Estimated Labor Costs for Testing Circulator Pumps

This final rule includes requirements regarding the sampling plan and representations for covered circulator pumps at subpart B of part 429 of title 10 of the Code of Federal Regulations. The sampling plan requirements are similar to those for several other types of commercial equipment and, among other things, require a sample size of at least two units per circulator pump basic model be tested when determining representative values CEI, as well as other circulator pump performance metrics.

In the December 2021 NOPR, DOE estimated the fully burdened mechanical engineering technician wage of $41.46/hr.[37] DOE estimated an average of 7.5 hours per pump. DOE calculated the total cost of labor for testing a circulator pump to be approximately $622 per basic model.[38] 86 FR 72096, 72130.

In the December 2021 NOPR, DOE requested comment on the estimated time and costs to complete a test of a single circulator pump basic model under the proposed test procedure. *Id.*

Grundfos commented that DOE underestimated the cost for testing because the estimate only included the testing portion and stated that additional testing tasks such as product scoping, test planning, data management, and required documentation updates are not captured in the analysis. (Grundfos, No. 7 at p. 7) HI provided laboratory technician and engineer labor estimates of twelve hours and six hours per basic model, respectively. (HI, No. 9 at p. 11) In response, DOE updated its labor estimate to arrive at a labor testing cost of $1,088 per basic model.[39] [40]

[31] DOE based this cost estimate on information gathered from manufacturers during the 2016 CPWG meetings.

[32] DOE based this cost estimate on information gathered from manufacturers during the 2016 CPWG meetings.

[33] DOE based this cost estimate on information gathered from manufacturers during the 2016 CPWG meetings.

[34] DOE based this cost estimate on information gathered from manufacturers during the 2016 CPWG meetings.

[35] DOE based this cost estimate on information gathered from manufacturers during the 2016 CPWG meetings.

[36] See section III.B.1 for a review of applicable circulator pump regulatory and voluntary programs.

[37] DOE estimated the hourly wage using data from BLS's ''Occupational Employment and Wages, May 2020'' publication. DOE used the ''Mechanical Engineering Technologies and Technicians'' mean hourly wage of $29.27 to estimate the hourly wage rate (*www.bls.gov/oes/current/oes173027.htm*). DOE then used BLS's ''Employer Costs for Employee Compensation—June 2021'' to estimate that wages and salary account for approximately 70.6 for private industry workers. (*www.bls.gov/news.release/archives/ecec_09162021.pdf*). Last accessed on May 15, 2022. Therefore, DOE estimated a fully-burdened labor rate of $41.46 ($29.27 ÷ 0.706 = $41.46),

[38] 7.5 mechanical engineering technician hours × $41.46/hr × 2 units per basic model = $621.90 (rounded to $622).

[39] DOE identified the hourly wage using data from BLS's ''Occupational Employment and Wages, May

Continued

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. Section 8(c) of appendix A of 10 CFR part 430 subpart C; 10 CFR 431.4. In cases where the industry standard does not meet EPCA statutory criteria for test procedures, DOE will make modifications through the rulemaking process to these standards as the DOE test procedure.

The industry standard DOE is incorporating by reference via proposals described in the NOPR (see 86 FR 72096, 72131) is discussed in further detail in section IV.N of this document.

HI commented that the testing outlined in the December 2021 NOPR adds some burden without any benefit and that DOE should stay consistent with HI 41.5. HI asserted that to test the 100 percent BEP flow at maximum speed for Manual Speed Controls and External Input Signal Controls the same way as for Pressure and Temperature Controls as proposed in Table III.2 of the December 2021 NOPR and this document would be a burden without any benefit since it is a repetition of already determined data without improvement in accuracy. For this reason, HI recommended that DOE stay consistent with HI 41.5 and not require this. Further, individual values of RMS voltage, RMS current, and True Power Factor are not always available; therefore, requiring mandatory reporting of this data would add burden without additional energy benefits. (HI, No. 9 at pp. 11–12) Grundfos agreed with the inclusion of industry standards in this rulemaking. (Grundfos, No. 7 at p. 7)

DOE is incorporating, by reference, sections of HI 41.5 that include testing of Manual Speed Controls and External Input Signal Controls. This is respectively discussed further in sections III.D.5 and III.D.6 of this document. The rounding requirements for metrics that are voluntary to report are provided in section III.E.2.d of this document. In addition, DOE is adopting test methods and calculations for circulator pumps with certain control varieties by incorporating certain sections of HI 41.5–2022.

DOE is also adopting through reference, sections of HI 40.6–2021, which is discussed in section III.E.2 of this document, in order to appropriately address circulator pump testing as specific from other rotodynamic pump testing.

I. 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 the preamble, this final regulatory action is consistent with these principles.

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

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 that by law must be proposed for public comment, unless the agency certifies that the rule, if promulgated, will not have a significant economic impact on a substantial number of small entities. As required by Executive Order 13272, ''Proper Consideration of Small Entities in Agency Rulemaking,'' 67 FR 53461 (August 16, 2002), DOE published procedures and policies on February 19, 2003, to ensure that the potential impacts of its rules on small entities are properly considered during the DOE rulemaking process. 68 FR 7990. DOE has made its procedures and policies available on the Office of the General Counsel's website: *www.energy.gov/gc/office-general-counsel.*

DOE conducted an initial regulatory flexibility analysis (''IRFA'') as part of the December 2021 NOPR. As part of the IRFA, DOE initially concluded that it would be unlikely for small business manufacturers to incur significant burden as result of the proposed test procedure given that: (1) most

2021'' publication. DOE used the ''Mechanical Engineering Technologies and Technicians'' and ''Mechanical Engineer'' mean hourly wages of $30.47 and $46.64, respectively, to estimate the hourly wage rate (*https://www.bls.gov/oes/current/oes_nat.htm*). DOE then used BLS's ''Employer Costs for Employee Compensation—December 2021'' to estimate that wages and salary account for approximately 70.6 for private industry workers.

[40] ((16 technician hours × $43.22/hr) + (6 engineer hours × $66.16/hr)) × (2 units per basic model) = $1,088 per basic model.

manufacturers are already testing to HI 40.6–2021 and (2) testing would not be required until a time DOE established energy conservation standards for circulator pumps or a manufacturer choose to make voluntary representations. 86 FR 72096, 72131–72133. DOE reviewed the test procedures in this final rule under the provisions of the Regulatory Flexibility Act and the procedures and policies published on February 19, 2003.

EPCA [41] 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 [42] of EPCA, added by Public Law 95–619, Title IV, section 441(a) (42 U.S.C. 6311–6317 as codified), 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))

For manufacturers of circulator pumps, the Small Business Administration (''SBA'') has set a size threshold, which defines those entities classified as ''small businesses'' for the purposes of the statute. DOE used the SBA's small business size standards to determine whether any small entities would be subject to the requirements of the rule. In 13 CFR 121.201, the SBA sets a threshold of 750 employees or fewer for an entity to be considered as a small business for this category. The equipment covered by this rule are classified under North American Industry Classification System (''NAICS'') code 333914,[43] ''Measuring, Dispensing, and Other Pumping Equipment Manufacturing.''

DOE used publicly available information to identify small businesses that manufacture circulator pumps covered in this rulemaking. DOE identified ten companies that are OEMs of circulator pumps covered by this rulemaking. DOE screened out companies that do not meet the definition of a ''small business'' or are foreign-owned and operated. DOE identified three small, domestic OEMs using subscription-based business information tools to determine the number of employees and revenue of the potential small businesses.

Given that DOE is referencing the prevailing industry test procedure, DOE has determined the test procedure in this final rule would not significantly increase burden for circulator pump manufacturers, including small businesses. Furthermore, compliance with the test procedure in this final rule is not required until such a time DOE adopts energy efficiency standards for circulator pumps, or in the scenario a manufacturer chooses to make voluntary representations.

Therefore, on the basis of the de minimis compliance burden, DOE certifies that this final rule does not have a ''significant economic impact on a substantial number of small entities,'' and 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

Although no energy conservation standards have been established for circulator pumps as of the publication of this final rule, manufacturers of circulator pumps would need to certify to DOE that their products comply with any potential future 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.

Certification data will be required for circulator pumps; however, DOE is not establishing certification or reporting requirements for circulator pumps in this final rule. Instead, DOE may consider proposals to establish certification requirements and reporting for circulator 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 circulator 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

[41] 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.

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

[43] The size standards are listed by NAICS code and industry description and are available at: *www.sba.gov/document/support--table-size-standards* (Last accessed on May 1, 2022).

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. 6316(a); 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 test procedure for circulator pumps adopted in this final rule incorporates testing methods contained in certain sections of the following commercial standards: HI 40.6–2021 and HI 41.5–2022. DOE has evaluated these standards and is unable to conclude whether it fully complies with the requirements of section 32(b) of the FEAA (*i.e.,* whether it was developed in a manner that fully provides for public participation, comment, and review.) DOE has consulted with both the Attorney General and the Chairman of the FTC about the impact on competition of using the methods contained in these standards and has received no comments objecting to their use.

M. Congressional Notification

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

N. Description of Materials Incorporated by Reference

In this final rule, DOE incorporates by reference the test standard HI 41.6–2021. This is an industry-accepted standard used to specify methods of testing for determining the head, flow rate, driver power input, pump power output, and other relevant parameters necessary to determine the CEI of applicable pumps proposed in this TP NOPR. The test procedure adopted in this final rule references various sections of HI 40.6–2021 that address test setup, instrumentation, measurement, and test specifications.

DOE also incorporates by reference the rating guideline HI 41.5–2022. This is an industry-accepted guideline used to test and rate circulator pumps as part of an industry program. Copies of HI 40.6–2021 and HI 41.5–2022 may be obtained from Hydraulic Institute, 6 Campus Drive, First Floor North, Parsippany, NJ, 07054–4406, (973) 267–9700, or by visiting *www.Pumps.org.*

V. Approval of the Office of the Secretary

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

List of Subjects

10 CFR Part 429

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

10 CFR Part 431

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

Signing Authority

This document of the Department of Energy was signed on August 24, 2022, by Dr. Geraldine L. Richmond, Undersecretary of Science and Innovation, 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 September 8, 2022.

Treena V. Garrett,

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

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

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

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

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

■ 2. Section 429.59 is amended by revising paragraphs (a)(1)(i) and (a)(2)(i) and adding paragraphs (a)(2)(iv) through (vii) to read as follows:

§ 429.59 Pumps.

* * * * *

(a) * * *

(1) * * *

(i) Any representation of the constant load pump energy index (PEI_{CL}), variable load pump energy index (PEI_{VL}), circulator energy index (CEI), or other measure of energy consumption of a basic model for which consumers would favor lower values shall be greater than or equal to the higher of:

(A) The mean of the sample,

where:

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

and $\bar{x}$ is the sample mean, n is the number of samples, and x_i is the maximum of the ith sample;

Or,

(B) The upper 95 percent confidence limit (UCL) of the true mean divided by 1.05,

where:

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

and $\bar{x}$ is the sample mean, *s* is the sample standard deviation, n is the number of samples, and $t_{0.95}$ is the t statistic for a 95 percent one-tailed confidence interval with n-1 degrees of freedom (from appendix A of subpart B of part 429).

(2) * * *

(i) *Rated hydraulic horsepower.* The representative value of rated hydraulic horsepower of a basic model of dedicated-purpose pool pump or circulator pump must be the mean of the rated hydraulic horsepower for each tested unit.

* * * * *

(iv) *Input power.* The representative value(s) of input power of a basic model of circulator pump at a load point(s) used in the calculation of CEI must be determined based on the mean of the input power at measured data point(s) for each tested unit.

(v) *Flow at BEP and maximum speed.* The representative value of flow at BEP and maximum speed of a basic model of circulator pump must be determined based on the mean of the flow at BEP and maximum speed for each tested unit.

(vi) *Head at BEP and maximum speed.* The representative value of head at BEP and maximum speed of a basic model of circulator pump must be determined based on the mean of the head at BEP and maximum speed for each tested unit.

(vii) *Other reported values.* The representative value of any other reported value of a basic model of circulator pump must be determined

based on the mean of that value for each tested unit.

* * * * *

■ 3. Section 429.110 is amended by revising paragraphs (e)(1) and (5) to read as follows:

§ 429.110 Enforcement testing.

* * * * *

(e) * * *

(1) For products with applicable energy conservation standard(s) in § 430.32 of this chapter, and commercial prerinse spray valves, illuminated exit signs, traffic signal modules and pedestrian modules, commercial clothes washers, dedicated-purpose pool pumps, circulator pumps, and metal halide lamp ballasts, DOE will use a sample size of not more than 21 units and follow the sampling plans in appendix A of this subpart (Sampling for Enforcement Testing of Covered Consumer Products and Certain High-Volume Commercial Equipment).

* * * * *

(5) For pumps subject to the test procedures specified in § 431.464(a) of this chapter, DOE will use an initial sample size of not more than four units and will determine compliance based on the arithmetic mean of the sample.

* * * * *

■ 4. Section 429.134 is amended by adding paragraph (i)(3) to read as follows:

§ 429.134 Product-specific enforcement provisions.

* * * * *

(i) * * *

(3) *Circulator pumps.* (i) The flow rate at BEP and maximum speed of each tested unit of the basic model will be measured pursuant to the test requirements of § 431.464(c) of this chapter, where the value of flow rate at BEP and maximum speed certified by the manufacturer will be treated as the expected BEP flow rate at maximum speed. The resulting measurement(s) will be compared to the value of flow rate at BEP and maximum speed certified by the manufacturer. The certified flow rate at BEP and maximum speed will be considered valid only if the measurement (either the measured flow rate at BEP and maximum speed for a single unit sample or the average of the measured flow rates for a multiple unit sample) is within 5 percent of the certified flow rate at BEP and maximum speed.

(A) If the representative value of flow rate is found to be valid, the measured flow rate at BEP and maximum speed will be used in subsequent calculations of circulator energy rating (CER) and circulator energy index (CEI) for that basic model.

(B) If the representative value of flow rate at BEP and maximum speed is found to be invalid, the mean of all the measured values of flow rate at BEP and maximum speed determined from the tested unit(s) will serve as the new expected BEP flow rate and the unit(s) will be retested until such time as the measured flow rate at BEP and maximum speed is within 5 percent of the expected BEP flow rate.

(ii) The rated hydraulic horsepower of each tested unit of the basic model will be measured pursuant to the test requirements of § 431.464(c) of this chapter. The resulting measurement will be compared to the rated hydraulic horsepower certified by the manufacturer. The certified rated hydraulic horsepower will be considered valid only if the measurement (either the measured rated hydraulic horsepower for a single unit sample or the average of the measured rated hydraulic horsepower values for a multiple unit sample) is within 5 percent of the certified rated hydraulic horsepower.

(A) If the certified rated hydraulic horsepower is found to be valid, the certified rated hydraulic horsepower will be used as the basis for determining scope of applicability for that model.

(B) If the certified rated hydraulic horsepower is found to be invalid, the arithmetic mean of all the hydraulic horsepower values resulting from DOE's testing will be used as the basis for determining scope of applicability for that model.

(iii) DOE will test each circulator pump unit according to the control setting with which the unit was rated. If no control setting is specified and no controls were available, DOE will test using the full speed test. If no control setting is specified and a variety of controls are available, DOE will test using the test method for any one of the control varieties available on board.

(iv) DOE will test each circulator pump using the description and equation for the control curve with which it was rated, if available.

* * * * *

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

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

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

■ 6. Section 431.462 is amended by:

■ a. Adding in alphabetical order definitions for the terms ''Adaptive pressure controls'', ''Circulator-less-volute'', ''Circulator pump'', ''Dry rotor, three-piece circulator pump'', ''Dry rotor, two-piece circulator pump'', ''External input signal control'', and ''Header pump''.

■ b. Revising the definition for ''Horizontal motor''; and

■ c. Adding in alphabetical order definitions for ''Manual speed control'', ''On-demand circulator'', ''Pressure control'', ''Temperature control'', and ''Wet rotor circulator pump''.

The additions and revision read as follows:

§ 431.462 Definitions.

* * * * *

Adaptive pressure control means a pressure control that senses the head requirements in the system in which it is installed and adjusts the pump control curve accordingly.

* * * * *

Circulator-less-volute means a circulator pump distributed in commerce without a volute and for which a paired volute is also distributed in commerce. Whether a paired volute is distributed in commerce will be determined based on published data, marketing literature, and other publicly available information.

Circulator pump means is a pump that is either a wet rotor circulator pumps; a dry rotor, two-piece circulator pump; or a dry rotor, three-piece circulator pump. A circulator pump may be distributed in commerce with or without a volute.

* * * * *

Dry rotor, three-piece circulator pump means:

(1) A single stage, rotodynamic, single-axis flow, mechanically-coupled, dry rotor pump that:

(i) Has a rated hydraulic power less than or equal to 5 hp at the best efficiency point at full impeller diameter,

(ii) Is distributed in commerce with a horizontal motor, and

(iii) Discharges the pumped liquid through a volute in a plane perpendicular to the shaft.

(2) Examples include, but are not limited to, pumps generally referred to in industry as CP3.

Dry rotor, two-piece circulator pump means:

(1) A single stage, rotodynamic, single-axis flow, close-coupled, dry rotor pump that:

(i) Has a rated hydraulic power less than or equal to 5 hp at best efficiency point at full impeller diameter,

(ii) Is distributed in commerce with a horizontal motor, and

(iii) Discharges the pumped liquid through a volute in a plane perpendicular to the shaft.

(2) Examples include, but are not limited to, pumps generally referred to in industry as CP2.

* * * * *

External input signal control means a variable speed drive that adjusts the speed of the driver in response to an input signal from an external logic and/or user interface.

* * * * *

Header pump means a circulator pump distributed in commerce without a volute and for which a paired volute is not distributed in commerce. Whether a paired volute is distributed in commerce will be determined based on published data, marketing literature, and other publicly available information.

Horizontal motor means a motor, for which the motor shaft position when functioning under operating conditions specified in manufacturer literature, includes a horizontal position.

* * * * *

Manual speed control means a control (variable speed drive and user interface) that adjusts the speed of the driver based on manual user input.

* * * * *

On-demand circulator pump means a circulator pump that is distributed in commerce with an integral control that:

(1) Initiates water circulation based on receiving a signal from the action of a user [of a fixture or appliance] or sensing the presence of a user of a fixture and cannot initiate water circulation based on other inputs, such as water temperature or a pre-set schedule.

(2) Automatically terminates water circulation once hot water has reached the pump or desired fixture.

(3) Does not allow the pump to operate when the temperature in the pipe exceeds 104 °F or for more than 5 minutes continuously.

* * * * *

Pressure control means a control (variable speed drive and integrated logic) that automatically adjusts the speed of the driver in response to pressure.

* * * * *

Temperature control means a control (variable speed drive and integrated logic) that automatically adjusts the speed of the driver continuously over the driver operating speed range in response to temperature.

* * * * *

Wet rotor circulator pump means a single stage, rotodynamic, close-coupled, wet rotor pump. Examples include, but are not limited to, pumps generally referred to in industry as CP1.

■ 7. Section 431.463 is amended by revising paragraph (a) and adding paragraphs (d)(5) and (6) to read as follows:

§ 431.463 Materials incorporated by reference.

(a) *General.* Certain material is incorporated by reference into this subpart with the approval of the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. To enforce any edition other than that specified in this section, the U.S. Department of Energy (DOE) must publish a document in the **Federal Register** and the material must be available to the public. All approved incorporation by reference (IBR) material is available for inspection at DOE and at the National Archives and Records Administration (NARA). Contact DOE at: the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Program, Sixth Floor, 950 L'Enfant Plaza SW, Washington, DC 20024, (202) 586–9127, *Buildings@ee.doe.gov, www.energy.gov/eere/buildings/building-technologies-office.* For information on the availability of this material at NARA, email: *fr.inspection@nara.gov,* or go to: *www.archives.gov/federal-register/cfr/ibr-locations.html.* The material may be obtained from the sources in the following paragraphs:

* * * * *

(d) * * *

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

(6) 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. Section 431.464 is amended by adding paragraph (c) to read as follows:

§ 431.464 Test procedure for measuring energy efficiency and other performance factors of pumps.

* * * * *

(c) *Circulator pumps*—(1) *Scope.* This paragraph (c) provides the test procedures for determining the circulator energy index for circulator pumps that are also clean water pumps, including on-demand circulator pumps and circulators-less-volute, and excluding submersible pumps and header pumps.

(2) *Testing and calculations.* Determine the circulator energy index (CEI) using the test procedure set forth in appendix D of this subpart Y.

■ 9. Add appendix D to subpart Y of part 431 to read as follows:

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

Note 1 to appendix D to subpart Y of part 431: Beginning March 20, 2023, any representations made with respect to the energy use or efficiency of circulator pumps subject to testing pursuant to 10 CFR 431.464(c) must be made in accordance with the results of testing pursuant to this appendix.

0. Incorporation by Reference

DOE incorporated by reference in § 431.463 the entire standard for HI 40.6–2021 and for HI 41.5–2022. However, not all provisions of HI 40.6–2021 and HI 41.5–2022 apply to this appendix. If there is any conflict between any industry standard and this appendix, follow the language of the test procedure in this appendix, disregarding the conflicting industry standard language.

0.1 Specifically, the following provisions of HI 40.6–2021 are not applicable:

(a) Section 40.6.4—Considerations when determining the efficiency of certain pumps, Section 40.6.4.1—Vertically suspended pumps

(b) Section 40.6.4—Considerations when determining the efficiency of certain pumps, Section 40.6.4.2—Submersible pumps

(c) Section 40.6.5—Test procedures, Section 40.6.5.3—Test report

(d) Section 40.6.5—Test procedures, Section 40.6.5.5—Test conditions, Section 40.6.5.5.2—Speed of rotation during test

(e) Section 40.6.6—Analysis, Section 40.6.6.1—Translation of the test results to the specified speed of rotation

(f) Section 40.6.6—Analysis, Section 40.6.6.1—Translation of the test results to the specified speed of rotation, Section 40.6.6.1.1—Translation of the test results into data based on specified speed of rotation

(g) Appendix B—Reporting of test results

(h) Appendix G—DOE compared to HI 40.6 nomenclature

0.2 Specifically, only the following provisions of HI 41.5–2022 are applicable:

(a) Section 41.5.3.4.1—Determination of CER—Full Speed

(b) Section 41.5.3.4.2—Determination of CER—Pressure Speed Control

(c) Section 41.5.3.4.3—Determination of CER—Temperature Speed Control

(d) Section 41.5.3.4.4.1—Determination of CER—External Input Signal Speed Control Only

(e) Section 41.5.3.4.4.2—Determination of CER—External Input Signal Speed Control Operated With Other Control Methods

(f) Section 41.5.3.4.5—Determination of CER—Manual Speed Control

1. General

To determine the circulator energy index (CEI), testing shall be performed in accordance with HI 40.6–2021, including Appendix E ''Testing Circulator Pumps,'' with the exceptions noted in section 0.1 of this appendix and the modifications and additions as noted throughout the following provisions. For the purposes of applying this appendix, the term ''pump power output,'' as defined in section 40.6.2, ''Terms and definitions,'' of HI 40.6–2021 shall be deemed to be synonymous with the term ''hydraulic horsepower'' used throughout that standard and this appendix.

2. Scope

2.1 This appendix is applicable to all circulator pumps and describes how to calculate the circulator energy index (CEI; section F) based on the pump energy rating for the minimally compliant reference circulator pump (CER_{STD}) and the circulator energy rating (CER) determined in accordance with one of the test methods listed in Table I of this appendix based on a control variety with which the circulator pump is distributed in commerce.

TABLE 1 TO APPENDIX D TO SUBPART Y OF PART 431—APPLICABILITY OF TEST METHODS BASED ON CIRCULATOR PUMP CONFIGURATION AND CONTROL METHOD WITH WHICH CIRCULATOR PUMP IS DISTRIBUTED IN COMMERCE

Circulator pump configuration	Control method with which circulator pump is distributed	Test method to be used for testing and calculation of CER
Circulator Pump + Motor	Circulator pumps at full speed or circulator pumps without pressure, temperature, external input signal, or manual speed control.	HI 41.5–2022 Section 41.5.3.4.1.
Circulator Pump + Motor + Controls	Circulator pumps with pressure control (including adaptive pressure control).	HI 41.5–2022 Section 41.5.3.4.2.
	Circulator pumps with temperature control	HI 41.5–2022 Section 41.5.3.4.3.
	Circulator pumps with only external input signal control, and which cannot be operated without an external input signal.	HI 41.5–2022 Section 41.5.3.4.4.1.
	Circulator pumps with external input signal control in addition to other control varieties, or which can be operated without an external input signal.	HI 41.5–2022 Section 41.5.3.4.4.2.
	Circulator pumps with manual speed control	HI 41.5–2022 Section 41.5.3.4.5.

2.2 If a given circulator pump model is distributed in commerce with multiple control varieties available, the manufacturer may select a control variety (or varieties) among those available with which to test the circulator pump, including the test method for circulator pumps at full speed or circulator pumps without external input signal, manual, pressure, or temperature controls).

3. Measurement Equipment

For the purposes of measuring flow rate, head, driver power input, and pump power output, the equipment specified in HI 40.6–2021 Appendix C must be used and must comply with the stated accuracy requirements in HI 40.6–2021 Table 40.6.3.2.3. 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.

4. Test Conditions

4.1 Pump specifications. Conduct testing 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 a pump,'' including section 40.6.4.4, ''Determination of pump overall efficiency''; section 40.6.5.4 (including Appendix A), ''Test arrangements''; and section 40.6.5.5, ''Test conditions.''

4.2 Twin head circulator pump. To test twin head circulator pumps, one of the two impeller assemblies should be incorporated into an adequate, single impeller volute and casing. An adequate, 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 essentially identical to their corresponding characteristics for a single impeller in the twin head circulator pump volute and casing.

4.3 Circulator-less-volute. To determine the CEI for a circulator-less-volute, test each circulator-less-volute with each volute for which the circulator-less-volute is offered for sale or advertised to be paired for that circulator pump model according to the testing and calculations described in the applicable test method listed in Table 1 of this appendix, depending on the variety of control with which the circulator pump model is distributed in commerce. Alternatively, each circulator-less-volute may be tested with the most consumptive volute with which is it offered for sale or advertised to be paired for that circulator pump model.

5. Data Collection and Analysis

5.1 Stabilization. Record data at any test point only under stabilized conditions, as defined in HI 40.6–2021 section 40.6.5.5.1.

5.2 Testing BEP at maximum speed for the circulator pump. Determine the BEP of the circulator pump at maximum speed as specified in Appendix E of HI 40.6–2021 including sections 40.6.5.5.1 and 40.6.6 as modified. Determine the BEP flow rate at maximum speed as the flow rate at the operating point of maximum overall efficiency on the circulator pump curve, as determined in accordance with section 40.6.6.3 of HI 40.6–2021 as modified by Appendix E, where overall efficiency is the ratio of the circulator pump power output divided by the driver power input, as specified in Table 40.6.2.1 of HI 40.6–2021. For the purposes of this test procedure, all references to ''driver power input'' in this appendix or HI 40.6–2021 shall refer to the input power to the controls, or to the motor if no controls are present.

5.3 Rounding. All terms and quantities refer to values determined in accordance with the procedures set forth in this appendix for the rated circulator pump. Perform all calculations using raw measured values without rounding. Round CER to three significant figures. Round CEI to the hundredths decimal place. Round rated hydraulic horsepower to the less precise of the following two values: three significant figures; the fourth decimal place when expressed in units of horsepower.

6. Calculation of CEI

Determine CEI using the following equation:

$$CEI = \frac{\mathrm{CER}}{CER_{STD}}$$

Where:

CEI = the circulator energy index (dimensionless);

CER = the circulator energy rating determined in accordance with Table 1 of this appendix (hp); and

CER_{STD} = the CER for a circulator pump that is minimally compliant with DOE's energy conservation standards with the same hydraulic horsepower as the tested pump, as determined in accordance with the specifications at paragraph (i) of § 431.465.

7. Determination of Additional Circulator Performance Parameters

7.1 To determine flow and head at BEP; pump power output (hydraulic horsepower) and driver power input at load points used in the calculation of CEI, including the rated hydraulic horsepower; and any other reported performance parameters, conduct testing according to section 1 of this appendix.

7.2 Determine the rated hydraulic horsepower as the pump power output measured at BEP and full impeller diameter for the rated pump.

7.3 Determine the true power factor at each applicable load point specified in the applicable test method listed in Table 1 of this appendix for each circulator pump control variety as a ratio of driver power input to the motor (or controls, if present) (P_i), in watts, divided by the product of the true RMS voltage in volts and the true RMS current in amps at each load point *i,* as shown in the following equation:

$$PF_i = \frac{P_i}{V_i \times I_i}$$

Where:

PF_i = true power factor at each load point *i,* dimensionless;

P_i = driver power input to the motor (or controls, if present) at each load point *i,* in watts;

V_i = true RMS voltage at each load point *i,* in volts;

I_i = true RMS current at each load point *i,* in amps; and

i = load point(s), defined uniquely for each circulator pump control variety as specified in the applicable test method listed in Table 1 of this appendix.

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