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: Notice of proposed rulemaking and request for comment.

SUMMARY: The U.S. Department of Energy (''DOE'') proposes to establish 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 proposes a test procedure for measuring the circulator energy index for circulator pumps. The proposed test method references the relevant industry test standard. The proposed 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. DOE is seeking comment from interested parties on the proposal.

DATES: DOE will accept comments, data, and information regarding this proposal no later than February 18, 2022. See section V ''Public Participation,'' for details. DOE will hold a webinar on Wednesday, February 2, 2022, from 12:30 p.m. to 3:30 p.m. See section V, ''Public Participation,'' for webinar registration information, participant instructions, and information about the capabilities available to webinar participants. If no participants register for the webinar, it will be cancelled.

ADDRESSES: Interested persons are encouraged to submit comments using the Federal eRulemaking Portal at *www.regulations.gov.* Follow the instructions for submitting comments. Alternatively, interested persons may submit comments, identified by docket number EERE–2016–BT–TP–0033, by any of the following methods:

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

2. *Email:* to *CirculatorPumps2016TP0033@ee.doe.gov.* Include docket number EERE–2016–BT–TP–0033 in the subject line of the message.

No telefacsimiles (''faxes'') will be accepted. For detailed instructions on submitting comments and additional information on this process, see section V of this document.

Although DOE has routinely accepted public comment submissions through a variety of mechanisms, including the Federal eRulemaking Portal, email, postal mail, or hand delivery/courier, the Department has found it necessary to make temporary modifications to the comment submission process in light of the ongoing coronavirus 2019 (''COVID–19'') pandemic. DOE is currently suspending receipt of public comments via postal mail and hand delivery/courier. If a commenter finds that this change poses an undue hardship, please contact Appliance Standards Program staff at (202) 586–1445 to discuss the need for alternative arrangements. Once the COVID–19 pandemic health emergency is resolved, DOE anticipates resuming all of its regular options for public comment submission, including postal mail and hand delivery/courier.

Docket: The docket, which includes **Federal Register** notices, public meeting attendee lists and transcripts (if a public meeting is held), 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.

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. See section V for information on how to submit comments through *www.regulations.gov.*

FOR FURTHER INFORMATION CONTACT:

Mr. Jeremy Dommu, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Office, EE–2J, 1000 Independence Avenue SW, Washington, DC, 20585–0121. Telephone: (202) 586–9870. Email: *ApplianceStandardsQuestions@ee.doe.gov.*

Ms. Amelia Whiting, U.S. Department of Energy, Office of the General Counsel, GC–33, 1000 Independence Avenue SW, Washington, DC, 20585–0121. Telephone: 202–586–2588. Email: *Amelia.Whiting@hq.doe.gov.*

For further information on how to submit a comment, review other public comments and the docket, or participate in the public meeting, contact the Appliance and Equipment Standards Program staff at (202) 287–1445 or by email: *ApplianceStandardsQuestions@ee.doe.gov.*

SUPPLEMENTARY INFORMATION: DOE proposes to incorporate by reference the following industry standard into part 431:

Hydraulic Institute (''HI'') 40.6–2021, (''HI 40.6–2021'') ''Methods for Rotodynamic Pump Efficiency Testing''.

Copies of HI 40.6–2021 can be obtained from: the Hydraulic Institute at 6 Campus Drive, First Floor North, Parsippany, NJ 07054–4406, (973) 267–9700, or by visiting: *www.Pumps.org.*

For a further discussion of this standard, see section IV.M. 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 test procedures and energy conservation standards. (42 U.S.C. 6311(1)(A)) Circulator pumps, which are the subject of this notice of proposed rulemaking (''NOPR''), 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. Currently, circulator pumps are not subject to DOE test procedures or energy conservation standards. 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 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))

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

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 representations about the efficiency of that equipment (42 U.S.C. 6314(d)). Similarly, DOE must use these test procedures to determine whether the equipment complies with relevant standards promulgated under EPCA. (42 U.S.C. 6316(a); 42 U.S.C. 6295(s))

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

Under 42 U.S.C. 6314, EPCA sets forth the criteria and procedures DOE must follow when prescribing or amending test procedures for covered equipment. EPCA requires that any test procedures prescribed or amended under this section must be reasonably designed to produce test results which reflect energy efficiency, energy use or estimated annual operating cost of a given type of covered equipment during a representative average use cycle 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 NOPR in accordance with the statutory authority in EPCA.

B. Background

As stated, 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. 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; end suction frame mounted/own bearings; in-line (''IL''); radially split, multi-stage, vertical, in-line diffuser casing; and submersible turbine (''ST'') pumps with the following characteristics:

- 25 gallons per minute (''gpm'') and greater (at best efficiency point (''BEP'') at full impeller diameter);

[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).

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

[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.

• 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 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). 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.

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 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 for circulator pumps to negotiate, if possible, Federal standards and a test procedure for circulator pumps 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. 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 meeting. (Docket No. EERE–2013–BT–NOC–0005, No. 91 at p. 2) [5]

In a letter dated June 9, 2017, Hydraulic Institute (''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 RFI published 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 request for information related to test procedures and energy conservation standards for circulator pumps and small vertical in-line pumps. 86 FR 24516 (''May 2021 RFI''). DOE received a number of comments in response to the May 2021 RFI. Table I.2 lists the commenters along with each commenter's abbreviated name used throughout this NOPR. Discussion of the

[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 *http://everyspec.com/MIL-SPECS.*

[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).

relevant comments, and DOE's responses, are provided in the appropriate sections of this document. A parenthetical reference at the end of a comment quotation or paraphrase provides the location of the item in the public record. [6]

TABLE I.2—WRITTEN COMMENTS RECEIVED IN RESPONSE TO MAY 2021 RFI

Commenter(s)	Reference in this NOPR	Commenter type
Hydraulic Institute	HI	Trade Association.
People's Republic of China	China	Country.
Grundfos Americas Corporation	Grundfos	Manufacturer.
Appliance Standards Awareness Project, American Council for an Energy-Efficient Economy, Natural Resources Defense Council.	Advocates	Efficiency Organization.
Northwest Energy Efficiency Alliance	NEEA	Efficiency Organization.
Pacific Gas and Electric Company, San Diego Gas and Electric, and Southern California Edison; collectively, the California Investor-Owned Utilities.	CA IOUs	Utility.
Anonymous Commenter	N/A	Anonymous [7].

The comments in response to the RFI expressed support for considering small vertical in-line pumps in the commercial and industrial pumps rulemaking rather than in the circulator pump rulemaking. (HI, No. 112 at p. 3; Grundfos, No. 113 at p. 2; CA IOUs, No. 116 at p. 6; NEEA, No. 115 at p. 4). As such, the scope of this NOPR is limited to circulator pumps.

II. Synopsis of the Notice of Proposed Rulemaking

In this NOPR, DOE proposes to establish in subpart Y to 10 CFR part 431 a test procedure 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.[8] The proposed 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 proposed 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 proposes to incorporate the test methods established in HI 40.6–2021, ''Methods for Rotodynamic Pump Efficiency Testing,'' with certain exceptions. DOE reviewed the relevant sections of HI 40.6–2021 and determined that HI 40.6–2021, in conjunction with the additional test methods and calculations proposed in this test procedure, would 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 proposed circulator pump test procedure, including HI 40.6–2021, and, based on the results of such analysis, found that the proposed 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 proposed test procedure is presented in section III.H.1 of this document.

DOE also considered HI 41.5–2021, ''Hydraulic Institute Program Guideline for Circulator Pump Energy Rating Program,'' which defines the requirements to participate in and list circulator pumps in the Hydraulic Institute Energy Rating Program and which references HI 40.6–2021 while providing additional instructions for testing circulator pumps to determine an Energy Rating value. In response to the May 2021 RFI, HI recommended that DOE incorporate by reference HI 41.5 as the test procedure. (HI, No. 112 at p. 2) DOE has 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. DOE has 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, are consistent with HI 41.5–2021.

This NOPR also proposes requirements regarding the sampling plan and representations for 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 established for general pumps. DOE also proposes 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).

Were the proposed test procedure and associated provisions made final, manufacturers would not be 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. Were DOE to establish test procedures as proposed, manufacturers choosing to make voluntary representations would be required to test the subject 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 TP NOPR, DOE proposes to establish in subpart Y of part 431 test procedures and related definitions for circulator pumps, amend 10 CFR 429.59 to establish sampling plans for this equipment, and establish enforcement provisions for this equipment in 10 CFR 429.110 and 10 CFR 429.134. The

[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–STD–0004, 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 Anonymous comment did not substantively address the subject of this rulemaking.

[8] The performance of a comparable pump that has a specified minimum performance level is referred to as the circulator energy rating (''CER'').

proposed amendments are summarized in Table III.1.

TABLE III.1—SUMMARY OF PROPOSALS IN THIS TP NOPR, THEIR LOCATION WITHIN THE CODE OF FEDERAL REGULATIONS, AND THE APPLICABLE PREAMBLE DISCUSSION

Topic	Location in CFR	Summary of proposals	Applicable preamble discussion
Definitions	10 CFR 431.462	Define 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, III.AIII.D.1.
Test Procedure	10 CFR 431.464 & Appendix D.	Establish CEI as the metric for circulator pumps, incorporate by reference HI 40.6–2021, and provide 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	Specify the minimum number of circulator pumps to be tested to rate a basic model and determination of representative values.	Section III.F.
Enforcement Provisions	10 CFR 429.110 & 10 CFR 429.134.	Establish a method for determining compliance of circulator pump basic models.	Section III.F.

The following sections discuss DOE's specific proposals regarding circulator pumps. Section III.B presents DOE's proposals related to definitions for categorizing and testing of circulator pumps. Sections III.C, III.D, III.E, and III.F discuss the proposed 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 May 2021 RFI, the Advocates urged DOE to adopt test procedures for circulator pumps based on the September and November 2016 CPWG Recommendations. (Advocates, No. 114 at p. 1) Grundfos supported the regulation of circulator products. (Grundfos, No. 113 at p. 1) The CA IOUs stated that other than the test procedure update to HI 41.5–2021 (discussed in section III.E.1 of this NOPR), they supported the adoption of the September and November 2016 CPWG Recommendations, including the provisions for circulator pump definitions, control type definitions, reference curve, weighting points, and the definition of CEI. (CA IOUs, No. 116 at p. 5) NEEA supported the September and November 2016 CPWG Recommendations with a few minor modifications based on additional information or lessons learned from years of experience implementing its circulator pump energy efficiency program. (NEEA, No. 115 at p.2) NEEA also commented that it has been working with HI and manufacturers to test and rate circulator pumps using HI's voluntary rating standard developed based on the CPWG term sheet. (*Id.*)

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, 4090–94 (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 NOPR, DOE is proposing 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.4, III.B.5 and III.D.1 of this NOPR). These definitions are necessary to establish the scope of applicability of the proposed circulator pump test procedure. The scope of the proposed test procedure is discussed in section III.B.6 of this document.

1. CPWG Recommendations

As discussed in the May 2021 RFI, 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 [9] 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 p. 1–2) The CPWG also recommended the following definitions relevant to scope:

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 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.

Horizontal motor means a motor that requires the motor shaft to be in a horizontal position to function as designed under typical operating conditions, as specified in manufacturer literature.

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

Submersible pump means a pump that is designed to be operated with the motor and bare pump fully submerged in the pumped liquid.

Header pump means a 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. (Docket No. EERE–2016–BT–STD–0004, No. 58, Recommendations #2B, 3A, and 3B at p. 2–3); 86 FR 24516, 24520.

DOE notes that generally these definitions 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 (''August 2017 DPPP TP final rule''). 82 FR 36858, 36922 (August 7, 2017);10 CFR 431.462.

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

2. Definition of Circulator Pump

Circulator pumps are a subset of small, IL pumps that are designed to provide a small amount of head to overcome pipe friction losses in a water circulation system for hydronic heating or cooling and potable hot water recirculation. During the CPWG meetings, the CPWG discussed the applications and utilities that circulator pumps serve and the distinctions in the designs of circulator pump varieties.

In defining circulator pump, the CPWG reviewed the descriptions established in 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.'' (Docket No. EERE–2016–BT–STD–0004, No. 64 at pp.41–43) Section 1.1.3.3.5 of ANSI/HI 1.1–1.2–2014 characterizes circulator pumps based on the following four unique features: (1) Rotating assemblies that must be horizontally mounted; (2) being fully supported in-line by the system piping; (3) utilizing special-purpose motors unique to this pump type; and (4) having a motor shaft power that does not exceed 3.75 kilowatts (''kW'') (5 horsepower (''hp'')).

Sections 1.1.3.3.5.1–2 of ANSI/HI 1.1–1.2–2014 provide definitions for three unique types of circulator pumps. These three unique circulator pump varieties are based on two main characteristics: (1) Whether the motor is isolated from or immersed in the pumped liquid, and (2) how the impeller and motor are connected. Regarding the first characteristic, a circulator pump may be wet rotor, meaning that the motor rotor is immersed in the pumped liquid during operation; or dry rotor, meaning that the pump is not immersed in the pumped liquid. Dry rotor pumps typically include a mechanical seal that isolates the motor rotor from the pumped liquid.

The second characteristic, which pertains to how the impeller and motor are connected, further subdivides wet rotor and dry rotor circulator pumps into close-coupled or mechanically-coupled varieties. A close-coupled pump has a motor and impeller that share a common shaft, while a mechanically-coupled pump features an impeller that has its own shaft that is connected by mechanical means to the motor shaft.

Based on these differentiating features, Sections 1.1.3.3.5.1–2 of ANSI/HI 1.1–1.2–2014 defines the following circulator pump varieties:

- Close-coupled circulator pumps (CP1 and CP2)—Close-coupled circulator pumps may have driver elements that are immersed in the pumped fluid (CP1) or isolated by a mechanical seal (CP2). The rotating assembly shares a common shaft; the bearing(s) of the rotating assembly absorb all pump hydraulic loads (axial and radial). The driver is aligned and assembled directly to the pump unit with machined fits.
- Flexibly-coupled circulator pumps (CP3)—In flexibly-coupledcirculator pumps, the pump has a shaft supported by its own bearings that absorb all pump hydraulic loads (axial and radial). The driver is aligned and assembled directly to the pump unit with machined fits, typically with a resilient mount to damped vibration. The pump and driver shafts are flexibly coupled via flexible element drive couplings.[10]

Consistent with the ANSI/HI 1.1–1.2–2014 classification, the CPWG discussed defining three varieties of circulator pumps: (1) Wet rotor circulator pumps, (2) dry rotor close-coupled circulator pumps, and (3) dry rotor mechanically-coupled circulator pumps. (Docket No. EERE–2016–BT–STD–0004, No. 64 at pp.41–43)

The specific definitions for wet rotor circulator pumps and dry rotor circulator pumps are discussed in the following sections.

The CPWG also discussed the applicability of the recommended test procedure and standards to circulator pumps distributed in commerce without a volute. As discussed in more detail in section III.B.4, the CPWG discussed how some circulator pumps are distributed in commerce without a volute, either as a replacement for an existing circulator pump that has failed or to be newly installed with a paired volute in the field. (Docket No. EERE–2016–BT–STD–0004, No. 74 at pp. 383–407). In section III.E.2.b, DOE proposes specific instructions regarding how to test a ''circulator-less-volute.''

To specify that the recommended circulator pump test procedure and standards are intended to apply to circulator pumps, with or without a volute, the CPWG recommended adding such language to the recommended circulator pump definition. (Docket No. EERE–2016–BT–STD–0004, No. 66 at pp. 156–164). The CPWG also recommended to define circulator pump as being comprised of the following pump categories distributed in commerce with or without a volute: Wet rotor circulator pumps, dry rotor close-coupled circulator pumps, and dry rotor mechanically-coupled circulator pumps. (Docket No. EERE–2016–BT–STD–0004, No. 58 Recommendation #1A at p. 1)

DOE notes that the terminology in the CPWG recommended definition for circulator pump does not match the terminology in the CPWG recommended definitions for the circulator pump categories. Specifically, the recommended circulator pump definition includes ''dry rotor close-coupled circulator pumps'' and ''dry rotor mechanically-coupled circulator pumps,'' while the recommended defined terms are ''dry rotor, two-piece circulator pump'' and ''dry rotor, three-piece circulator pumps.'' (Docket No. EERE–2016–BT–STD–0004, No. 58 Recommendation #1A, 3A, and 3B at pp. 1–3) Those defined terms reference close-coupling and mechanical-coupling, respectively. DOE notes that HI 41.5–2021 defines circulator pump in section 41.5.1.5.1 as a wet rotor circulator pump (CP1); a dry rotor, two-piece circulator pump (CP2); or a dry rotor three-piece circulator pump (CP3). Based on their use in the industry test procedure, DOE understands that ''two-piece'' and ''three-piece'' are the preferred industry terms over the terms ''close-coupled'' and ''mechanically-

[10] ''Flexibly-coupled'' is a more specific use of the term ''mechanically-coupled''. Consistent with 10 CFR 431.462 and CPWG recommendations, DOE uses the term ''mechanically-coupled'' throughout the remainder of this notice.

coupled,'' and has proposed the use of the industry terms.

DOE is proposing a definition of circulator pump at 10 CFR 431.462 consistent with the definition recommended by the CPWG. Specifically, DOE proposes 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.

DOE requests comment on the proposed definition for circulator pump.

The definitions of the pump categories that comprise the scope of ''circulator pump'' are addressed in the following section. In response to the May 2021 RFI, China asserted that the range and definition of circulator pumps is not clear and that schematic diagrams should be provided for each product on the basis of their text description. (China, No. 111 at p. 3) DOE believes that the proposed definition of circulator pump, in combination with the proposed definitions of the three primary kinds of circulator pumps in the following section, sufficiently address the range of circulator pumps, and that schematic diagrams would not provide additional benefit.

3. Definition of Circulator Pump Varieties

In the May 2021 RFI, DOE requested comment on the CPWG's recommended definitions for wet rotor circulator pump; dry rotor, two-piece circulator pump; dry rotor, three-piece circulator pump; and horizontal motor, including whether any changes in the market since the CPWG's recommendations would affect the recommended definitions and scope. 86 FR 24516, 24520–24521.

HI, Grundfos, and the CA IOUs generally agreed with the CPWG's recommended definitions for these varieties of circulator pumps. (HI, No. 112 at p. 2; Grundfos, No. 113 at p. 1; CA IOUs, No. 116 at p. 5) Other comments expressed support for the CPWG recommendations generally, as discussed in section III.A of this document.

As discussed previously, the CPWG recommended definitions for wet rotor circulator pump; dry rotor, two-piece circulator pump; and dry rotor, three-piece circulator pump were based on review of the descriptions of circulator pump categories established in the standard ANSI/HI 1.1–1.2–2014. DOE notes that the updated version of this industry standard, ANSI/HI 14.1–14.2–2019, ''Rotodynamic Pumps for Nomenclature and Definitions,'' has revised the descriptions of circulator pump categories to be identical to the CPWG recommended definitions, and section 41.5.1.5.1 of HI 41.5–2021 also includes definitions identical to the CPWG recommended definitions. DOE has reviewed the CPWG recommended definitions and has tentatively determined that these definitions appropriately distinguish the varieties of circulator pumps available on the market and as originally described in the industry standard ANSI/HI 1.1–1.2–2014.

Based on the discussion in the prior paragraphs, DOE proposes 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.

DOE currently defines a ''horizontal motor'' as a motor that requires the motor shaft to be in a horizontal position to function as designed, as specified in the manufacturer literature. 10 CFR 431.462. The definition of ''horizontal motor'' is used in 10 CFR 431.462 to exclude certain pumps from the IL pump category.[11] The definition of ''horizontal motor'' recommended by the CPWG includes the additional phrase ''under typical operating conditions'' to qualify ''function as designed.'' The CPWG discussed that this qualifier was added to address the potential that a motor would not be covered as a horizontal motor if a manufacturer were to advertise its circulator pump as being able to be installed in a non-horizontal orientation under certain conditions, such as high operating pressure (*i.e.,* conditions other than typical conditions). (Docket No. EERE–2016–BT–STD–0004, No. 64 at pp. 75–83) The CPWG discussed that the requirement to consider motor installation in the context of typical operating conditions, as specified in the manufacturer literature, would address this potential. (Docket No. EERE–2016–BT–STD–0004, No. 66 at pp. 55–57) 86 FR 24516, 24520. DOE did not receive any comments on the definition of horizontal motor in response to the May 2021 RFI.

DOE has reviewed the horizontal motor definitions and has tentatively concluded that the existing definition of horizontal motor in 10 CFR 431.462 could benefit from additional specificity. However, DOE does not believe the term ''typical operating conditions'' recommended by the CPWG provides sufficient specificity, as the term could refer to any conditions specified in the manufacturer's manual. In order to address the concern that a pump with a horizontal motor would be considered an IL pump instead of a circulator pump if the motor must be non-horizontal under non-typical conditions such as high operating pressure, DOE instead proposes the following definition of 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.

DOE has tentatively concluded that this proposed update 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.

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

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

In the May 2021 RFI, 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 24516, 24521; (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) As discussed in the May 2021 RFI, CPWG asserted that circulator pumps distributed in commerce without volutes meet the definition of pump, and that not subjecting such equipment to test procedures and standards would represent a significant loophole. 86 FR 24516, 24521; (Docket No. EERE–2016–

[11] The definition of IL pumps includes the following sentence: ''Such pumps do not include pumps that are mechanically coupled or close-coupled, have a pump power output that is less than or equal to 5 hp at BEP at full impeller diameter, and are distributed in commerce with a horizontal motor.'' 10 CFR 431.462.

BT–STD–0004, No. 70 at pp. 89–91; No. 74 at pp.383–403) The CPWG also discussed that including circulators-less-volute within the scope of DOE regulation is consistent with the treatment of circulator pumps under the European Union's regulations [12] which applies to circulator pumps ''with or without housing.'' (Docket No. EERE–2016–BT–STD–0004, No. 74 at pp. 373–376)

As noted in the May 2021 RFI, the CPWG also discussed that circulators-less-volute that are solely intended to be installed in other equipment use the other equipment as the volute, and do not have a matching volute that is separately distributed in commerce and, therefore, would not pose the same loophole risk. According to the CPWG, such pumps would also be difficult to test and rate. Specifically, the CPWG discussed that circulator pump manufacturers would not have access to or design authority for the volute design. In addition, the circulator pump could not be tested as a standalone circulator pump because the volute would be unable to be removed from the other equipment, and no paired volute would be distributed in commerce with which the header pump could be tested. According to the CPWG, such equipment would potentially require extensive and burdensome equipment to test appropriately. As such, 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. (Docket No. EERE–2016–BT–STD–0004, No. 74 at pp. 413–416) 86 FR 24516, 24521.

As stated in the May 2021 RFI, 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.'' (Docket No. EERE–2016–BT–STD–0004, No. 74 at pp. 384–386). The CPWG recommended defining ''header pump'' as a pump that consists of a circulator-less-volute intended to be installed in an OEM piece of equipment that serves as the volute, and to exclude them from the recommended circulator pump test procedure and standards. (Docket No. EERE–2016–BT–STD–0004, No. 58 Recommendation #2B at p. 2); 86 FR 24516, 24521. The CPWG also 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)

In the May 2021 RFI, DOE requested comment on the definition of header pump. 86 FR 24516, 24521. HI agreed with the CPWG recommended definition of ''header pump,'' stating that no substantive changes have occurred in the market, and that such pumps should be excluded from regulation. (HI, No. 112 at p. 2) NEEA supported the recommended definition of ''header pump'' and the recommended exclusion of them, noting that they are challenging to test. NEEA also commented that DOE should monitor the market for header pumps and make sure it does not become a loophole after regulation. (NEEA, No. 115 at p. 3) Grundfos stated that no change to the definition is warranted, but that header pumps should be regulated in the same way that circulators-less-volute are regulated; *i.e.,* by requiring a reference volute for testing, as is required in the EU, in order to avoid creating a loophole. (Grundfos, No. 113 at p. 1–2). China stated that the test method for header pumps has not been provided and that DOE should define the test method for these pumps. (China, No. 111 at p. 3)

DOE notes that HI 41.5–2021 does not address either header pumps or circulators-less-volute. DOE tentatively agrees that a circulator-less-volute designed solely for use as a component in a separate piece of equipment should be distinguished from circulators-less-volute generally for the purpose of the proposed test procedure for the reasons discussed by the CPWG. As discussed in section III.E.2.b, the CPWG recommended specific test procedure provisions for circulators-less-volute that are not designed solely for installation in a separate piece of equipment (*i.e.,* a header pump). (Docket No. EERE–2016–BT–STD–0004, No. 58 Recommendation #12 at p. 2) To provide a distinction between a circulator-less-volute and a header pump, DOE proposes 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.

DOE requests comment on the proposed definitions of header pump and circulator-less-volute.

DOE acknowledges that EU Regulation No 622/2012 includes provisions to test circulator pumps integrated in products dismantled from the product and measured with a reference pump housing, which means ''a pump housing supplied by the manufacturer with inlet and outlet ports on the same axis and designed to be connected to the pipework of a heating system or secondary circuit of a cooling distribution system.'' [13] As stated previously, the CPWG discussed that there would be no available paired volutes with which to test a header pump, and as such testing such pumps would require extensive and potentially burdensome equipment to test appropriately. In its comments recommending that use of a reference volute should be required for testing header pumps, Grundfos has not sufficiently addressed these testing concerns for header pumps raised by the CPWG. In addition, DOE tentatively concludes that requiring testing of header pumps using a reference volute 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 is not proposing to include header pumps in the scope of this test procedure, and accordingly is not proposing a test method for header pumps.

[12] See EC No 622/2012; *https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32012R0622.*

[13] European Commission Regulation No 622/2012 of 11 July 2012 amending Regulation (EC) No 641/2009 with regard to ecodesign requirements for glandless standalone circulators and glandless circulators integrated in products. *https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32012R0622. Accessed 2021–09–21.*

5. Definition of On-Demand Circulator Pumps

In the May 2021 RFI, 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. The CPWG recommended a definition for ''on-demand circulator pumps'' to be incorporated as necessary. (Docket No. EERE–2016–BT–STD–0004, No. 98 Non-Binding Recommendation #1 at pp. 4–5) 86 FR 24516, 24521. 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 recommended defintion for ''on-demand circulator pumps'' is 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.

(Docket No. EERE–2016–BT–STD–0004, No. 98 Non-Binding Recommendation #1 at pp. 4–5); 86 FR 24516, 24521.

In addition, the CPWG recommended that an on-demand circulator pump must not be capable of operating without the control without physically destructive modification of the unit, such as any modification that would violate the product's standards listing. (Docket No. EERE–2016–BT–STD–0004, No. 98 Non-Binding Recommendation #1 at p. 5); 86 FR 24516, 24521.

DOE requested comment regarding the CPWG-recommended definition of ''on-demand circulator pump'' and whether it is appropriate to retain on-demand circulator pumps within the scope of future analysis. 86 FR 24516, 24521.

HI agreed with the recommended definition of on-demand circulator pumps and stated that the CPWG intention of defining them was for the purpose of possible exclusion from standards due to limited run hours. (HI, No. 112 at p. 3) Grundfos commented that on-demand products should be regulated as circulator pumps because they are built with standard circulator pumps that incorporate additional features, and that having them unregulated would create a loophole allowing less-efficient induction-based products to remain on the market. (Grundfos, No. 113 at p. 1–2) NEEA agreed with the recommended definition of on-demand circulator pumps, but did not agree that they should be treated separately by DOE regulations. NEEA commented that these pumps can save energy by reducing run time, and that these savings are not addressed in the recommended test method. NEEA recommended that in a future rulemaking, DOE consider the potential energy savings from domestic hot water run-hour controls and consider providing a ratings credit for circulator pumps equipped with efficient temperature, on-demand, timer, or learning run-hour controls. (NEEA, No. 115 at p. 4).

DOE notes that HI 41.5–2021 does not address or refer to on-demand circulator pumps. 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, p. 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.[14] (*Id.* at p. 195–196)

DOE proposes to define on-demand circulator pump at 10 CFR 431.462 as recommended by the CPWG. DOE believes that the recommended added specification that the on-demand circulator pump must not be capable of operating without the control without physically destructive modification of the unit, such as any modification that would violate the product's standards listing, is already encompassed by the provision in the recommended definition that the control be ''integral'' and by the definition of ''integral'' in 10 CFR 431.462: a part of the device that cannot be removed without compromising the device's function or destroying the physical integrity of the unit.

DOE is not proposing to exclude on-demand circulator pumps from the scope of the test procedure. At this time, DOE has not considered developing a credit for these controls, as was suggested in comments. DOE notes that if on-demand circulator pumps are equipped with other controls that reduce speed as defined in section III.D.1, they may be tested according to the relevant test methods rather than using the no controls test. DOE will consider whether standards are appropriate for this equipment in a future energy conservation standards rulemaking.

DOE requests comment on its proposal to include on-demand circulator pumps within the scope of this test procedure. DOE also requests data and information that would justify a CEI credit for on-demand circulator pumps.

6. Applicability of Test Procedure Based on Pump Configuration

In addition to recommending specific definitions, the CPWG also discussed and provided recommendations pertinent to the scope of applicability of the recommended circulator pumps test procedure. The CPWG recommended that the scope of the recommended test procedure would be limited to wet rotor circulator pumps, dry rotor close-coupled circulator pumps, and dry rotor mechanically-coupled circulator pumps, as discussed in section III.B.2. (Docket No. EERE–2016–BT–STD–0004, No. 58, Recommendation #1A, at p. 1) The CPWG also recommended to limit the scope of the circulator pump rulemaking to clean water pumps only and to exclude header pumps and submersible pumps. (Docket No. EERE–2016–BT–STD–0004, No. 58 Recommendations #2A and 2B at p. 2)

In the January 2016 TP final rule, DOE established a definition for ''clean water pump.'' 81 FR 4046, 4100 (Jan. 25, 2016). DOE noted that several common pumps would not meet the definition of clean water pumps, as they are not designed for pumping clean water, including wastewater, sump, slurry, or solids handling pumps; pumps designed for pumping hydrocarbon product fluids; chemical process pumps; and sanitary pumps. *Id.* at 4100. The CPWG reviewed this definition and, to be consistent with the general pumps rulemaking, recommended to limit the scope of the circulator pump

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

rulemaking to clean water pumps only, whereby clean water pump means 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 (0.25 kilograms per cubic meter), and with a maximum dissolved solid content of 3.1 pounds per cubic foot (50 kilograms per cubic meter), 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 °C), as defined at 10 CFR 431.462. (Docket No. EERE–2016–BT–STD–0004, No. 58 Recommendations #2A at p. 2) The CPWG discussed how this was important to ensure certain small, chemical process pumps would be excluded based on the fact that they are not designed to pump clean water. (Docket No. EERE–2016–BT–STD–0004, No. 70 at pp. 36–42)

DOE did not receive any comments on the May 2021 RFI related to the CPWG recommendation to limit scope of the circulator pump rulemaking to clean water pumps. DOE agrees with the CPWG that limiting the scope of the circulator pump rulemaking to clean water pumps, consistent with the scope of general pumps in 10 CFR 431.464, is appropriate. Regulation of chemical process pumps would require many other considerations beyond that for clean water pumps, and DOE believes that excluding small chemical process pumps from the scope of regulation would not create any loophole risks to the clean water circulator pump market. DOE proposes to apply the existing clean water pump definition to circulator pumps, thus limiting the scope of applicability of the proposed circulator pumps test procedure to circulator pumps that meet the definition of clean water pump.

Regarding the exclusion of submersible pumps, the CPWG discussed a variety of close-coupled, wet rotor pumps that are typically used for decorative water features in swimming pools and ponds. (Docket No. EERE–2016–BT–STD–0004, No. 70 at pp. 47–63 and No. 47, pp. 523–525) The CPWG discussed how these decorative water feature pumps might otherwise meet the definition of a wet rotor circulator pump (see section III.B.2); however, these pumps are unique from traditional wet rotor circulator pumps, in that they are submersible pumps and, as such, are intended to be operated with the entire pump and motor assembly fully submerged in the pumped liquid. Therefore, the CPWG recommended to exclude submersible pumps from the scope of applicability of any circulator pump test procedure and standards. (Docket No. EERE–2016–BT–STD–0004, No. 74 at pp. 299–303)

In response to the May 2021 RFI, HI agreed with the scope agreed to by the CPWG. (HI, No. 112 at p. 3)

DOE agrees with the CPWG that submersible decorative water feature pumps are similar in design to wet rotor circulator pumps in that they are wet rotor, rotodynamic pumps, but that they are intended to be operated with the entire pump and motor assembly fully submerged in the pumped liquid, which presents additional considerations for any test procedure and energy conservation standards. Given that these decorative water feature pumps are submersible, DOE does not believe that if unregulated they would pose any loophole risk to the clean water circulator pump market. Therefore, DOE proposes to exclude submersible pumps from the scope of applicability of the circulator pump test procedure. DOE notes that the definition of submersible pump recommended by the CPWG is identical to the definition that currently exists in 10 CFR 431.462, as adopted in the August 2017 DPPP TP final rule. 82 FR 36858, 36922. As such, DOE is not proposing amendments to that definition.

As discussed in section III.B.4, DOE tentatively agrees with the recommended exclusion of header pumps and tentatively agrees with the inclusion of circulators-less volute. Also, as discussed in section III.B.5, DOE proposes to include on-demand circulator pumps within the scope of this test procedure. In summary, DOE proposes that the test procedure would be applicable to circulator pumps (as defined in section III.B.2) that are clean water pumps, including circulators-less-volute and on-demand circulator pumps, and excluding header pumps and submersible pumps. The specific test methods proposed for circulator pumps are discussed in more detail in section III.D of this document.

DOE requests comment on the proposed scope of applicability of the circulator pump test procedure to circulator pumps that are clean water pumps, and the exclusion of header pumps and submersible pumps from the scope of the proposed test procedure.

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 is also proposing to rely on the definition of ''basic model'' as currently defined at 10 CFR 431.462. 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. 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. 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.

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).

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DOE has reviewed this definition and has tentatively determined that the general definition is appropriate for circulator pumps. DOE understands that, like dedicated purpose pool pumps, circulator pumps are exclusively single-stage pumps and, therefore, the provision regarding variation in number of stages would not be applicable. Furthermore, DOE understands that, like each dedicated purpose pool pump motor model, each circulator pump model is offered with only one impeller diameter, unlike general pumps for which a given pump model may be sold with many different impeller diameters that are customized for each application. Therefore, DOE believes that the provision for grouping individual pumps that vary only in impeller diameter, or impeller trim, would also not be applicable to circulator pumps; any variation in impeller trim would constitute a separate basic model for circulator pumps. Finally, as neither the multistage nor impeller trim specifications for basic model designation apply to circulator pumps, the provision regarding variation in motor horsepower resulting from variation in either of those characteristics would also not apply to circulator pumps. Therefore, 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.

DOE requests 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.

C. Rating Metric

As discussed in the May 2021 RFI, the CPWG focused on defining a performance-based metric that was similar to the PEI metric established for the January 2016 TP final rule. (Docket No. EERE–2016–BT–STD–0004, No. 64 at pp. 246–247) The CPWG recommended using the PEI_{CIRC} metric, which would be defined as the pump energy rating (''PER'') for the rated circulator pump model (''PER_{CIRC}''), divided by the PER for a circulator pump that is minimally compliant with energy conservation standards serving the same hydraulic load (''$PER_{CIRC,STD}$''). (Docket No. EERE–2016–BT–STD–0004, No. 58, Recommendation #5 at p. 4); 86 FR 24516, 24522.

The equation for PEI_{CIRC} as recommended by the CPWG is shown in the equation (1):

$$PEI_{CIRC} = \left[\frac{PER_{CIRC}}{PER_{CIRC,STD}}\right] \quad (1)$$

Where:

PER_{CIRC} = circulator pump energy rating (hp); and

$PER_{CIRC,STD}$ = pump energy rating for a minimally compliant circulator pump serving the same hydraulic load.

(Docket No. EERE–2016–BT–STD–0004, No. 58 Recommendation #5 at p. 4); 86 FR 24516, 24522.

As stated in the May 2021 RFI, PER_{CIRC} would be determined as the weighted average input power to the circulator pump motor or controls, if available, to a given circulator pump over a number of specified load points. Due to differences in the various control varieties available with circulator pumps, the CPWG recommended that each circulator pump control variety have unique weights and test points that are used in determining PER_{CIRC}.[15] (Docket No. EERE–2016–BT–STD–0004, No. 58 Recommendations #6A and #6B at pp. 4–6) 86 FR 24516, 24522. The test points, weights, and test methods necessary for calculating PER_{CIRC} for pressure controls, temperature controls, manual speed controls, external input signal controls, and circulator pumps with no control (*i.e.,* without external input signal, manual, pressure, or temperature control)[16] are described in section III.D. 86 FR 24516, 24522.

As recommended by the CPWG, $PER_{CIRC,STD}$ would be determined similarly for all circulator pumps, regardless of control variety. $PER_{CIRC,STD}$ would represent the weighted average input power to a minimally compliant circulator pump serving the same hydraulic load. As such, $PER_{CIRC,STD}$ would essentially define the minimally compliant circulator pump performance, such that the energy conservation standard level would always be defined as 1.00, and lower numbers would represent better performance. The CPWG discussed the derivation of $PER_{CIRC,STD}$ in the Working Group negotiations and, ultimately, recommended a standard level that is nominally equivalent to a single-speed circulator pump equipped with an electrically commutated motor. (Docket No. EERE–2016–BT–STD–0004, No. 102 at pp. 53–56; Docket No. EERE–2016–BT–STD–0004, No. 98 Recommendations #1 and 2A–D at pp. 1–4); 86 FR 24516, 24522.

The CPWG specified a method for determining $PER_{CIRC,STD}$ with procedures to determine the minimally compliant overall efficiency at the various test points based on the hydraulic performance of the rated circulator pump. (Docket No. EERE–2016–BT–STD–0004, No. 98 Recommendations #1 and 2A–D at pp. 1–4); 86 FR 24516, 24522. As discussed, $PER_{CIRC,STD}$ 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 $PER_{CIRC,STD}$, 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.[17] DOE notes that the recommended method for determining $PER_{CIRC,STD}$ relies on the

[15] In order to determine weighted average input power, input power must be measured at multiple test points, and each test point must be weighted. The test points and weights for each test method are discussed in section III.D.

[16] In this document, circulator pumps with ''no controls'' are also inclusive of other potential control varieties that are not one of the specifically identified circulator pump control varieties. Any circulator pump without one of the defined control varieties would be treated as a circulator pump with no controls, regardless of whether it is a single-speed circulator pump or has a control variety not defined in this test procedure. See section III.D.7 of this document.

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

hydraulic horsepower of the rated circulator pump. DOE discusses measurement of this parameter in section III.G.

DOE requested comment on the CPWG recommendation to adopt PEI_{CIRC} as the metric to characterize the energy use of certain circulator pumps and on the recommended equation for PEI_{CIRC}, including whether anything in the technology or market has changed since publication of the 2016 Term Sheets that would lead to this metric no longer being appropriate. 86 FR 24516, 24522.

In response, HI and Grundfos recommended changing the metric nomenclature from PEI_{CIRC} to CEI (Circulator Energy Index) to avoid confusion and/or differentiate coverage from the general pump rule. (HI, No. 112 at p. 3; Grundfos, No. 113 at p. 2) HI similarly recommended corresponding changes to PER_{CIRC} to CER (Circulatory Energy Rating). (HI, No. 112 at p. 3). As stated in section III.E.1, the Advocates and NEEA supported adopting HI 41.5–2021, the industry rating guideline, that includes the updated metric nomenclature discussed by HI in its comments. (Advocates, No. 114 at p. 1; NEEA, No. 115 at p. 4–5). The CA IOUs also supported modifying the term sheet to adopt HI 41.5–2021, and supported adopting term sheet provisions including the definition of CEI. (CA IOUs, No. 116 at p. 2, 5)

DOE agrees with the CPWG that the recommended PEI_{CIRC} metric, as shown in equation (1), will reasonably reflect the energy use of circulator pumps over a representative average use cycle. DOE also agrees with commenters that changing the name of the metric to CEI will reduce possibility for confusion. As such, DOE proposes to adopt the CEI metric as the performance-based metric for representing the energy performance of circulator pumps, as defined in equation (2), and consistent with section 41.5.3.2 of HI 41.5–2021. DOE notes that while HI 41.5–2021 defines the denominator as CER_{REF}, DOE believes that the terminology CER_{STD} is more reflective of the Federal energy conservation standards. Any standards considered for any circulator pumps for which the CEI is applicable would use this metric as a basis for the standard level.

$$CEI = \left[\frac{\text{CER}}{CER_{STD}}\right] \qquad \textbf{(2)}$$

Where:

CER = circulator energy rating (hp); and
CER_{STD} = circulator energy rating for a minimally compliant circulator pump serving the same hydraulic load.

DOE requests 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.

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

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) In order 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. (Docket No. EERE–2016–BT–STD–0004, No. 58 Recommendations #6A and #6B at pp. 4–6)

Manual speed controls are controls in which the speed of the motor is adjusted manually, typically at the time of installation, to match the system head and flow requirements of the installation.

Pressure controls are controls that use a variable speed drive to automatically adjust the speed of the motor based on the pressure in the system at any given time according to a fixed constant or proportional (*i.e.,* sloped) control curve.[18] Models with pressure controls typically provide several fixed control curve options available to accommodate different systems with varying pressure drops across different zones. These controls are typically installed in multi-zone hydronic heating applications to vary the speed of the circulator pump, based on the number of zones open, in order to achieve the appropriate flow rate through each zone.

Adaptive pressure controls are a specific variety of pressure controls that use pressure sensors to continually evaluate the head and flow requirements in the system and adjust the sensitivity of the control response[19] to specifically suit the system's head and flow requirements. In addition to being designed to operate in multi-zone systems, adaptive pressure controls may also have the ability to operate in a single zone system, such as a domestic hot water recirculation system, to adjust for any oversizing that might have occurred in the design and pump selection process. As such, adaptive pressure controls have the potential to save more energy than conventional (*i.e.* non-adaptive) pressure-based controls.

Temperature controls are controls that use a variable speed drive to automatically adjust the speed of the pump continuously over the operating speed range to respond to a change in temperature in the system. These controls may be installed in single- or multi-zone systems and adjust the circulator pump's operating speed to provide the optimum flow rate based on the heat load in each zone. Specifically, temperature controls are typically designed to achieve a fixed temperature drop through the system and will adjust the speed of the pump to increase or decrease the flow rate to precisely match the required thermal load (*i.e.,* to maintain the target temperature drop). 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 of energy to serve a given load.

Finally, external input signal control refers to a system in which the speed of the circulator pump is controlled by control logic that is external to the circulator pump. This could be the case

[18] Constant pressure control curves supply the same non-zero head pressure regardless of flow. Proportional pressure control curves reduce head in response to a reduction in flow, but maintain a minimum head pressure at zero flow.

[19] In adaptive pressure controls, the sensitivity of the control response is adjusted by changing the slope of the control curve.

in circulator pumps that are, for example, designed to be installed in conjunction with a boiler and are controlled by the boiler's firing controls, as opposed their own internal control logic.

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

Section III.D.2 discusses the proposed 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 being proposed for pressure controls, temperature controls, manual speed controls, external input signal controls, and no controls,[20] respectively.

In response to the May 2021 RFI, several stakeholders commented about components of CEI that differ by control type method. China stated that DOE should offer the specific data or calculation method for CER_{STD} and have executive consultation among World Trade Organization members before the procedure is officially published and implemented. China also commented that the weighted average input power for CEI is set differently than the international general rules, and requested that DOE offer scientific evidence for the weight assignment. (China, No. 111 at p. 3) Grundfos stated that the weights used in determining CEI should be aligned across control modes to simplify testing and that the baseline calculation method should match the control method weights. (Grundfos, No. 113 at p. 3) The CA IOUs supported the weighting points provided in the CPWG term sheets. (CA IOUs, No. 116 at p. 5)

In response to China and Grundfos, DOE discusses the weighting assignments in the individual test methods within this section. In general, the CPWG recommended unique weights for most control varieties, which were understood to be representative of their operation in the field. (See sections III.D.3, III.D.4, III.D.5, and III.D.6. of this NOPR)

HI 41.5–2021 section 41.5.3 specifies rating the most consumptive and least consumptive of the control curves that are available on a circulator pump as shipped. The industry test standard provides an example stating that if pressure control is the most consumptive option and multiple pressure control curve settings are provided, the circulator pump would be tested and rated per the pressure control test method, but with the most and least consumptive control curves. DOE notes that this example does not seem consistent with the preceding text, and that in the HI Energy Rating portal for circulator pumps,[21] the most consumptive rating is always based on full speed (no controls), while the least consumptive rating is based on one of the control varieties on-board, if any.

In response to the May 2021 RFI, HI stated that for clarity, and to align with the CPWG negotiated intent (referencing page 473 of the CPWG transcript from July 13, 2016), DOE should implement the least consumptive control mode CEI for the regulatory rating. (HI, No. 112 at p. 2)

NEEA commented that in the context of the CPWG recommendation, they would expect most manufacturers to rate with the least consumptive control curve available, which would encourage manufacturers to produce circulator pumps with efficient controls and would enable utilities to identify equipment with efficient control options. NEEA also suggested that DOE also allow circulator pumps with multiple control options to be rated with the most consumptive control curve available, consistent with HI 41.5–2021. NEEA stated that allowing circulator pumps to have multiple ratings would encourage adoption of energy efficient options and technologies beyond the minimum threshold, while holding all manufacturers to a consistent standard of performance and providing information for consumers to fully understand the energy consumption of the equipment. (NEEA, No. 115 at p. 5)

The CPWG did not make a specific recommendation on how to select which control mode to use for a rating other than that for pressure controls, a manufacturer should be able to choose the tested control curve, when multiple options are available, but should report the control curve used and method of adjustment (*e.g.,* whether the rating was achieved through automatic speed adjustment, manual speed adjustment or through simulated pressure signal) to DOE with certification reporting. (Docket No. EERE–2016–BT–STD–0004, No. 58 Recommendation #9 at p. 7)

If given the option to choose a control variety for rating, DOE expects that most manufacturers would choose the least consumptive control curve. DOE reviewed the transcript cited by HI and did not identify justification that the intent of the CPWG was to recommend testing the least consumptive control mode. DOE believes that proposing a least consumptive approach, as suggested by HI, could require manufacturers to conduct multiple tests to identify the least consumptive control curve, which may cause additional burden. DOE does not think it is likely that a requirement to identify the least consumptive control curve would provide additional benefits to manufacturers (beyond that from an allowance to choose a control curve to test) such as an incentive to develop energy efficient control strategies. DOE proposes the approach presented in the CPWG recommendation, which would allow manufacturers to select the control variety used for testing if multiple control varieties are available on the circulator pump. In response to NEEA's recommendation to also allow ratings with the most consumptive control curve available, DOE proposes in this NOPR that manufacturers may select multiple control varieties with which to test their circulator pumps. DOE will address certification reporting requirements in any future energy conservation standard rulemaking.[22]

DOE requests comment on the proposal to allow manufacturers to select the control variety used for testing if the circulator pump model is distributed in commerce with multiple control varieties. DOE specifically requests comment on whether DOE should instead require manufacturers to test a circulator pump model that offers multiple control varieties with the least consumptive control variety. DOE also requests comment on the burden that would be associated with such an approach.

1. Definitions Related to Circulator Pump Control Varieties

As stated in the May 2021 RFI, the CPWG recommended definitions for the following control varieties for circulator pumps: Manual speed control, pressure control, temperature control, and external input signal control. 86 FR 24516, 24523. The definitions of these pump control varieties recommended by the CPWG are as follows:

• *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.

[20] 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.

[21] The HI Energy Rating portal is available at *er.pumps.org/circulator/ratings.*

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

• *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.

(Docket No. EERE–2016–BT–STD–0004, No. 58, Recommendation #4 at p. 4) 86 FR 24516, 24523.

DOE requested comment on the recommended definitions for manual speed control, pressure control, temperature control, and external input signal control. 86 FR 24516, 24523.

In response to the May 2020 RFI, HI agreed with the current scope and definition recommended by the CPWG and noted that the definitions have not been changed in the adoption of HI 41.5–2021. (HI, No. 112 at p. 4). Grundfos and the CA IOUs also agreed with these definitions for control methods (Grundfos, No. 113 at p. 3; CA IOUs, No. 116 at p. 5) As stated previously, NEEA and the Advocates in general supported the term sheet recommendations. (Advocates, No. 114. at p. 1; NEEA, No. 115 at p. 2) DOE notes that HI 41.5–2021 section 41.5.1.5.1 includes definitions for manual speed control, pressure control, temperature control, and external input signal control that are identical to the CPWG recommendations.

DOE has reviewed these definitions recommended by the CPWG and believes that the definitions appropriately describe the characteristics of the relevant circulator pump controls. Furthermore, DOE believes these definitions appropriately identify each type of control for the purpose of determining the applicable test method based on the characteristics of a circulator pump's control variety. Therefore, consistent with CPWG recommendations and continued stakeholder support, DOE proposes 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.

In the May 2021 RFI, DOE noted that the CPWG did not recommend a definition for adaptive pressure controls, although it did recommend a separate test procedure for them, because, as discussed by the CPWG, adaptive pressure controls are able to adjust the slope of the control curve to fit the system needs through an ongoing learning process inherent in the software. (Docket No. EERE–2016–BT–STD–0004, No. 72 at pp. 45–46) 86 FR 24516, 24523.

DOE requested comment on a possible definition for adaptive pressure control. 86 FR 24516, 24523. Grundfos generally objected to addressing adaptive pressure control in the DOE test procedure. (Grundfos, No. 113 at p. 3; see discussion in section III.D.3), but did not comment specifically on the definition.

DOE notes that HI 41.5–2021 section 41.5.1.5.1 includes the following definition for adaptive pressure control: ''a pressure control that adjusts the control curve automatically based on the conditions of use.'' DOE believes that this definition would benefit from additional clarity regarding the conditions to which the control responds; specifically, DOE proposes 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 requests comment on its proposed definition of adaptive pressure control.

In the May 2021 RFI, DOE requested comment on whether any additional control variety is now currently on the market and if it should be considered in this rulemaking. 86 FR 24516, 24523. In response, HI stated that it is not aware of any additional control methods. (HI, No. 112 at p. 4) NEEA recommended that in a future rulemaking, DOE consider the potential energy savings from domestic hot water controls, especially temperature-based controls. NEEA suggested that DOE consider providing a CEI credit for circulator pumps equipped with efficient temperature, on-demand, timer, or learning run-hour controls. (NEEA, No. 115 at p. 4)

DOE acknowledges that additional controls exist for circulator pumps that reduce run-time rather than reduce speed. DOE proposes to limit the promulgation of test methods in this rulemaking to those control varieties recommended by the CPWG, which include only controls that reduce speed, and may consider additional control varieties in future rulemakings. DOE discusses the concept of applying ''credits'' for on-demand controls in section III.B.5 of this document.

2. Reference System Curve

The May 2021 RFI 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. 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. 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. 86 FR 24516, 24523.

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. 86 FR 24516, 24523. The CPWG recommended that DOE incorporate a quadratic reference system curve, which intersects the BEP and has a static offset of 20 percent of BEP head, as shown in equation (3). (Docket No. EERE–2016–BT–STD–0004, No. 58 Recommendations #8 at pp. 6–7) 86 FR 24516, 24523.

$$H = \left[0.8 * \left(\frac{Q}{Q_{100\%}}\right)^2 + 0.2\right] * \mathrm{H}_{100\%} \quad \textbf{(3)}$$

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).
(Docket No. EERE–2016–BT–STD–0004, No. 58 Recommendations #8 at pp. 6–7); 86 FR 24516, 24523.

In the May 2021 RFI, DOE requested comment on whether the CPWG-recommended reference system curve shape, including the static offset, is reasonable for circulator pumps. 86 FR 24516, 24523. HI, Grundfos, and the CA IOUs agreed with the recommended reference curve. (HI, No. 112 at p. 4; Grundfos, No. 113 at p. 3; CA IOUs, No. 116 at p. 5).

DOE notes that the reference curve in equation (3) is 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). DOE has tentatively determined that the reference curve established for general pumps would provide representative results for circulator pumps. As such, DOE proposes to adopt the reference curve as shown in equation (3).

3. Pressure Control

As described in the May 2021 RFI, pressure controls are a variety of circulator pump control in which the variable speed drive is automatically adjusted based on the pressure in the system. For example, such controls are common in multi-zone hydronic heating applications where the flow and speed are adjusted in response to zones opening or closing. CPWG recommended that for all circulator pumps distributed in commerce with pressure controls, the PER_{CIRC} should be calculated as the weighted average input power at 25, 50, 75, and 100 percent of BEP flow with unique weights shown in equation (4):

$$PER_{CIRC} = \sum_{i} \omega_i \left(P_{in,i}\right) \quad \textbf{(4)}$$

Where:
PER_{CIRC} = 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.
(Docket No. EERE–2016–BT–STD–0004, No. 58 Recommendations #6A at pp. 4–5 and #7 at p.6); 86 FR 24516, 24523–24524.

The CPWG recommended the weights of 0.05, 0.40, 0.40, and 0.15 at test points of 25, 50, 75, and 100 percent of BEP flow, respectively, based on subcommittee review of other relevant test methods that document the typical load profile of hydronic heating and/or cooling applications, including AHRI 550/590–2011 ‘‘Performance Rating Of Water-Chilling and Heat Pump Water-Heating Packages Using the Vapor Compression Cycle,’’ ASHRAE 103 ‘‘Method of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers, and EN 16297–1:2012 ‘‘Pumps. Rotodynamic pumps. Glandless circulators. General requirements and procedures for testing and calculation of energy efficiency index (EEI),’’ as well as the fact that pumps with pressure controls will unlikely operate near BEP flow because systems are sized to be able to meet the full demand of the design day, which occurs only on rare occasion.[23]

In addition to the test point flow rates, the test method for pressure controls must also specify the head values (or range of head values) for evaluation. For pressure controls, the head values associated with the specified flow rates are determined by the control curve of the pressure control being evaluated. Traditional pressure controls typically follow a fixed, linear control curve that can represent maintenance of constant pressure at a variety of different flow rates, or can reduce the pressure as the flow is reduced. Often, a single circulator pump will be equipped with a number of different pressure control options, as illustrated in Figure III.1.

The CPWG recommended testing circulator pumps with pressure controls using automatic speed adjustment based on the factory selected control setting, manual speed adjustment, or simulated pressure signal to trace a factory selected control curve setting that will achieve the test point flow rates with a head at or above the reference system curve. (Docket No. EERE–2016–BT–STD–0004, No. 58 Recommendation #9 at p. 7) To test circulator pumps with pressure controls under this recommendation, manufacturers would select a pressure-based control curve for the purpose of the test procedure, provided that all of the head values that result from that are at or above the reference system curve discussed in section III.D.2. For example, Figure III.1 depicts three fixed pressure control options (low, medium, and high), but only the highest pressure control option results in head values that are all at or above the reference system curve. Under the CPWG's recommendation, the speed of the pump would be adjusted according to the selected control curve using one of three methods: Manual speed adjustment, simulated pressure signal, or automatic adjustment.

[23] This discussion took place during a CPWG subcommittee meeting, so there is no transcript in the docket. This presentation includes the results from the subcommittee: *https://www.regulations.gov/document/EERE-2016-BT-STD-0004-0027.*

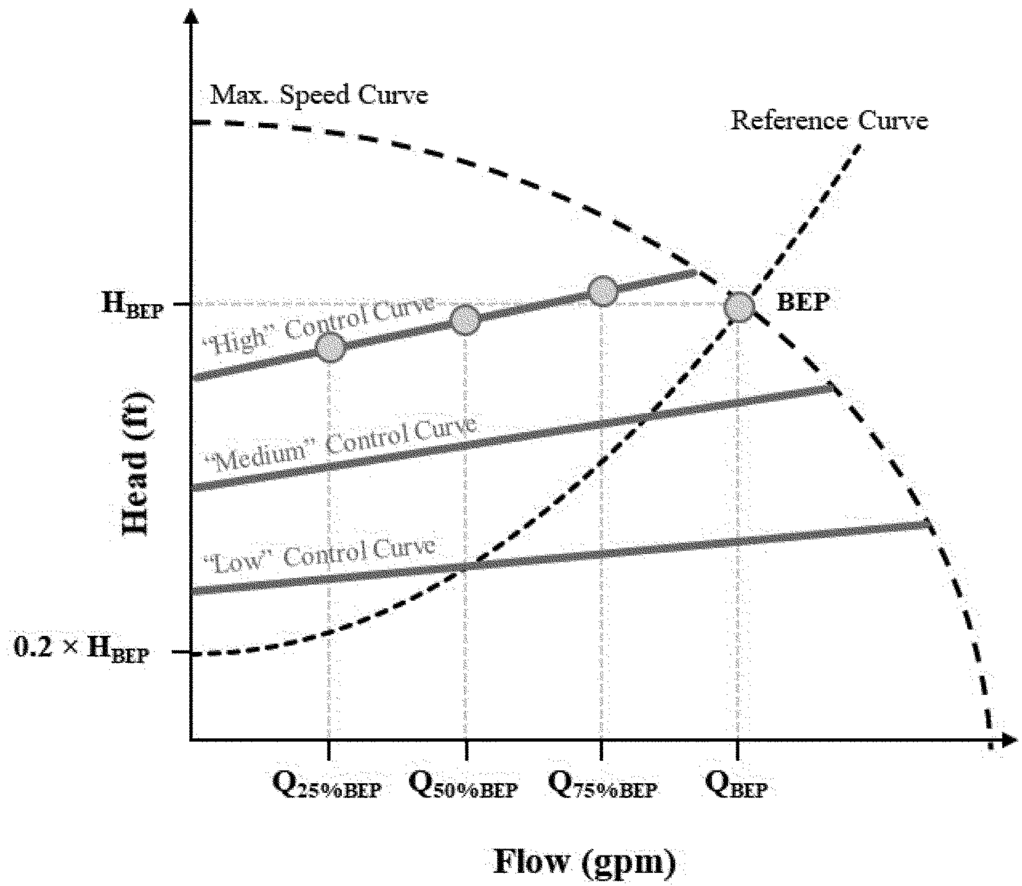

Figure III.1. Illustration of Testing of Pressure Controls with Multiple Control Curve Options

The CPWG also recommended that if a circulator pump with pressure controls is tested with automatic speed adjustment, that the pump can be manually adjusted to achieve 100 percent BEP flow and head point at max speed. (Docket No. EERE–2016–BT–STD–0004, No. 58 Recommendation #9 at p. 7); 86 FR 24516, 24524. DOE interpreted this to mean that the test point at 100 percent BEP flow and maximum speed may be generated using a combination of alternative speed control and throttling. This modification would be necessary in the event the manufacturer-selected control curve does not intersect the maximum speed pump curve at the BEP of the pump, as shown in Figure III.1. In such a case, the test point at 100 percent of BEP flow and maximum speed could be generated from the control curve at the maximum speed setting of the pump and throttled to reach the specific test point.

In the May 2021 RFI, DOE requested comment on the recommended test methods, test points, and weights for circulator pumps with pressure controls. 86 FR 24516, 24524.

HI recommended that DOE implement the testing methodology in HI 41.5–2021 section 41.5.3.4.2 for pressure control, which does not require all test points on a control curve to exist above the reference curve. Specifically, HI asserted that the minimum system control head should be the value at 25 percent BEP on the reference curve for the manual control (and pressure control) method. HI stated that it found that intersecting the pump curve at BEP and requiring the control mode to be above the reference curve was too limiting. HI asserted that this approach did not represent the controls available in the market, nor did it properly demonstrate the benefit of the onboard controls. HI stated that section 41.5.3.4.2 allows controls to be rated below the reference curve with power correction back to the reference curve. (HI, No. 112 at 4) HI stated that this change eliminates the need for all control curves to exist above the reference curve, allowing for a better presentation 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) HI provided an additional appendix in support of its recommendation for the changes. (HI, No. 112 at p.11–12) Grundfos recommended that DOE accept the approach defined in HI 41.5 for calculating CEI that allows for constant pressure control methods to be rated across the entire curve. (Grundfos, No. 113 at p. 2)

The CA IOUs stated that experiences with field testing the metric on circulator pumps in the market led to discovering unintended challenges of testing both constant and proportional pressure controls in most applications. The CA IOUs noted that these products generally operate at head pressure below or significantly below the reference curve at one or more measurement points; thus, most programmed pressure control curves in a product are not testable under the previous methodology. Some products do not have any pre-set control methods that meet all the requirements and thus must be tested as having no controls. The CA IOUs added that all of the below reference curve performance measurements remain valid after adjustment, since the adjustment uses an assumed constant efficiency calculation. The CA IOUs asserted that this ensures that products do not gain any arbitrary input power advantage from the head pressure below the reference curve adjustment. The CA IOUs stated that not addressing this issue would force DOE to grant numerous test procedure waivers. (CA IOUs, No. 116 at pp.2, 4–5)

DOE has reviewed the revised test method for pressure control in section 41.5.3.4.2 of HI 41.5–2021. DOE notes that HI 41.5–2021 does not include the CPWG recommendation to allow manual adjustment of automatic speed adjusted controls to achieve 100 percent BEP flow and head point at maximum speed (although this provision is included for adaptive pressure controls, discussed later in this section). As stated previously, DOE did not understand this recommendation to mean that the pressure control curve should intersect the pump curve at BEP, which HI noted in their comments was too limiting. However, section 41.5.3.4.2 #2a–c of HI 41.5–2021 in general allows for throttling in combination with any of the three recommended methods to adjust speed: Automatic speed adjustment based on the factory selected control setting, manual speed adjustment, or simulated pressure signal to trace a factory selected control curve setting. In addition, as noted by HI, HI 41.5–2021 also contains a requirement that the control curve setting must achieve 100 percent BEP flow of the reference curve. DOE understands this to mean that a control curve cannot include artificial limitations on speed. Otherwise, DOE understands that any control curve would be able to achieve 100 percent of BEP flow of the reference curve after intersecting with the maximum speed curve. Finally, DOE understands that the provision that the control must produce head equal to or greater than 25 percent of BEP head at a minimum of one test point is designed to limit testing of control curves that would not be viable in the field.

DOE agrees 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. DOE notes that in this proposal, all three curves depicted in Figure III.1 could be used in this test method. For all of these reasons, DOE is proposing a test method for circulator pumps with pressure controls consistent with the method included in HI 41.5–2021. Specifically, DOE proposes 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. DOE proposes 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. Additionally, DOE proposes that the CEI for circulator pumps with pressure controls be calculated with the unique weights and test points as shown in equation (4).

DOE requests comment on the proposed test method for circulator pumps with pressure controls, including whether DOE's interpretation of the new provisions in HI 41.5–2021 are accurate.

DOE is 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. DOE's interpretation HI 41.5–2021 is that these types of controls are not addressed in the industry standard. To test such controls, DOE proposes 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). If only the maximum or minimum head value can be adjusted, DOE proposes that only the adjustable setting would be adjusted. In either case, DOE also proposes that the settings can be adjusted for testing only if they are adjustable by the user. DOE believes 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. DOE notes that further adjustment to attain 100 percent of BEP head would be required.

In summary, for adjustable pressure controls with user-adjustable maximum and/or minimum head values, DOE proposes 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 requests 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.

The CPWG also identified a specific style of pressure control that adapts the control curve setting dynamically to the system in which it is installed; the CPWG referred to this style of pressure control as adaptive pressure controls. (Docket No. EERE–2016–BT–STD–0004, No. 72 at p. 45) As discussed in the introduction to section III.D, 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. The CPWG noted that current adaptive pressure controls are learning-based controls that gradually adjust the pressure control set point over time based on the needs of the system. (Docket No. EERE–2016–BT–STD–0004, No. 72 at pp. 45–46) As such, the CPWG recommended separate test methods for pressure controls and adaptive pressure controls, noting the difference in operation and control logic between the control varieties. (Docket No. EERE–2016–BT–STD–0004, No. 73 at p. 176) Specifically, the CPWG discussed that since adaptive pressure controls gradually adjust the control curve over time to optimize the pressure control performance for the system in which it is installed, the test method specified for circulator pumps with pressure controls was not applicable because there is no fixed pressure control curve that can be evaluated. (Docket No. EERE–2016–BT–STD–0004, No. 72 at pp. 45–46) Instead, adaptive pressure controls have a control ''area'' that is defined by a minimum head value (H_{auto_min} and H_{set_min}), the maximum speed pump curve, and a maximum head value (H_{set}), as depicted in in Figure III.2.

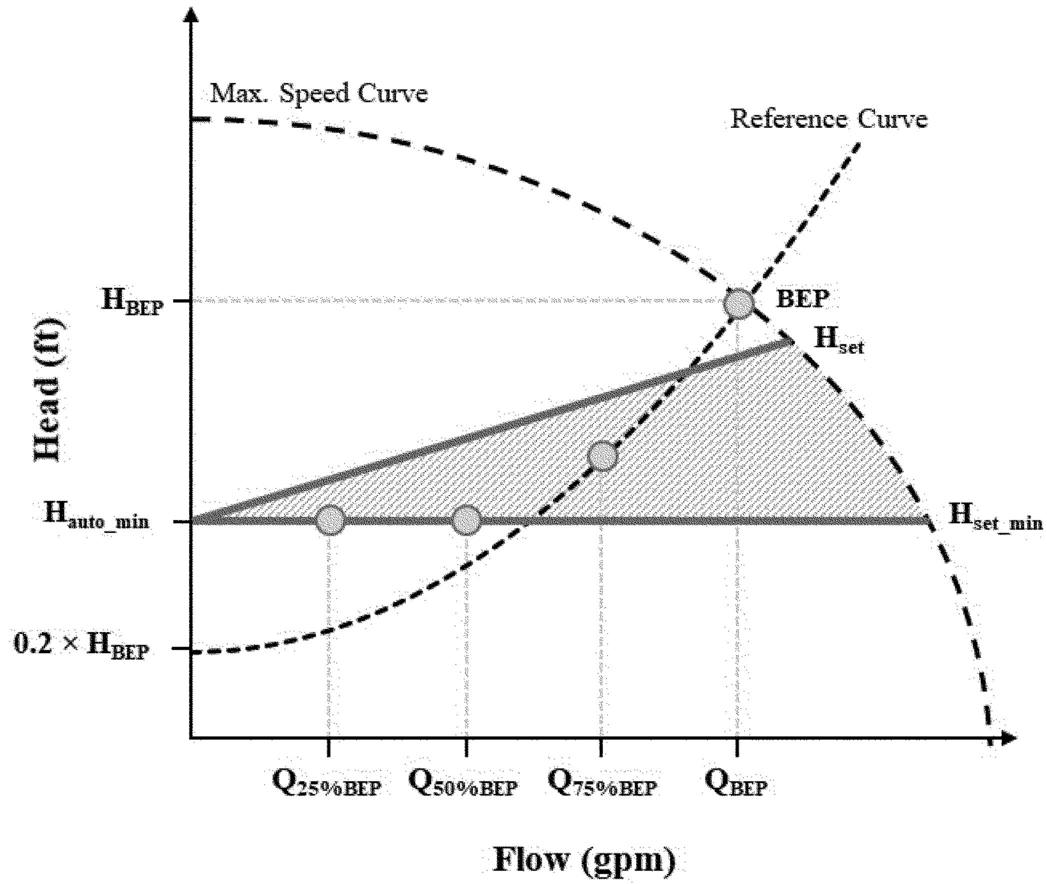

Figure III.2 Most Common Adaptive Control Operating Conditions and Proposed Test Method Test Points

Within the adaptive pressure control ''area,'' a multitude of different control curves may be selected based on the detected system head requirements. Therefore, the CPWG discussed the need to specify the ''control curve'' within an adaptive pressure control's control area along which such controls would be evaluated. (Docket No. EERE–2016–BT–STD–0004, No. 66 at pp. 95–98) For circulator pumps with adaptive pressure controls, the CPWG recommended that testing be conducted at the minimum thresholds for head based on manufacturer literature and through manual speed adjustment to achieve the test point flow rates with head values at or above the reference curve. (Docket No. EERE–2016–BT–STD–0004, No. 58 Recommendation #9 at p. 7); 86 FR 24516, 24524.

For example, in Figure III.2, the CPWG recommended test method would result in minimum head thresholds of H_{auto_min} at no flow conditions and H_{set_min} at maximum flow, essentially the bottom edge of the adaptive pressure control area. However, DOE notes that the CPWG also specified that the test points could not be below the reference system curve (specified in section III.D.2), similar to pressure controls. Therefore, the CPWG discussed how adaptive pressure controls would be tested through manual speed adjustment to test points that are at or above the reference system curve or minimum head thresholds of the adaptive pressure control area, whichever is greater. (Docket No. EERE–2016–BT–STD–0004, No. 66 at pp. 95–98) This results in, for example, the test points denoted with the circles along the minimum pressure setting curve and the reference system curve in Figure III.2.

In response to the May 2021 RFI, DOE requested comment on the recommended test methods, test points, and weights for circulator pumps with adaptive pressure controls. 86 FR 24516, 24524.

In response, the CA IOUs encouraged DOE to incorporate representative field data for adaptive controls in a future test method, asserting there may be a minimal relationship between the preloaded defaults or reference curve and the eventual operating points of these devices in the field, in aggregate. The CA IOUs further recommended that DOE collaborate with industry to develop test procedures for these units to capture energy savings occurring in the overall marketplace. (CA IOUs, No. 116 at p. 7)

Grundfos commented that adaptive pressure control should not be an allowed test method in DOE's regulations. Grundfos stated that adaptive pressure controls cannot be tested in the way they operate. Grundfos commented that because the recommended test procedure would allow such pumps to be manually adjusted to the reference curve, a manufacturer could state that any product has adaptive pressure controls and test the product in a manner that is not aligned with actual performance. (Grundfos, No. 113 at p. 3)

DOE notes that the test method for such controls in HI 41.5–2021 (section

41.5.3.4.2 #4) is consistent with the CPWG recommendation. Section 41.5.3.4.2 #4 also allows for manual adjustment to achieve 100 percent BEP flow and head point at max speed.

In response to Grundfos, DOE notes that, as recommended by the CPWG, the proposed test procedure would require minimum head thresholds to be documented in the manufacturer literature associated with the given circulator pump model and be accessible based on the capabilities of the control with which the pump is distributed in commerce. That is, the minimum head thresholds may be manually set before testing the pump (similar to adjustable pressure controls), but such adjustment must be possible on the control with which the circulator pump is distributed in commerce and described in the manufacturer's literature. DOE believes this would ensure that the evaluated control threshold is representative of minimum head values that are realized in the field.

In response to the CA IOUs, DOE welcomes additional field data that could provide more information to support a future update of any finalized adaptive control test method. Based on the information currently available, DOE has tentatively determined that the adaptive pressure control test method recommended by the CPWG and proposed in this NOPR is reasonably designed to reflect energy use under typical operating conditions.

In summary, consistent with HI 41.5–2021, for adaptive pressure controls, DOE proposes 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 proposes 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.

DOE requests 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 requests comment on the HI 41.5–2021 provision for manual adjustment to achieve 100 percent BEP flow and heat point at max speed, which is not included for other pressure controls.

4. Temperature Control

As previously discussed and as presented in the May 2021 RFI, 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 24516, 24524.

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); 86 FR 24516, 24524.

As temperature controls serve similar hydronic heating applications as pressure controls, the CPWG assigned the same weights, which are representative of the loads the circulator pump is serving. (Docket No. EERE–2016–BT–STD–0004, No. 70 at pp. 113–115) Specifically, for circulator pumps with temperature controls, the CPWG recommended weights of 0.05, 0.40, 0.40, and 0.15 at test points of 25, 50, 75, and 100 percent of BEP flow, respectively. (Docket No. EERE–2016–BT–STD–0004, No. 58 Recommendation #7 at p.6)

Since circulator pumps with temperature controls are not limited by head requirements present in pressure controls and can match the required speed to meet the demand of the system, the head values at the specified flow rates of 25, 50, 75, and 100 percent of BEP flow are not dictated by the control curve logic. As such, the temperature control is able to achieve the exact head values at each flow rate described by the reference system curve (discussed in section III.D.2). Assuming the reference system curve represents a typical system, testing temperature controls along the reference system curve represents their likely performance because temperature controls have the ability to sense and respond precisely to the load on the system.

In addition to the test points, the CPWG also discussed how circulator pumps with temperature control should be controlled during testing. The CPWG discussed how testing temperature controls using conditioned water would be extremely burdensome and expensive. The CPWG discussed that providing less burdensome options for testing would represent a reasonable compromise to reduce the burden associated with testing temperature controls, while still resulting in representative energy performance ratings. (Docket No. EERE–2016–BT–STD–0004, No. 70 at pp. 282–288) Therefore, the CPWG recommended that circulator pumps with temperature controls be tested based on manual speed adjustment or with a simulated temperature signal to activate the temperature-based control to achieve the test point flow rates with a head at or above the reference curve. (Docket No. EERE–2016–BT–STD–0004, No. 58 Recommendation #9 at p. 7); 86 FR 24516, 24524.

In the May 2021 RFI, DOE requested comment on the recommended test methods, test points, and weights for circulator pumps with temperature controls. Specifically, DOE requested comment on whether the technology or market for such controls has changed sufficiently since the term sheet to warrant a different approach. 86 FR 24516, 24524.

HI stated that it was not aware of any technical or market changes. (HI, No. 112 at p. 4) Grundfos stated that temperature control is a form of external control (*i.e.,* temperature sensor input to the controller), and that therefore, temperature control should be removed and included as part of external control for testing purposes. Grundfos suggested, however, that in this case manufacturers should be allowed to identify temperature control on their products. (Grundfos, No. 113 at p. 3–4)

DOE notes that the temperature control test method recommended by the CPWG is consistent with that in section 41.5.3.4.3 of HI 41.5–2021. In response to Grundfos, DOE notes that 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) DOE also notes 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. 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. The reasons for this difference are discussed in section III.D.6. As such, DOE proposes to remain consistent with the CPWG recommendations and HI 41.5–2021 regarding specification of a temperature control test method.

DOE tentatively determines that the CPWG 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 proposes 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 proposes to use the weights and test points shown in equation (4) for circulator pumps distributed in commerce with temperature controls.

DOE requests comment on the proposed test methods, test points, and weights for circulator pumps with temperature controls.

5. Manual Speed Control

As discussed previously and as stated in the May 2021 RFI, manual speed controls are a control variety for which the speed of the pump is adjusted manually, typically to one of several pre-set speeds, by a dial or a control panel to fit the demand of the system within which it is installed. The CPWG discussed how circulator pumps installed with manual speed controls are typically only adjusted one time upon installation, if at all, and will operate at that set speed as if it were a single-speed circulator pump. As such, many manual speed control circulator pumps operate at full speed in the field, while a portion of them may be turned down to a medium or low speed to suit the needs of the systems. (Docket No. EERE–2016–BT–STD–0004, No. 65 at pp. 131–133); 86 FR 24516, 24524.

Therefore, the CPWG recommended to test circulator pumps with manual speed controls 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) based on manual speed adjustment to the lowest speed setting that will achieve a head at or above the reference curve at the test point flow rate for the reduced speed input power values. (Docket No. EERE–2016–BT–STD–0004, No. 58 Recommendation #9 at p. 7); 86 FR 24516, 24524.

To accomplish a single rating representative of the ‘‘average’’ energy use of a manual speed circulator, the CPWG recommended that for circulator pumps distributed in commerce with manual speed controls, the PER_{CIRC} should be calculated as the weighted average of $P_{in,max}$ (the weighted average input power at specific load points across the maximum speed curve) and $P_{in,reduced}$ (the weighted average input power at specific load points at reduced speed), but recommended separate load points and speed factors, as shown in equations (5), (6), and (7):

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

Where:

PER_{CIRC} = circulator pump energy rating (hp);

z_{max} = speed factor weight of 0.75;

P_{in_max} = weighted average input power at maximum rotating speed of the circulator (hp), as specified in equation (6);

$z_{reduced}$ = speed factor weight of 0.25; and

$P_{in\_reduced}$ = 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.

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

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 and head values at or above the reference curve.

(Docket No. EERE–2016–BT–STD–0004, No. 58 Recommendation #6B and 7 at pp. 5–6); 86 FR 24516, 24524–24525.

The CPWG specified the speed factor for maximum speed (z_{max}) and reduced speed ($z_{reduced}$) to represent the likelihood that the circulator pump would operate at maximum versus reduced speed, or the likelihood that an installer would turn down the speed of the circulator pump in the field. The CPWG concluded that about 75 percent of the time, circulator pumps with manual speed controls are operated at maximum speed. (Docket No. EERE–2016–BT–STD–0004, No. 71 at p. 377) Therefore, the CPWG recommended that the speed factor for maximum speed (z_{max}) should be 0.75 and the speed factor for reduced speed ($z_{reduced}$) should be 0.25. (Docket No. EERE–2016–BT–STD–0004, No. 58 Recommendation #7 at p. 6)

The CPWG concluded that when a circulator pump with manual speed control is installed and set to maximum speed, it operates like a single-speed pump and should receive the same weighting as a circulator pump with no controls for the maximum speed weights, represented as w_{i_max} in equation (6). (Docket No. EERE–2016–BT–STD–0004, No. 70 at pp. 183–184) For the weights associated with reduced speeds using manual speed controls, the CPWG concluded that equal weighting of 0.3333 for each of the reduced speed points of 25, 50, and 75 percent of BEP flow at maximum speed would best represent the ‘‘average’’ performance of the manual speed circulator pump at reduced speed, represented as $w_{i\_reduced}$ in equation (7). (Docket No. EERE–2016–BT–STD–0004, No. 71 at pp. 433–437)

DOE requested comment on the CPWG-recommended test method and the unique test points, weights, and speed factors for circulator pumps distributed in commerce with manual speed controls. Specifically, DOE requested comment on whether the technology or market for such controls has changed sufficiently since the term sheet to warrant a different approach. 86 FR 24516, 24525.

Grundfos recommended that DOE remove manual speed control from the regulation, stating that these pumps should be tested as circulator pumps with no control. (Grundfos, No. 113 at p. 4) Grundfos asserted that these devices are not manually controlled in real application and are simply set at a desired speed, violating the intention of energy savings and the intention of the ability to reduce speed during operation. (Grundfos, No. 113 at p. 3)

DOE notes that the CPWG specifically 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. (Docket No. EERE–2016–BT–STD–0004, No. 70 at p. 201–202) As stated previously, 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 proposes to include manual speed control as a test method in the circulator pump test procedure.

HI recommended using the modified testing methodology in HI 41.5–2021 section 41.5.3.4.5 for manual speed control. Specifically, HI believes the minimum system control head should be the value at 25 percent BEP on the reference curve for the manual control (and pressure control) method. HI described its findings that intersecting the pump curve at BEP and requiring the control mode to be above the reference curve was too limiting. HI asserted that this did not represent the controls available in the market, nor did it properly demonstrate the benefit of the onboard controls. HI commented that section 41.5.3.4.5 allows controls to be rated below the reference curve with power correction back to the reference curve. (HI, No. 112 at 5) HI stated that this change eliminates the need for all control curves to exist above the reference curve, allowing for a better presentation 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)

The Advocates supported the update in HI 41.5–2021 that includes a modification to correct for test data below the reference curve, stating that this improves representativeness for many circulator pump models. (Advocates, No. 114 at pp. 1–2) As stated previously, NEEA generally supported adopting HI 41.5–2021 as the test method for pumps, which incorporates these modifications discussed by HI and the Advocates. (NEEA, No. 115 at p. 4)

DOE tentatively determines the CPWG recommendations regarding the test method 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. However, DOE understands that through stakeholders' experience with using this test method, certain changes to the term sheet recommendations would improve representativeness by capturing the benefit of onboard controls available in the market. Therefore, DOE proposes 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 proposes 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), but with removal of the requirements for test points to be at or above the reference curve. DOE notes that HI 41.5–2021 section 41.5.3.4.5 #3 still retains that provision, which DOE assumes to be an error based on HI's comments and recommendations in response to the May 2020 RFI.

DOE also notes 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 also believes this provision is superfluous as manual speed controls by definition do not require an external input signal.

DOE requests 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.

6. External Input Signal Control

As discussed previously and as stated in the May 2021 RFI, the final control variety considered by the CPWG was external input signal controls. External input signal controls are controls in which the device that responds to the stimulus, or the primary control logic, is external to the circulator pump. Unlike pressure and temperature 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 part of 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. 84) 86 FR 24516, 24525.

For circulator pumps that have only an external input signal control, the CPWG recommended testing along the reference control curve to achieve the test point flow rates with a head at or above the reference system curve with the same weights as temperature and pressure controls, as shown in equation (4). The CPWG recommended that, in order to ensure that the rating was representative of the performance of such pumps, the external input signal control must be the only control mode that can be used with the circulator pump, and the circulator pump must not be able to operate without an external input signal. (Docket No. EERE–2016–BT–STD–0004, No. 58 Recommendations #9 at pp. 7–8); 86 FR 24516, 24525.

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). The CPWG recommended testing circulator pumps with external input signal controls similar to manual speed controls. (Docket No. EERE–2016–BT–STD–0004, No. 47 at p. 480) Specifically, the CPWG recommended testing a circulator pump sold with external input signal controls and another control variety with a simulated signal 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 using a simulated signal to the lowest speed setting that will achieve a head at or above the reference curve at the test point flow rates for the reduced speed input power values. (Docket No. EERE–2016–BT–STD–0004, No. 58 Recommendation #9 at pp. 7–8); 86 FR 24516, 24525.

As such, the CPWG recommended that for circulator pumps distributed in commerce with external input signal controls among other control varieties, the PER_{CIRC} should be calculated as the weighted average of $P_{in,max}$ (the weighted average input power at specific load points across the maximum speed curve) and $P_{in,reduced}$ (the weighted average input power at specific load points at reduced speed), similar to circulator pumps with manual speed control, as shown in equation (8), (9), and (10):

$$PER_{CIRC} = z_{max}\left(P_{in_{max}}\right) + z_{reduced}\left(P_{in_{reduced}}\right) \quad \textbf{(8)}$$

Where:

PER_{CIRC} = 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);

$Z_{reduced}$ = weighted average input power at reduced rotating speed of the circulator (hp).

$$P_{in_{max}} = \sum_i \omega_{i_{max}}\left(P_{in,i_{max}}\right) \quad \textbf{(9)}$$

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.

$$P_{in_{reduced}} = \sum_i \omega_{i_{reduced}}\left(P_{in,i_{reduced}}\right) \quad \textbf{(10)}$$

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, 75 percent of the flow at BEP of max speed and head values at or above the reference curve.

(Docket No. EERE–2016–BT–STD–0004, No. 58 Recommendations #6B and #7 at pp. 5–6); 86 FR 24516, 24525–24526.

The CPWG recommended the speed factors of 0.30 at maximum speed and 0.70 at reduced speed in order to produce a rating on an equivalent basis as that of a circulator pump with a typical differential pressure control. (Docket No. EERE–2016–BT–STD–0004, No. 58 Recommendation #7 at p. 6). In addition, these speed factors would represent the likelihood that a circulator pump with an external input signal control is selected to operate with that external input signal control, and whether the signal it receives results in the circulator pump reducing speed. 86 FR 24516, 24526.

DOE requested comment on the CPWG-recommended test method for circulator pumps distributed in commerce with only external input signal controls, as well as for those distributed in commerce with external input signal controls in addition to other control varieties. Specifically, DOE requested comment on whether the technology or market for such controls has changed sufficiently since the term sheet to warrant a different approach. 86 FR 24516, 24526.

HI stated that it is not aware of any technical or market changes. (HI, No. 112 at p. 5). As stated previously, Grundfos recommended that external input and temperature controls be tested in the same way, with labeling to differentiate these control methods for consumer purposes. Grundfos stated that the functional characteristics are the same between both methods. (Grundfos, No. 113 at p. 4) DOE addressed this comment in section III.D.4.

DOE notes that the CPWG-recommended test method for circulator pumps distributed in commerce with only external input signal controls is generally consistent with that found in section 41.5.3.4.4 of HI 41.5–2021. HI 41.5–2021 contains additional specifications not found in CPWG recommendations that, for circulator pumps with only external input signal control, manual speed adjustment or simulated external input signal can be used to achieve the relevant flow rates (section 41.5.3.4.4.1 #2). DOE also notes that the CPWG-recommended test method for circulator pumps distributed in commerce with external input signal controls in addition to other control varieties is mostly consistent with that found in section 41.5.3.4.4.2 of HI 41.5–2021. However, where the CPWG recommendations specify testing using a simulated signal, whereas HI 41.5–2021 specifies testing using manual speed adjustment (section 41.4.3.4.4.2 #2). In addition, HI 41.5–2021 does not specify using the lowest speed setting that results in a head value at or above the reference system curve; rather, it specifies to manually adjust the speed to achieve the specified flow rates with head at or above the reference control curve (section 41.4.3.4.4.2 #2).

DOE proposes to specify a test method for circulator pumps sold only with external input signal control and that cannot operate without an external input signal. Specifically, DOE proposes 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). DOE also proposes 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 proposes that in either case, either manual speed adjustment or simulated external input signal can be used to achieve the relevant flow rates. DOE is not proposing that the speed adjustment include the ‘‘lowest speed setting’’ that results in a head value at or above the reference system curve; however, DOE addresses this issue in its enforcement provision proposals (section III.F.2). Finally, DOE proposes 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).

Based on consideration of the CPWG recommendations and stakeholder comments, DOE tentatively concludes that the proposed test provisions for circulator pumps distributed in commerce with external input signal controls would produce representative results for such equipment and would not be unduly burdensome to conduct.

DOE requests 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. In particular, DOE requests 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. DOE also seeks comment on whether it is necessary to reference the ‘‘lowest speed setting’’ when determining the appropriate test points. Finally, DOE seeks 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.

7. No Controls

As discussed previously and as stated in the May 2021 RFI, for circulator pumps with no controls,[24] the CPWG recommended testing the pump along the maximum speed circulator pump curve to achieve the test point flow rates of 25, 50, 75, and 100 percent of BEP flow. (Docket No. EERE–2016–BT–STD–0004, No. 58 Recommendation #9 at p. 7); 86 FR 24516, 24526.

The CPWG also recommended that for circulator pumps distributed in commerce without manual speed controls, pressure controls, temperature controls or external input signal controls, PER_{CIRC} should be calculated with the unique weights and test points as shown in equation (11):

[24] 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.

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

Where:
PER_{CIRC} = 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.
(Docket No. EERE–2016–BT–STD–0004, No. 58 Recommendation #6A at pp. 4–5); 86 FR 24516, 24526.

The CPWG recommended the 0.25 weights at each test point (*i.e.,* 25, 50, 75, and 100 percent of the flow at BEP) in order to account for the variety of systems and operating points a single-speed circulator pump may encounter. (Docket No. EERE–2016–BT–STD–0004, No. 70 at pp. 172–173); 86 FR 24516, 24526.

DOE requested comment on the CPWG-recommended test methods, test points, and weights for circulator pumps with no controls. 86 FR 24516, 24526.

HI stated that it is not aware of any changes; however, HI recommended that DOE change the term ''no controls'' to ''full speed'' to ensure market clarity and align with common terminology. (HI, No. 112 at p. 5) Grundfos also recommended that DOE change this name to Full Speed to clarify the intent of the testing and make it clear that this test method is only to define the baseline circulator pump CEI and is not a qualified control method for rating a circulator pump by itself. (Grundfos, No. 113 at p. 4)

DOE notes that the CPWG recommended test method for circulator pumps with no controls is consistent with that in section 41.5.3.4.1 of HI 41.5–2021 (''Determination of CER—Full Speed''). In response to Grundfos, DOE notes that the ''no controls'' test method as recommended by the CPWG and as proposed in this NOPR is a test method for rating a pump that does not have any of the other controls for which a test method is specified. DOE proposes to define this test method separately from the calculation to determine the CER_{STD}. In response to HI, DOE understands that as part of the HI Energy Rating program, manufacturers are using the no controls test to determine the most consumptive rating for their pumps. Therefore, in order 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 proposes 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 proposes additional language in the scope section regarding this clarification.

Consistent with the recommendations of the CPWG, DOE proposes 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 agrees 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 proposes to use equation (11) with the unique weights and test points to test circulator pumps with no controls, with nomenclature updated from PER_{CIRC} to CER.

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

E. Determination of Circulator Pump Performance

As stated in the May 2021 RFI, 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)

Two updated versions of HI 40.6—HI 40.6–2016 and HI 40.6–2021—have been published since the CPWG meetings concluded. Section III.E.1 discusses HI 40.6–2021, the industry standard, which DOE proposes to incorporate by reference, for measuring the performance of circulator pumps, noting the changes made from the previous version of HI 40.6–2014. DOE believes 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) 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 proposes 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).

1. Incorporation by Reference of HI 40.6–2021

As stated in the May 2021 RFI, in 2016, HI published an updated industry standard, HI 40.6–2016, ''Methods for Rotodynamic Pump Efficiency Testing'' (''HI 40.6–2016''). 86 FR 24516, 24526. This update aligned the definitions and procedures described in HI Standard 40.6 with the DOE test procedure for pumps published in the January 2016 TP final rule. Appendix A to subpart Y to 10 CFR part 431. In the September 2020 Early Assessment RFI for pumps, DOE requested comment on the potential effect of incorporating HI 40.6–2016 by reference as the DOE test procedure for pumps. 85 FR 60734, 60737. Grundfos, NEEA, and HI commented that HI expects to publish another standard update in 2021 and urged DOE to incorporate by reference HI 40.6–2021 rather than HI 40.6–2016 (Grundfos, Docket No. EERE–2020–BT–TP–0032, No. 07 at p. 2; NEEA, Docket No. EERE–2020–BT–TP–0032, No. 08 at p. 6; HI, Docket No. EERE–2020–BT–TP–0032, No. 06 at pp. 1, 3). HI specified that HI 40.6–2016 included updates to match DOE's test procedure for pumps, and that HI 40.6–2021 would further include editorial revisions and would add circulator pump testing, and also would not impact measured values, burden, or representativeness. (HI, Docket No. EERE–2020–BT–TP–0032, No.06 at p. 3); 86 FR 24516, 24526. At the time of the May 2021 RFI development, HI 40.6–2021 was not yet published.

In the May 2021 RFI, DOE sought comment and feedback on whether HI 40.6–2016 or HI 40.6–2021 is an appropriate test method for conducting wire-to-water testing of circulator pumps, as recommended by the CPWG. In addition, DOE sought comment on whether the modifications in HI 40.6–2016 and/or HI 40.6–2021 adequately capture the CPWG recommended modifications in Recommendation #10. 86 FR 24516, 24526.

HI stated that HI 40.6–2021 should be incorporated by reference and that the 2021 edition modified the 2016 version only to add specific testing requirements for circulator pumps. (HI, No. 112 at p. 5) Grundfos also stated that DOE should accept HI 40.6–2021 for incorporation into the regulation and that it provides appropriate testing methods as defined by the CPWG. Grundfos also stated that there were some specific deviations from Recommendation #10 with respect to ''Relevant Parameters at Specific Load Points.'' Specifically, Grundfos stated that while implementing the industry rating program, manufacturers identified that requiring all tested flow points to be within ±10 percent of the reference curve was not feasible for pressure control, especially when operating at constant pressure at heads below the BEP head. Grundfos further stated that the HI committee made modifications to this recommendation in HI 41.5 that preserve the integrity of the calculation of efficiency and allow for these products to be properly tested and labeled. (Grundfos, No. 113 at p. 4–5)

NEEA, the Advocates, and the CA IOUs recommended that DOE adopt HI 41.5–2021 as the test method for circulator pumps. (NEEA, No. 115 at p. 4, Advocates, No. 114 at p. 1, CA IOUs, No. 116 at p. 2) The Advocates stated that an update to the program guideline, HI 41.5–2021, includes a modification to correct for test data below the reference curve and that they understand that this change improves representativeness for many circulator pump models and is consistent with the intent of the term sheets. They also stated that HI 41.5–2021 includes additional minor modifications to improve accuracy and clarity. (Advocates, No. 114 at pp. 1–2) Similarly, NEEA stated that HI 41.5–2021 includes slight modifications from the original term sheet for testing with pressure controls that operate below the reference curve, and that the modifications provide more representative values. (NEEA, No. 115 at p.4)

China made several requests related to specific provisions in the HI 40.6 test procedure. China commented that DOE should present the information related to pump test acceptance grades and corresponding tolerance, referring to Table 8 of part 4.4.1 and the provision of part 4.4.2 in ISO 9906:2012. China recommended that DOE clarify the scientific basis of the selection of the 7 test points which are 40, 60, 75, 90, 100 and 120 percent of the flow rate at the expected BEP. China further recommended that DOE clarify the efficiency testing method for integrated design products of electric pumps. (China, No. 111 at p. 3)

Since publication of the May 2021 RFI, HI has published HI 40.6–2021. DOE has 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,[25] volume per unit time,[26] pump total head,[27] and other relevant quantities, which are essential to determining the metric.

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 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 notes 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 has reviewed HI 40.6–2021 with respect to the minor modifications listed by the CPWG in Recommendation #10. DOE has 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. These provisions are discussed in section III.E.2.c of this NOPR. The recommendations for rounding values for calculation and reporting purposes are not addressed in HI 40.6–2021 or HI 41.5–2021; DOE discusses these provisions in section III.E.2.d of this document.

In response to NEEA, the Advocates, and the CA IOUs, DOE does not propose to incorporate by reference HI 41.5–2021 as the test method for circulator pumps, as noted in section II. DOE instead proposes to rely on the industry test standard, HI 40.6–2021, with additional provisions in regulatory text consistent with HI 41.5–2021.

In response to China, with respect to section 40.6.4.4 of HI 40.6–2021, DOE notes that HI 40.6–2021 provides methods to determine energy efficiency as opposed to guaranteeing certain performance (*e.g.,* pump head, flow, power, or efficiency) in a particular application. As such, acceptance grades are not relevant. However, HI 40.6–2021 does define permissible fluctuations in Table 40.6.3.2.2. With respect to the test points in 40.6.5.5.1, DOE discusses these further in section III.E.2.c of this document.

With respect to section 40.6.3 of HI 40.6–2021 and the efficiency testing method of integrated design products of

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

[26] 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.*''

[27] 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.

electric pumps, DOE is not clear what is meant by ''integrated design products.'' However, section 40.6.4.4 of HI 40.6–2021 discusses determination of pump overall efficiency of a motor pump unit or a complete pump (*i.e.,* bare pump, mechanical equipment, driver and drive coupled together and treated as an integral unit). In addition, Appendix E of HI 40.6–2021 specifies that for circulator pumps, all power measurements must be measured inclusive of the driver, or driver and controls when applicable, and refers to section 40.6.4.4.

After considering stakeholder comments, DOE proposes to incorporate HI 40.6–2021, inclusive of Appendix E, for the purposes of testing circulator pumps, including the minor modifications and additions discussed previously. However, DOE also proposes to exclude certain sections of HI 40.6–2021 that are not relevant to determining the CEI of tested circulator pumps, as discussed in section III.E.2.a. Additionally, there are specifications that the CPWG recommended for the circulator pump test procedure that are not included in HI 40.6–2021, including test arrangements for twin-head circulator pumps and circulators-less-volute specific procedures for calculating the CEI and rounding of values. DOE also discusses determination of driver power input at specified load points, as included in HI 40.6–2021 and HI 41.5–2021, as compared to the CPWG recommendations. These modifications and additions are discussed in sections III.E.2.b through III.E.2.d of this document.

DOE requests comment on the proposal to incorporate by reference HI 40.6–2021, inclusive of Appendix E, into the proposed appendix D to subpart Y, with the exceptions, modifications, and additions described in section III.E.2 of this document.

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

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 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. In addition, DOE proposes 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.

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

Although DOE is incorporating by reference HI 40.6–2021 as the basis for its test procedure, DOE notes that 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.

DOE is not proposing to 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.

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 circulated pump test procedure, rated or nominal speeds are not relevant, as DOE is not proposing 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 is not proposing 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 is not proposing to reference 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.

DOE also proposes to exclude section 40.6.5.3, ''Test report,'' that 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 would propose specific certification and reporting requirements for circulator pumps as part of an energy conservation standard rulemaking, should such standards be proposed.[28]

Finally, DOE proposes to exclude 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.

In summary, for the reasons stated previously, DOE is not proposing to reference 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.

In addition, DOE notes that Appendix E of HI 40.6–2021 includes modifications to testing in section 40.6.5.5.1 and 40.6.6.3, as discussed in section III.E.2.c of this NOPR. DOE is proposing to reference HI 40.6–2021 inclusive of Appendix E and the modifications therein.

DOE requests comment on its proposal to not reference 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.

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

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. HI 40.6–2014 does not specify the procedures for testing twin head circulator pumps. In the May 2021 RFI, DOE noted that the CPWG recommended that to test twin head circulator pumps, one of the two impeller assemblies is to 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. (Docket No. EERE–2016–BT–STD–0004, No. 58 Recommendation #11 at p. 9); 86 FR 24516, 24526–24527.

In the May 2021 RFI, DOE sought comment on whether the

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

recommendation for testing twin-head circulator pumps had been adequately addressed in HI 40.6–2021. 86 FR 24516, 24527. HI stated that in HI 41.5–2021, section 41.5.3 specifies the testing of twin head pumps and refers to HI 40.6 as the testing standard to be used. HI also noted that in section 41.5.1.5.1, the approach for testing twin head circulator pumps aligns with Recommendation #11 from the CPWG. (HI, No. 112 at p. 5) Grundfos commented that HI 40.6 does not directly address twin-head or volute-less products and that DOE would need to specify the testing requirements for these product variants. Grundfos further commented that HI 41.5.3 does identify how to test a twin-head circulator pump and is aligned with the current twin-head testing process that DOE established for IL products in 10 CFR part 431 subpart Y. (Grundfos, No. 113 at p. 5)

DOE has reviewed the test specification for twin head circulator pumps and proposes the test specifications recommended by the CPWG for twin head circulator pumps, which is consistent with section 41.5.3 of HI 41.5–2021 and with stakeholder comments. This proposed treatment of twin head circulator pumps would be consistent with the treatment of twin head pumps in the general pumps test procedure at appendix A to subpart Y of part 431.

DOE requests comment on the proposed test procedure for twin head circulator pumps.

As discussed in section III.B.4, 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. HI 40.6–2014 did not specify procedures for testing circulators-less-volute. As stated in the May 2021 RFI, the CPWG recommended that to test circulators-less-volute, the circulator-less-volute should be paired with the specific volute(s) with which the circulator pump is advertised to be paired, based on manufacturer's literature, to determine the CEI rating for each circulator-less-volute and volute combination. (Docket No. EERE–2016–BT–STD–0004, No. 58 Recommendation #12 at p. 9); 86 FR 24516, 24527.

In the May 2021 RFI, DOE sought comment on whether the recommendation for circulators-less-volute had been adequately addressed in HI 40.6–2021. 86 FR 24516, 24527. Grundfos stated that HI 40.6 does not directly address volute-less products and that DOE would need to define the testing requirements for this product variant. For testing of circulating pumps without volutes, Grundfos stated that a ''reference volute'' can be used for testing purposes, in which the manufacturer defines the volute to be used during testing, and that this same process is used in the regulated EU market. (Grundfos, No. 113 at p. 1–2, 5) China stated that the test method of circulator-less-volute pumps has not been specified and that DOE should define the test method for these pumps. (China, No. 111 at p. 3)

DOE notes that HI 41.5–2021 does not address circulators-less-volute. As such, DOE is proposing instructions for testing circulators-less-volute. Specifically, consistent with CPWG recommendations and Grundfos' comment, DOE proposes that the circulator-less-volute would be paired with specific volute(s) 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 recognizes that circulators-less-volute may be offered for sale or advertised to be paired with multiple volutes, and that each combination may have a different CEI. Since each of these volutes may impact the CEI rating, each volute and circulator-less-volute pairing would represent a unique pairing. Therefore, DOE proposes that the CEI for each volute and circulator-less-volute pairing be determined separately. In the context of other equipment, DOE provides that manufacturers may elect to group similar individual models within the same equipment class into the same basic model to reduce testing burden, provided all representations regarding the energy use of individual models within that basic model are identical and based on the most consumptive unit. *See* 76 FR 12422, 12429 (Mar. 7, 2011). DOE proposes 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. 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 requests comment on the proposed test procedure for circulators-less-volute. Specifically, DOE seeks comment as to any additional details that should be addressed in testing a circulator-less-volute with any given volute to determine applicable CEI values.

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

The CPWG recommended that for single speed circulator pumps, the measured input power and flow data corresponding to the load points from 60 percent of expected BEP flow to 120 percent of expected BEP flow be linearly regressed and the input power at the specific load points of 25, 50, 75, and 100 percent of BEP flow be determined from that regression equation. (Docket No. EERE–2016–BT–STD–0004, No. 58 Recommendation #10 at p. 8) Appendix E of HI 40.6–2021 provides the following testing modifications for circulator pumps, which differ from the CPWG recommendations:

- 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.

In response to the May 2021 RFI, China commented that the seven test points (*i.e.,* 40, 60, 75, 90, 100 and 120 percent of the flow rate at the expected BEP of the pump) in section 40.6.5.5.1 are approximately selected, and that these selected points are different from those of PEI. China recommended that DOE clarify the basis of the selection of these seven points. (China, No. 111 at p. 3)

DOE notes that Appendix E to HI 40.6–2021 has modified the provision referenced by China. DOE has reviewed Appendix E and determined that unlike general pumps, which require load points at 75, 100, 110, and 120 percent of BEP flow, Appendix E requires determining the driver power input at 25, 50, 75, and 100 percent of BEP flow. If DOE were to define the lowest test point as 40 percent, the lowest required drive power input point (25 percent) would fall outside the range of tested points (*i.e.,* 40 percent to 120 percent). Whereas, if DOE were to define the lowest test point as 10 percent, the lowest required drive power input point (25 percent) would fall withing the range of tested points (*i.e.,* 10 percent to 120 percent). DOE tentatively concludes that specifying a test range, which is broader than the range for which driver power input must be determined, through the use of a mathematical regression would result in more accurate driver power input values than a test range that is narrower than the range for which driver power input must be determined. Therefore, DOE has preliminarily determined that it is appropriate, consistent with Appendix E of HI 40.6–2021, to require test points starting at 10 percent rather than a higher value such as 40 percent or 60 percent of expected BEP flow. Therefore, DOE proposes to rely on the modified test points in Appendix E of HI 40.6–2021. DOE notes that Appendix E also specifies curve fitting using specific polynomial curves of best fit (6th order for head versus flow and 3rd order for power versus flow). DOE has no reason to believe that these curves are not appropriate, and as such, proposes to rely on the curve fitting in Appendix E of HI 40.6–2021.

DOE requests comment on its proposal to adopt the provisions in Appendix E of HI 40.6–2021 for determining circulator pump driver power input at specified flow rates, including whether these provisions are more appropriate than those recommended by the CPWG.

DOE notes 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 notes 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.

The CPWG recommended that for circulator pumps with pressure controls, manual speed controls, temperature controls, and external input signal controls, all tested flow values must be within ±10 percent of the target flow load points as specified by the reference system curve. In addition, the CPWG recommended that the tested driver input power should be adjusted to the specified flow and head points, except that any head values that are above the reference system curve by more than 10 percent should not be adjusted. The CPWG also clarified that, in their recommendation, if the tested head value is below the reference curve by more than 10 percent, the circulator pump must be retested. (Docket No. EERE–2016–BT–STD–0004, No. 58 Recommendation #10 at p. 8) While not specifically recommended, the CPWG discussed adjusting the test points proportionally, consistent with the method for adjusting reduced speed test points adopted in the January 2016 TP final rule. *See* 81 FR 4086, 4155–4156 (Jan. 25, 2016); (Docket No. EERE–2016–BT–STD–0004, No. 70 at pp. 325–328)

HI 41.5–2021 includes certain modifications to these provisions, as noted by HI in their comments. Specifically, under HI 41.5–2021, all tested flow values must be within ±5 percent of the target flow load points as specified by the reference system curve. (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 change 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 change 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 change 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. As stated previously, HI, NEEA, the CA IOUs, and the Advocates supported use of HI 41.5–2021. (HI, No. 112 at p. 2; NEEA, No. 115 at p. 4, Advocates, No. 114 at p. 1, CA IOUs, No. 116 at p. 2).

DOE interprets HI 41.5–2021's updated provision to reduce the tested flow tolerance to ±5 percent of the target flow load points as an indication that this tolerance has been achievable in tests.

DOE notes that HI's comment and the Introduction to HI 41.5–2021 (section 41.5.1) state that correction of power to the reference curve above the reference curve has been removed. However, in section 41.5.3.4.2 (pressure speed control) and 41.5.3.4.5 (manual speed control), the test method says ''Adjust measured driver input power to the specific flow and head points as defined in [the reference curve], except do not adjust for head values when head is at or above the reference curve.'' This indicates that driver input power measured above the reference curve should still be adjusted based on deviation from the flow point. In addition, section 41.5.3.4.3 (temperature speed control) and 41.5.3.4.4 (external input signal speed control) still retain the provision not to adjust for head values that are above the reference curve by more than 10 percent.

DOE proposes to incorporate the provisions in HI 41.5–2021, rather than removing all correction of power measured above the reference curve for all test methods. DOE believes that correction for flow points within the tolerance is still appropriate. If stakeholders comment that the test methods in HI 41.5–2021 have been implemented incorrectly and that all correction of power above the reference curve should be removed, and provide accompanying support, DOE will consider adopting the provisions in HI 41.5–2021. DOE understands that artificially adjusting head values significantly above the reference system curve back to the reference system curve would result in an unrepresentative CEI rating.

DOE notes that in the case that the tested head value is within 10 percent of the reference system curve, it is likely that the tested circulator pump could achieve the specified flow and head values along the reference system curve and that the deviation in head, in this case, would likely be due to experimental uncertainty. DOE notes that unlike pressure controls and manual speed controls, circulator pumps with temperature controls and circulator pumps with external input signal controls should be able to match the required speed to meet the exact head values at each flow rate described by the reference system curve. Therefore, DOE believes that continuing to adjust for head values within 10 percent above the reference curve would not be likely to cause any discontinuity in CEI for these control methods.

Regarding permitting testing below the reference curve for pressure control and manual speed control, DOE proposes these changes to the CPWG recommendations in sections III.D.3 and III.D.5 of this document. DOE also agrees that given testing below the curve would be permitted, the measured test points should be corrected back to the reference curve, as included in HI 41.5–2021.

DOE notes 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.

DOE also proposes 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 Circulator Pump Working Group. Specifically, DOE proposes 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):

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

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).

DOE also proposes 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).

Finally, DOE proposes, 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):

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

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).

With regards to the test points to which the tolerance and adjustment methods are applicable, DOE notes 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 believes 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, as discussed in detail in section III.D, 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 believes, as recommended by the CPWG, the proposed tolerances and proportional adjustment would be applicable. However, for the test points at 25, 50, and 75 percent of maximum speed, DOE believes 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 believes this is consistent with section 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 notes 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 believes 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 notes 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 requests comment on this deviation. Table III.3 summarizes the proposed applicability of the different adjustment methods to the various test points for each circulator pump variety.

TABLE III.3—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 requests comment on the proposal that for circulator pumps with pressure and manual speed controls, if all the tested flow values are within ±5 percent of the flow load points specified by the reference curve and tested head values are below the head load points specified by the reference curve, the tested driver power input values would be proportionally adjusted to the specified flow and head points. If the tested head values are above the reference system curve, only the flow values would be proportionally adjusted to the specified value. DOE requests comment on whether HI intended to remove all power correction (including flow correction) above the reference curve for pumps with pressure and manual speed controls.

DOE requests comment on the proposal that for temperature and external input signal controls, if all the tested flow values are within ±5 percent of the flow load points specified by the reference system curve and all the tested head values are within ±10 percent of 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 head points. If the tested head values are above the reference system curve by more than 10 percent, only the flow values would be proportionally adjusted to the specified value. DOE requests comment on whether HI intended to remove all power correction above the reference curve for temperature and external input signal controls.

DOE also requests 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 requests comment on which category is most appropriate for the 100 percent of BEP flow point.

d. Calculation and Rounding Modifications and Additions

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

DOE agrees 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, 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 proposes to round CER to three significant figures and to round CEI to the nearest hundredths place. Additionally, DOE proposes 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 hydraulic horsepower and true power factor values to the hundredths place unless otherwise specified.

DOE requests comment on the proposal that all calculations be performed with the raw measured data, to ensure accuracy, and to round CER, 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 the tenths place (*i.e.,* 0.1); and CEI, hydraulic horsepower, and true power factor values to the hundredths place (*i.e.,* 0.01).

3. Rated Hydraulic Horsepower

As discussed in section III.B.2, 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 proposes 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 notes that hydraulic horsepower (termed pump power output [29]) is defined in HI 40.6–2021, which DOE proposes to incorporate by reference (see section III.E.1). 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 proposes to use to describe the size of dry rotor circulator pumps, DOE proposes 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 believes that measuring and reporting rated hydraulic horsepower at BEP and full impeller diameter for each dry rotor circulator pump variety would result in the most consistent determination of applicability of this circulator pump test procedure.

DOE requests comment on the proposal to use rated hydraulic horsepower, identified as the measured hydraulic horsepower at BEP and full impeller diameter for the rated pump, as the primary standardized metric to determine the scope of applicability of dry rotor circulator pumps in this circulator pump test procedure.

F. Sampling Plan and Enforcement Provisions for Circulator Pumps

For determining the proposed representative values (*i.e.,* both the proposed energy- and non-energy-related metrics) for each basic model, DOE proposes that 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 is proposing specific enforcement procedures that DOE would follow when testing equipment to verify compliance of any circulator pump basic model. The following sections III.F.1 and III.F.2 discuss DOE's proposed sampling plan and enforcement provisions for circulator pumps.

1. Sampling Plan

DOE provides, in subpart B to 10 CFR part 429, sampling plans for covered equipment. 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.

For circulator pumps, DOE proposes to adopt statistical sampling plans similar to that adopted for pumps. That is, DOE proposes 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 lower 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:

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

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).

Under this proposal, 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 proposes to apply this same minimum sample size requirement to circulator pumps. Thus, if a statistical sampling plan is used, DOE proposes 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. 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.

DOE notes that the proposed sampling provisions would be applicable to all energy-related metrics for which each manufacturer elected to make representations. DOE believes that, similar to other pumps, a 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 notes that the proposed circulator pump test procedure is based on the same fundamental test standard (*i.e.,* HI 40.6–2021), with identical equipment accuracy requirements and test tolerances. In addition, DOE believes circulator pumps would realize similar performance variability to other commercial and industrial equipment, such as general pumps and dedicate-purpose pool pumps, based on a statistical analysis conducted by DOE discussed in section III.F.2 of this document.

In addition to CEI, the rated hydraulic horsepower would also 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 (see section III.B.2). DOE proposes that the representative value of rated

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

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, the true power factor and the flow and head at BEP at each load point are important characteristics that may aid utilities in crafting incentive programs regarding circulator pumps or aid customers in properly selecting circulator pumps. As discussed in section III.E.1, DOE notes that HI 40.6–2021 specifies measurement equipment for determining the circulator pump performance characteristics of true RMS current, true RMS voltage, input power, and the flow and head at BEP at each load point. Additionally, as discussed in section III.E.1, DOE discussed how to calculate true power factor based on the measurements of true RMS current, true RMS voltage, and real power. To ensure such values are determined in a consistent manner, DOE also proposes 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.

Finally, consistent with provisions for other commercial and industrial equipment, DOE notes 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.

DOE requests comment on the proposed statistical sampling procedures and certification requirements for circulator pumps.

2. Enforcement Provisions

Enforcement provisions govern the process DOE would follow when performing an assessment of basic model compliance with standards, as described under subpart C of 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 proposes that the same general enforcement provisions contained in subpart C of 10 CFR part 429 would be applicable to circulator pumps.

Related to enforcement testing of circulator pumps, as specified in 10 CFR 429.110(e)(1), DOE proposes that it would conduct the applicable circulator pump test procedure, once adopted, to determine the CEI for tested circulator pump models. In this rulemaking, DOE is proposing circulator-pump specific enforcement testing provisions for 10 CFR 429.134.[30] 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 requests comment on how, absent information on the tested control method for a basic model, DOE should determine which test method to conduct.

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 proposes 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 (see section III.D.3). In addition, for circulator pumps rated with adaptive pressure controls, DOE proposes 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 proposes to test using any control that meets the requirements specified in the pressure control test method. DOE would consider adopting more specific provisions in the final rule given feedback on the most appropriate selection criteria.

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) As discussed in section III.D.6, this requirement has been removed in HI 41.5–2021. For external input signal controls and temperature controls, DOE proposes that it would conduct enforcement testing with this provision. DOE understands 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 proposes 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).

DOE requests 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.

In addition, DOE believes that, as circulator pumps have relatively large shipments and are generally a high-volume piece of equipment, DOE should apply the enforcement testing sample size and calculations applicable to consumer products and certain high-volume commercial equipment specified in appendix A to subpart C of 10 CFR part 429. Therefore, DOE proposes 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.

DOE notes 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)[31] stating that DOE would

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

[31] 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

Continued

assess compliance of any pump basic models undergoing enforcement testing based on the arithmetic mean of up to four units. 81 FR 4086, 4121 (Jan. 25, 2016). 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. DOE believes that circulator pumps should be treated similarly to DPPP because of the shipments and high volume of the equipment.

DOE requests 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.

In addition, 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, see section III.B.2). Therefore, DOE is also proposing 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 proposes 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 believes such an approach would result in more reproducible and equitable compliance determinations among DOE, manufacturers, and test labs.

The 5 percent tolerance on hydraulic horsepower is based on a statistical analysis DOE conducted of the maximum allowed testing uncertainty due to fluctuations in measurements, measurement uncertainty, and the typical manufacturing uncertainty. The maximum experimental uncertainty is discussed in HI 40.6–2021, which DOE proposes to incorporate by reference in the DOE test procedure (section III.E.1). DOE estimated the manufacturing variability based on the maximum tolerances on head and flow that are allowed in the ANSI/HI 14.6–2011 standard tolerance grade 1B. Specifically, ANSI/HI 14.6–2011 requires that the tested flow be within ±5 percent of the pump performance curve and the tested head be within ±3 percent of the pump performance curve for the acceptance grade 1B. DOE recognizes that these are all worst-case uncertainties and that testing a unit with the maximum possible variability in every parameter would be extremely unlikely. Therefore, DOE assumed that the maximum uncertainty would represent a worst case. For the purposes of analysis, DOE assumed the maximum uncertainty was three standard deviations away from the mean (encompassing 99.7 percent of the population) and conducting the analysis assuming a tolerance of one standard deviation.

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

G. Representations of Energy Use and Energy Efficiency

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. 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.''

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))

With respect to representations, generally, DOE understands 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 proposes to allow manufacturers to continue making these representations. In order 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 proposes 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, 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.

DOE notes 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 proposes to incorporate by reference in the DOE test procedure (section III.E.1). DOE believes that further specification is not necessary regarding the determination of these parameters. DOE notes 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 assumes this curve would be used to calculate pump power output at any relevant load point.

DOE requests 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).

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).

DOE also requests 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.

H. Test Procedure Costs and Harmonization

1. Test Procedure Costs and Impact

In this NOPR, DOE proposes to establish 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. This NOPR also contains proposals regarding representations, enforcement, and labeling provisions for circulator pumps that would be added to 10 CFR parts 429 and 431, respectively. DOE has tentatively determined that these proposed amendments would impact testing costs as discussed in the following paragraphs.

DOE proposes to incorporate, 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 (3) determine the minimum test sample (*i.e.,* number of units) and permitted method of determining represented values.

By adopting industry standards, DOE has tentatively determined that the proposed amendments in this NOPR would establish 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 that would not be unduly burdensome for manufacturers to conduct. DOE is presenting the costs associated with testing equipment and procedure consistent with the requirements of the proposed test procedure, as would be required to certify compliance with any future energy conservation standard.

DOE recognizes that, because such testing is not currently required or standardized in the United States, testing facilities may vary from one pump manufacturer to another. As such, DOE has estimated a maximum expected testing burden associated with this test procedure NOPR, which is associated with an expectation where all pump manufacturers do not have existing testing capabilities and would be required to purchase the necessary test equipment in accordance with the proposed test procedure, if finalized.

To estimate the burden associated with the testing and sampling plan requirements proposed in this test procedure NOPR, DOE understands that in order to conduct the proposed test procedure, each manufacturer would either (a) have to test the units in-house or (b) test the units at a third-party testing facility. If a manufacturer elects to test circulator pumps in-house, that manufacturer may have to undertake the following burden inducing activities: (1) Acquire necessary testing equipment that is capable of testing circulator pumps in compliance with the test procedure, including acquisition and calibration of any necessary measurement equipment, and (2) conduct the DOE test procedure on two units of each covered circulator pump basic model.

DOE's cost estimates factored in capital costs and labor costs. Capital cost estimates are based on previous manufacturer interviews. 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 estimates 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 size, DOE is using a 100-gallon water reservoir as a typical size and thus estimates the cost at approximately $930 for the water reservoir.[32]

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. DOE estimates a cost of $2,745 for the piping and valves necessary to test the circulator pumps within the scope of the proposed test procedure.[33]

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 estimates the cost for power conditioning equipment as $2,200.[34]

The proposed circulator pump test procedure contains requirements regarding the characteristics and accuracy of the measurement equipment necessary to precisely and accurately determine 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 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. DOE estimates a typical flow measurement equipment capable of accommodating the full range of

[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.

circulator pumps subject to this proposed test procedure to be $4,400.[35]

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 indicates that most manufacturers utilize differential pressure transducers to measure pressure in the test setup. Based on this information and DOE research, DOE estimates the average cost of the pressure measurement devices to be $1,650.[36]

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 proposes specific requirements regarding the accuracy and quantities measured for such power measuring equipment, as discussed in section III.E.1. 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. Based on information provided by manufacturers and DOE's own research, DOE estimates the typical cost for the electrical measurement equipment to conduct this proposed test procedure is $4,400.[37]

Additionally, temperature measurements would be necessary, to perform the test procedure as proposed. 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 estimates a cost of $220 for potential temperature measurement devices.[38]

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 proposed test procedure and estimates the typical cost for a data acquisition system as $21,000.[39]

In total, DOE estimates 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.

However, DOE notes that the majority of circulator pump manufacturers may already have existing testing capabilities to verify equipment performance, as well as certify performance for other applicable circulator pump programs.[40] Therefore, DOE interprets the previously estimated $37,600 value as a worst-case estimate that is not representative of the likely eventual burden to most manufacturers.

DOE requests comment on the capital cost burden associated with the proposed circulator pump test procedure, including the estimated capabilities of current manufacturers. Specifically, DOE requests comment on the estimate that the likely capital cost burden incurred by existing circulator pump manufacturers would be between $0 and $37,600.

b. Between Estimated Labor Costs for Testing Circulator Pumps

This test procedure NOPR also proposes 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.

Based on wage and salary data from the Bureau of Labor Statistics, DOE estimates the fully burdened mechanical engineering technician wage of $41.46/hr.[41] DOE received information from manufacturers about the typical time required to test a circulator pump for applicable programs with similar testing requirements proposed in this test procedure NOPR.[42] The time for testing ranged from an hour per test to over 24 hours when completing testing for multiple programs. The longer testing is a function of the longer stabilization times required for some manufacturers' circulator pumps with new motors. On average, the expected testing time for this proposed test procedure is approximately 7.5 hours per pump based on DOE research and estimates from manufacturers. Using the labor rate established previously, the total cost of labor for testing a circulator pump is estimated to be approximately $622 per basic model.[43]

DOE requests comment on the estimated time and costs to complete a test of a single circulator pump basic model under the proposed test procedure.

Based on a review of the market. DOE is proposing to adopt the industry standard, HI 40.6–2021, ''Methods for Rotodynamic Pump Efficiency Testing,'' with certain exceptions. As previously discussed, DOE estimates the potential capital costs to be approximately $37,600 per manufacturer and DOE estimates the potential labor costs to be approximately $622 per basic model. However, because HI 40.6–2021 is the generally accepted industry standard, DOE believes that manufacturer costs would most likely be less than the estimated costs, as most manufacturers are already testing to HI 40.6–2021. Further, relative costs arising from the proposed test procedure would fall further to the degree to which manufacturers are already rating pumps in accordance with the proposed test procedure. As of mid-October, DOE observes 68 models from 4 manufacturers listed in the Hydraulic Institute's voluntary rating program.[44] While this figure represents a minority of available circulator pump models on the market, the Hydraulic Institute's program is relatively new and manufacturer may still be in the process of adding models. Finally, costs may fall further to the extent already-rated

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

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

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

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

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

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

[41] 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 September 21, 2021. Therefore DOE estimated an fully-burdened labor rate of $41.46 ($29.27 ÷ 0.706 = $41.46),

[42] See section III.B.1 for a discussion of applicable programs and the similarity to DOE's proposed test procedure.

[43] 7.5 hours × $41.46/hr × 2 units per basic model = $621.90 (rounded to $622).

[44] The Hydraulic Institute. Energy Rating Program Database. Available at: *er.pumps.org/circulator/ratings.* Last accessed: October 12, 2021.

models as the basis for certification of other, similar models under the same basic model.

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 proposes to incorporate by reference via proposals described in this NOPR is discussed in further detail in section IV.M.

DOE requests comments on the benefits and burdens of the proposed additions to industry standards referenced in the test procedure for circulator pumps.

DOE notes that, as discussed in section III.E.2, it is proposing exceptions and additions to HI 40.6–2021 in order to appropriately address circulator pump testing as specific from other rotodynamic pump testing. In addition, DOE is proposing test methods and calculations for circulator pumps with certain control varieties, which are supplemental to the test procedure in HI 40.6–2021. DOE notes that these test method proposals are consistent with HI 41.5–2021, which, as discussed in section II, is a program guideline rather than a test standard.

I. Compliance Date

EPCA prescribes that, if DOE amends a test procedure, all representations of energy efficiency and energy use, including those made on marketing materials and product labels, must be made in accordance with that amended test procedure, beginning 180 days after publication of such a test procedure final rule in the **Federal Register**. (42 U.S.C. 6314(d)(1)) To the extent the test procedure proposed in this document is required only for the evaluation and issuance of updated efficiency standards, use of the test procedure, if finalized, would not be required until the implementation date of updated standards. 10 CFR 431.4; Section 8(d) of appendix A 10 CFR part 430 subpart C.

If DOE were to publish an amended test procedure, 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 Order 12866

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

B. Review Under the Regulatory Flexibility Act

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

The following sections detail DOE's IRFA for this test procedure rulemaking.

1. Description of Why Action Is Being Considered

DOE proposes to amend subpart Y of 10 CFR part 431 to establish a test procedure for circulator pumps in advance of the finalization of any energy conservation standards for this equipment. (*See* Docket No. EERE–2016–BT–STD–0004.) The test procedure for circulator pumps proposed in this test procedure NOPR includes the methods necessary to: (1) Measure the performance of the covered equipment, (2) use the measured results to calculate the CEI to represent the energy consumption of the circulator pump, inclusive of a motor and any controls, and (3) determine the minimum test sample (*i.e.,* number of units) and permitted method of determining represented values. In this test procedure NOPR, DOE also proposes to set the scope of those circulator pumps to which the proposed test methods would apply.

2. Objective of, and Legal Basis for, Rule

EPCA [45] 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 [46] 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))

Under 42 U.S.C. 6314, EPCA sets forth the criteria and procedures DOE must follow when prescribing or amending test procedures for covered equipment. EPCA requires that any test procedures prescribed or amended under this section must be reasonably designed to produce test results which reflect energy efficiency, energy use or estimated annual operating cost of a given type of covered equipment during a representative average use cycle and requires that test procedures not be unduly burdensome to conduct. (42 U.S.C. 6314(a)(2)) To fulfill these requirements, in this test procedure NOPR, DOE proposes to establish a test procedure for circulator pumps in advance of the finalization of any energy conservation standards for this equipment. (*See* Docket No. EERE–2016–BT–STD–0004.)

3. Description and Estimate of Small Entities Regulated

For manufacturers of circulator pumps, the Small Business Administration (''SBA'') has set a size threshold, which defines those entities

[45] 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).

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

classified as ''small businesses'' for the purposes of the statute. DOE used the SBA's small business size standards to determine whether any small entities would be subject to the requirements of the rule. *See* 13 CFR part 121. The equipment covered by this rule are classified under North American Industry Classification System (''NAICS'') code 333914,[47] ''Measuring, Dispensing, and Other Pumping Equipment Manufacturing.'' 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.

DOE reviewed the test procedures proposed in this NOPR under the provisions of the Regulatory Flexibility Act and the procedures and policies published on February 19, 2003. DOE used publicly available information to identify potential 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 potential small, domestic OEMs for consideration. DOE used subscription-based business information tools to determine the number of employees and revenue of the potential small businesses.

DOE requests comment on the number of small businesses DOE identified.

4. Description and Estimate of Compliance Requirements

DOE estimates that this proposed test procedure would not require any manufacturer to incur any additional testing burden associated with the proposed test procedure, if finalized, DOE recognizes that circulator pump energy conservation standards may be proposed or promulgated in the future and pump manufactures would then be required to test all covered circulator pumps in accordance with the proposed test procedures. (*See* Docket No. EERE–2016–BT–STD–0004) Therefore, although such is not yet required, DOE is presenting the costs associated with testing equipment and procedure consistent with the requirements of the proposed test procedure, as would be required to certify compliance with any future energy conservation standards.

In the test procedure outlined in this NOPR for circulator pumps, DOE proposes a new metric, called CEI. To determine the applicable measured values for determining circulator pump performance, DOE proposes to incorporate by reference the test methods established in HI 40.6–2021, ''Methods for Rotodynamic Pump Efficiency Testing,'' with certain exceptions. DOE also proposes to set the scope of those circulator pumps to which the proposed test methods would apply.

DOE recognizes that, because such testing is not currently required in the United States, testing facilities may vary from one pump manufacturer to another. As such, DOE has estimated the potential testing burden associated with this test procedure NOPR, which is associated with a situation where a given pump manufacturer does not have existing test facilities and would be required to purchase the necessary test equipment in accordance with any test procedure final rule. Furthermore, DOE believes that manufacturer costs would most likely be less than the estimated costs because most manufacturers are already testing to HI 40.6–2021. Additionally, if manufacturers are already testing to HI 40.6–2021, manufacturers would not be required to re-test those models. DOE's cost estimates factored in capital expenditures required to purchase the necessary testing equipment as well as labor expenditures required to conduct the testing. DOE has tentatively determined that most manufacturers would choose to perform in-house testing as opposed to third-party lab testing.

DOE estimated the range of potential costs for the three small, domestic manufacturers of circular pumps. When developing cost estimates for these manufacturers, DOE considered the cost of testing equipment as well as the labor required to test per basic model. Should DOE adopt energy conservation standards in terms of CEI, the small businesses could incur capital costs of up to $37,600 per manufacturer. Additionally, DOE estimates testing labor costs of approximately $622 per basic model. DOE estimates, based on market research, that circulator pump manufacturers would each typically rate between 75 to 125 models with an average of 100 models per small business manufacture. Therefore, DOE estimates that the associated testing labor costs for a typical small business to be approximately $62,200 to test each small business's currently covered circulator pump basic models.[48]

Should DOE adopt energy conservation standards in terms of CEI, small businesses could incur total capital and labor testing costs of approximately $99,800. DOE understands the annual revenue of the three small businesses to be approximately $2 million, $5 million, and $158 million. Therefore, testing costs could cause these small businesses to incur up to 5 percent, 2 percent, and less than 1 percent of annual revenue, respectively.

DOE requests comment on the estimated potential costs for the small businesses.

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

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

6. Significant Alternatives to the Rule

The discussion in the previous section analyzes impacts on small businesses that would result from DOE's proposed test procedure, if finalized. In reviewing alternatives to the proposed test procedure, DOE examined not establishing a performance-based test procedure for circulator pumps or establishing prescriptive-based test procedures for circulator pumps. While not establishing performance-based test procedures or establishing prescriptive-based test procedures for circular pumps would reduce the burden on small businesses, DOE must use test procedures to determine whether the products comply with relevant standards promulgated under EPCA. (42 U.S.C. 6295(s))

DOE notes there currently are no energy conservation standards prescribed for circular pumps. Therefore, manufacturers would not be required to conduct the proposed test procedure, if made final, until such time as compliance is required with energy conservation standards, should DOE establish such standards, unless manufacturers voluntarily chose to make representations as to the energy use or energy efficiency of circulator pumps.

Additional compliance flexibilities may be available through other means. EPCA provides that a manufacturer whose annual gross revenue from all of its operations does not exceed $8 million may apply for an exemption from all or part of an energy conservation standard for a period not longer than 24 months after the effective date of a final rule establishing the standard. (42 U.S.C. 6295(t)) Additionally, section 504 of the

[47] 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 July 16, 2021).

[48] $622 (per basic model) × 100 (average number of basic models per small business) = $62,200.

Department of Energy Organization Act, 42 U.S.C. 7194, provides authority for the Secretary to adjust a rule issued under EPCA in order to prevent ''special hardship, inequity, or unfair distribution of burdens'' that may be imposed on that manufacturer as a result of such rule. Manufacturers should refer to 10 CFR part 430, subpart E, and 10 CFR part 1003 for additional details.

C. Review Under the Paperwork Reduction Act of 1995

Although no energy conservation standards have been established for circulator pumps as of the publication of this NOPR, 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 circulator 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.

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

D. Review Under the National Environmental Policy Act of 1969

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

F. Review Under Executive Order 12988

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

G. Review Under the Unfunded Mandates Reform Act of 1995

Title II of the Unfunded Mandates Reform Act of 1995 (''UMRA'') requires each Federal agency to assess the effects of Federal regulatory actions on State, local, and Tribal governments and the private sector. Public Law 104–4, sec. 201 (codified at 2 U.S.C. 1531). For a proposed regulatory action likely to result in a rule that may cause the expenditure by State, local, and Tribal governments, in the aggregate, or by the private sector of $100 million or more in any one year (adjusted annually for inflation), section 202 of UMRA requires a Federal agency to publish a written statement that estimates the resulting costs, benefits, and other effects on the national economy. (2 U.S.C. 1532(a), (b)) The UMRA also requires a Federal agency to develop an effective process to permit timely input by elected officers of State, local, and Tribal governments on a proposed ''significant intergovernmental mandate,'' and requires an agency plan for giving notice and opportunity for timely input to potentially affected small governments before establishing any requirements that might significantly or uniquely affect small governments. On March 18, 1997, DOE published a statement of policy on its process for intergovernmental consultation under UMRA. 62 FR 12820; also available at *www.energy.gov/gc/office-general-counsel.* DOE examined this proposed 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 proposed rule would not have any impact on the autonomy or integrity of the family as an institution. Accordingly, DOE has concluded that it is not necessary to prepare a Family Policymaking Assessment.

I. Review Under Executive Order 12630

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

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

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

K. Review Under Executive Order 13211

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

The proposed regulatory action to establish a test procedure for measuring the energy efficiency of circulator pumps 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 proposed test procedure for circulator pumps would incorporate testing methods contained in certain sections of the following commercial standard: Hydraulic Institute (HI) 40.6–2021, (''HI 40.6–2021'') ''Methods for Rotodynamic Pump Efficiency Testing''. DOE has evaluated this standard 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 will consult with both the Attorney General and the Chairman of the FTC concerning the impact of these test procedures on competition, prior to prescribing a final rule.

M. Materials Incorporated by Reference

In this NOPR, DOE proposes to incorporate by reference the test standard published by Hydraulic Institute (HI), titled ''Methods for Rotodynamic Pump Efficiency Testing,'' HI 40.6–2021. HI 40.6–2021 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 proposed in this NOPR references various sections of HI 40.6–2021 that address test setup, instrumentation, measurement, and test specifications. This standard can be obtained from the organization directly at the following address: Hydraulic Institute, 6 Campus Drive, First Floor North, Parsippany, NJ 07054–4406, (973) 267–9700, or by visiting *www.Pumps.org.*

V. Public Participation

A. Participation in the Webinar

The time and date of the webinar are listed in the **DATES** section at the beginning of this document. If no participants register for the webinar, it will be cancelled. Webinar registration information, participant instructions, and information about the capabilities available to webinar participants will be published on DOE's website: *www.eere.energy.gov/buildings/appliance_standards/standards.aspx?productid=66.* Participants are responsible for ensuring their systems are compatible with the webinar software.

B. Procedure for Submitting Prepared General Statements for Distribution

Any person who has an interest in the topics addressed in this NOPR, or who is representative of a group or class of persons that has an interest in these issues, may request an opportunity to make an oral presentation at the webinar. Such persons may submit to *ApplianceStandardsQuestions@ee.doe.gov.* Persons who wish to speak should include with their request a computer file in WordPerfect, Microsoft Word, PDF, or text (ASCII) file format that briefly describes the nature of their interest in this rulemaking and the topics they wish to discuss. Such persons should also provide a daytime telephone number where they can be reached.

Persons requesting to speak should briefly describe the nature of their interest in this rulemaking and provide a telephone number for contact. DOE requests persons selected to make an oral presentation to submit an advance copy of their statements at least two weeks before the webinar. At its discretion, DOE may permit persons who cannot supply an advance copy of their statement to participate, if those persons have made advance alternative arrangements with the Building Technologies Office. As necessary, requests to give an oral presentation should ask for such alternative arrangements.

C. Conduct of the Webinar

DOE will designate a DOE official to preside at the webinar/public meeting and may also use a professional facilitator to aid discussion. The meeting will not be a judicial or evidentiary-type public hearing, but DOE will conduct it in accordance with section 336 of EPCA (42 U.S.C. 6306). A court reporter will be present to record the proceedings and prepare a transcript. DOE reserves the right to schedule the order of presentations and to establish the procedures governing the conduct of the webinar/public meeting. There shall not be discussion of proprietary information, costs or prices, market share, or other commercial matters regulated by U.S. anti-trust laws. After the webinar/public meeting and until the end of the comment period, interested parties may submit further comments on the proceedings and any aspect of the rulemaking.

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

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

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

D. Submission of Comments

DOE will accept comments, data, and information regarding this proposed rule no later than the date provided in the **DATES** section at the beginning of this proposed rule. Interested parties may submit comments using any of the methods described in the **ADDRESSES** section at the beginning of this document.

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

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

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

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

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

Include contact information each time you submit comments, data, documents, and other information to DOE. No faxes will be accepted.

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

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

Confidential Business Information. Pursuant to 10 CFR 1004.11, any person submitting information that he or she believes to be confidential and exempt by law from public disclosure should submit via email two well-marked copies: One copy of the document marked confidential including all the information believed to be confidential, and one copy of the document marked non-confidential with the information believed to be confidential deleted. DOE will make its own determination about the confidential status of the information and treat it according to its determination.

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

E. Issues on Which DOE Seeks Comment

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

(1) DOE requests comment on the proposed definition for circulator pump.

(2) DOE requests comment on the proposed definition for horizontal motor, including whether it meets the intent of the CPWG or whether it would include other motors not intended to be captured in the definition.

(3) DOE requests comment on the proposed definitions of header pump and circulator-less-volute.

(4) DOE requests comment on its proposal to include on-demand circulator pumps within the scope of this test procedure. DOE also requests data and information that would justify a CEI credit for on-demand circulator pumps.

(5) DOE requests comment on the proposed scope of applicability of the circulator pump test procedure to circulator pumps that are clean water pumps, and the exclusion of header pumps and submersible pumps from the scope of the proposed test procedure.

(6) DOE requests 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.

(7) DOE requests 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.

(8) DOE requests comment on the proposal to allow manufacturers to select the control variety used for testing if the circulator pump model is distributed in commerce with multiple control varieties. DOE specifically requests comment on whether DOE should instead require manufacturers to test a circulator pump model that offers multiple control varieties with the least consumptive control variety. DOE also requests comment on the burden that would be associated with such an approach.

(9) DOE requests comment on its proposed definition of adaptive pressure control.

(10) DOE requests comment on the proposed test method for circulator pumps with pressure controls, including whether DOE's interpretation of the new provisions in HI 41.5–2021 are accurate.

(11) DOE requests 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.

(12) DOE requests 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 requests comment on the HI 41.5–2021 provision for manual adjustment to achieve 100 percent BEP flow and heat point at max speed, which is not included for other pressure controls.

(13) DOE requests comment on the proposed test methods, test points, and weights for circulator pumps with temperature controls.

(14) DOE requests 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.

(15) DOE requests 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. In particular, DOE requests 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. DOE also seeks comment on whether it is necessary to reference the ''lowest speed setting'' when determining the appropriate test points. Finally, DOE seeks 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.

(16) DOE requests comment on the proposed test method for circulator pumps distributed in commerce with no controls.

(17) DOE requests comment on the proposal to incorporate by reference HI 40.6–2021, inclusive of Appendix E, into the proposed appendix D to subpart Y, with the exceptions, modifications, and additions described in section III.E.2 of this document.

(18) DOE requests comment on its proposal to not reference 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.

(19) DOE requests comment on the proposed test procedure for twin head circulator pumps.

(20) DOE requests comment on the proposed test procedure for circulators-less-volute. Specifically, DOE seeks comment as to any additional details that should be addressed in testing a circulator-less-volute with any given volute to determine applicable CEI values.

(21) DOE requests comment on its proposal to adopt the provisions in Appendix E of HI 40.6–2021 for determining circulator pump driver power input at specified flow rates, including whether these provisions are more appropriate than those recommended by the CPWG.

(22) DOE requests comment on the proposal that for circulator pumps with pressure and manual speed controls, if all the tested flow values are within ±5 percent of the flow load points specified by the reference curve and tested head values are below the head load points specified by the reference curve, the tested driver power input values would be proportionally adjusted to the specified flow and head points. If the tested head values are above the reference system curve, only the flow values would be proportionally adjusted to the specified value. DOE requests comment on whether HI intended to remove all power correction (including flow correction) above the reference curve for pumps with pressure and manual speed controls.

(23) DOE requests comment on the proposal that for temperature and external input signal controls, if all the tested flow values are within ±5 percent of the flow load points specified by the reference system curve and all the tested head values are within ±10 percent of 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 head points. If the tested head values are above the reference system curve by more than 10 percent, only the

flow values would be proportionally adjusted to the specified value. DOE requests comment on whether HI intended to remove all power correction above the reference curve for temperature and external input signal controls.

(24) DOE also requests 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 requests comment on which category is most appropriate for the 100 percent of BEP flow point.

(25) DOE requests comment on the proposal that all calculations be performed with the raw measured data, to ensure accuracy, and to round CER, 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 the tenths place (*i.e.,* 0.1); and CEI, hydraulic horsepower, and true power factor values to the hundredths place (*i.e.,* 0.01).

(26) DOE requests comment on the proposal to use rated hydraulic horsepower, identified as the measured hydraulic horsepower at BEP and full impeller diameter for the rated pump, as the primary standardized metric to determine the scope of applicability of dry rotor circulator pumps in this circulator pump test procedure.

(27) DOE requests comment on the proposed statistical sampling procedures and certification requirements for circulator pumps.

(28) DOE requests comment on how, absent information on the tested control method for a basic model, DOE should determine which test method to conduct.

(29) DOE requests 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.

(30) DOE requests 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.

(31) DOE seeks comment upon the applicability of a 5 percent tolerance on hydraulic horsepower for each tested circulator pump model or if a higher or lower percentage variation would be justified.

(32) DOE requests 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).

(33) DOE also requests 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.

(34) DOE requests comment on the capital cost burden associated with the proposed circulator pump test procedure, including the estimated capabilities of current manufacturers. Specifically, DOE requests comment on the estimate that the likely capital cost burden incurred by existing circulator pump manufacturers would be between $0 and $37,600.

(35) DOE requests comment on the estimated time and costs to complete a test of a single circulator pump basic model under the proposed test procedure.

(36) DOE requests comments on the benefits and burdens of the proposed additions to industry standards referenced in the test procedure for circulator pumps.

(37) DOE requests comment on the number of small businesses DOE identified.

(38) DOE requests comment on the estimated potential costs for the small businesses.

Approval of the Office of the Secretary

The Secretary of Energy has approved publication of this notice of proposed rulemaking and request for comment.

List of Subjects

10 CFR Part 429

Administrative practice and procedure, Confidential business information, Energy conservation, Household appliances, Reporting and recordkeeping requirements.

10 CFR Part 431

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

Signing Authority

This document of the Department of Energy was signed on November 16, 2021, by Kelly Speakes-Backman, Principal Deputy Assistant Secretary and Acting Assistant Secretary for Energy Efficiency and Renewable Energy, pursuant to delegated authority from the Secretary of Energy. That document with the original signature and date is maintained by DOE. For administrative purposes only, and in compliance with requirements of the Office of the Federal Register, the undersigned DOE Federal Register Liaison Officer has been authorized to sign and submit the document in electronic format for publication, as an official document of the Department of Energy. This administrative process in no way alters the legal effect of this document upon publication in the **Federal Register**.

Signed in Washington, DC, on November 17, 2021.

Treena V. Garrett,

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

For the reasons stated in the preamble, DOE is proposing to amend 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:

■ a. Revising paragraphs (a)(1)(i), (a)(2)(i) and (a)(2)(iii), and

■ b. Adding paragraphs (a)(2)(iv) through (vii).

The revisions and addition 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 i^{th} sample;

Or,

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

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

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.

* * * * *

(iii) *True power factor.* The representative value of true power factor of a basic model of dedicated-purpose pool pump or circulator pump must be determined based on the mean of the true power factors for each tested unit of dedicated-purpose pool pump or circulator pump motor, respectively.

(iv) *True RMS current and true RMS voltage.* The representative values of true RMS current and true RMS voltage of a basic model of circulator pump must be determined based on the mean of the true RMS currents and true RMS voltages, respectively, for each tested unit.

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

(vi) *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.

(vii) *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.

* * * * *

■ 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 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) 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 would test using the full speed test. If no control setting is specified and a variety of controls are available, DOE would test using the test method for any one of the control varieties available on board.

(iii) Pressure controls will be tested in the automatic setting except that adaptive pressure controls will be tested at the manual control option that results in the lowest head values at each test point below maximum speed. When conducting tests of pressure controls for which the no control curve is specified, the circulator pump will be tested using any control curve meeting the requirements specified in the test method.

(iv) External input signal controls and temperature controls will be tested at the lowest speed setting that will achieve a head at or above the reference curve.

(v) Manual speed controls will be tested using the speed setting closest to (above or below) each of the head points specified by the reference system curve.

* * * * *

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,'' ''Header pump,'' ''Manual speed control,'' ''On-demand circulator,'' ''Pressure control,'' ''Temperature control,'' and ''Wet rotor circulator pump.''; and

■ b. Revising the definition of the term ''Horizontal motor.''

The additions and revision read as follows:

§ 431.462 Definitions.

* * * * *

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.

* * * * *

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 a single stage, rotodynamic, single-axis flow, mechanically-coupled, dry rotor pump that:

(1) Has a rated hydraulic power less than or equal to 5 hp at the 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.

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 5 hp 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.

* * * * *

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 paragraph (d)(5) to read as follows:

§ 431.463 Materials incorporated by reference.

(a) Certain material is incorporated by reference into this subpart with the approval of the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. To enforce any edition other than that specified in this section, DOE must publish a document in the **Federal Register** and the material must be available to the public. All approved material is available for inspection 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) 586–2945, *https://www.energy.gov/eere/buildings/appliance-and-equipment-standards-program,* and may be obtained from the other sources in this section. It is also available for inspection at the National Archives and Records Administration (NARA). 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.*

* * * * *

(d) * * *

(5) HI 40.6–2021, (''HI 40.6–2021''), ''Methods for Rotodynamic Pump Efficiency Testing,'' copyright 2021, IBR approved for appendix D to subpart Y of this part.

* * * * *

■ 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

I. Test Procedure for Circulator Pumps

A. *General*

A.1 Referenced materials. DOE incorporated by reference in § 431.463 the entire standard for HI 40.6–2021. However, not all provisions of HI 40.6–2021 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. Specifically, the following provisions are not applicable:

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

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

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

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

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

(6) 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
(7) Appendix B—Reporting of test results
(8) Appendix G—DOE compared to HI 40.6 nomenclature

A.2 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 A.0 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.

B. *Scope.*

B.1 Section II of this appendix describes the testing of circulator pumps with external input signal controls and the calculation of CER for these circulator pumps.

B.2 Section III of this appendix describes the testing of circulator pumps with manual speed controls and the calculation of CER for these circulator pumps.

B.3 Section IV of this appendix describes the testing of circulator pumps with pressure controls and the calculation of CER for these circulator pumps.

B.4 Section V of this appendix describes the testing of circulator pumps with temperature controls and the calculation of CER for these circulator pumps.

B.5 Section VI of this appendix describes the testing of circulator pumps without external input signal, manual, pressure, or temperature controls (*i.e.,* full speed test) and the calculation of CER for these circulator pumps.

B.6 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 without external input signal, manual, pressure, or temperature controls (*i.e.,* full speed test).

C. *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.

D. *Test conditions.*

D.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.''

D.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.

D.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 sections II, III, IV, V, or VI of this appendix, depending on the variety of control with which the circulator pump model is distributed in commerce, as specified in section B of this appendix. 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.

E. *Data collection and analysis.*

E.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.

E.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.

E.3 Reference system curve. The reference system curve for each circulator pump variety is defined uniquely for each pump as a quadratic function with a fixed head component of 20 percent of the head at BEP at maximum speed as defined by the following equation:

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

Where:

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

E.4 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 PER_{CIRC}, BEP flow at maximum speed and BEP head at maximum speed values to three significant figures. Round real power, true RMS current and true RMS voltage values the tenths place (*i.e.,* 0. 1). Round PEI_{CIRC}, hydraulic horsepower, true power factor, and all other reported values to the hundredths place unless otherwise specified.

F. *Calculation of CEI.*

F.1 Determine CEI using the following equation:

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

Where:

CEI = the circulator energy index (dimensionless);
CER = the circulator energy rating determined in accordance with section II (for circulator pumps with external input signal controls), section III (for circulator pumps with manual speed controls), section IV (for circulator pumps with pressure controls), section V (for circulator pumps with temperature controls), or section VI (for circulator pumps without external input signal, manual, pressure or temperature controls) (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.

G. *Determination of Additional Circulator Performance Parameters.*

G.1 To determine flow and head at BEP, as well as pump power output (hydraulic horsepower), driver power input, overall (wire-to-water) efficiency, true RMS current, true RMS voltage, real power, and/or power factor at relevant load points, conduct testing according to section I.A.1 of this appendix.

G.2 Determine the rated hydraulic horsepower as the pump power output measured at BEP and full impeller diameter for the rated pump.

G.3 Determine the true power factor at each applicable load point specified in sections II, III, IV, V, or VI 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 sections II, III, IV, V, or VI of this appendix.

II. Testing and Calculation of CER for Circulator Pumps With External Input Signal Controls

A. *Scope.*

A.1 This section II applies only to circulator pumps sold with only external input signal controls and circulator pumps sold with external input signal controls in addition to other control varieties.

B. *Circulator pumps with only external input signal control, and which cannot be operated without an external input signal.*

B.1 Adjust the speed of the pump using a manual speed adjustment or with a simulated external signal to activate the external signal input control to achieve flow rates of 25, 50, 75, and 100 percent of the BEP flow rate (as determined according to section I.E.2 of this appendix) with head values that are at or above the reference system curve (defined in section I.E.3 of this appendix). Measure the driver power input at those flow rates.

B.1.1 All tested flow values must be within ±5 percent of the target flow load points as specified by the reference system curve.

B.1.2 For tested head values more than 10 percent above the head load points specified by the reference system curve, adjust the tested driver power input to the specified flow point using the following equation:

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

Where:

$P_{in,i}$ = 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).

B.1.3 For tested head values within ±10 percent of the head load points specified by the reference system curve, adjust the tested driver power input to the specified flow and head point using the following equation:

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

Where:

$P_{in,i}$ = 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).

B.1.4 If the tested head value is below the head load point specified by the reference system curve by more than 10 percent, the test point must be retested.

B.2. Calculating the circulator energy rating. Determine the CER of each tested circulator pump using the following equation:

$$CER = \sum_i \omega_i \left(P_{in,i}\right)$$

Where:

CER = circulator energy rating (hp);
ω_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;
$P_{in,i}$ = driver power input at each test point i (hp); and
i = test point(s), corresponding to 25, 50, 75, and 100 percent of the flow at BEP.

C. *Circulator pumps with external input signal control in addition to other control varieties, or which can be operated without an external input signal.*

C.1 Determination of circulator pump driver power input.

C.1.1 Determine the driver power input at 25, 50, and 75 percent of the measured BEP flow rate at maximum speed (as determined according to section I.E.2 of this appendix) of the tested circulator pump in accordance with Appendix E of HI 40.6–2021.

C.1.2 Determine the driver power input at 100 percent of BEP flow at maximum speed and at 25, 50, 75 percent of the BEP flow rate and reduced speed by using a manual speed adjustment or a simulated external input signal to adjust the speed of the driver to achieve those flow rates with a head value at or above the reference system curve defined in section I.E.3 of this appendix. Measure the driver power input at those flow rates.

C.1.2.1 All tested flow values must be within ±5 percent of the target flow load points as specified by the reference system curve.

C.1.2.2 For tested head values more than 10 percent above the head load points specified by the reference system curve, adjust the tested driver power input to the specified flow point using the following equation:

$$P_{in,i_{reduced}} = \left(\frac{Q_{R,i}}{Q_{T,j}}\right) P_{T,j}$$

Where:

$P_{in,i\_reduced}$ = 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).

C.1.2.3 For tested head values within ±10 percent of the head load points specified by the reference system curve, adjust the tested driver power input to the specified flow and head point using the following equation:

$$P_{in,i_{reduced}} = \left(\frac{H_{R,i}}{H_{T,j}}\right)\left(\frac{Q_{R,i}}{Q_{T,j}}\right) P_{T,j}$$

Where:

$P_{in,i\_reduced}$ = 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
$P_{T,i}$ = the tested driver power input at load point j (hp).

C.1.2.4 If the tested head value is below the head load point specified by the reference system curve by more than 10 percent, the test point must be retested.

C.2 Calculating the circulator energy rating. Determine the CER of each tested circulator pump using the following equation:

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

Where:

CER = circulator 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), calculated in accordance with section II.C.2.1 of this appendix;
$z_{reduced}$ = speed factor weight of 0.70; and

$P_{in\_reduced}$ = weighted average input power at reduced rotating speeds of the circulator pump (hp), calculated in accordance with section II.C.2.2 of this appendix.

C.2.1 Determine the weighted average input power at maximum speed using the following equation:

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

Where:

P_{in_max} = weighted average input power at maximum speed of the circulator pump (hp);

ω_{i_max} = 0.25;

P_{in,i_max} = driver power input at maximum rotating speed of the circulator pump at each test point i (hp) determined in accordance with section II.C.1.1 of this appendix; and

i = test point(s) corresponding to 25, 50, 75, and 100 percent of the flow at BEP and maximum speed.

C.2.2 Determine the weighted average input power at reduced speeds of the circulator pump using the following equation:

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

Where:

$P_{in\_reduced}$ = weighted average input power at reduced speeds of the circulator pump (hp);

$\omega_{i\_reduced}$ = 0.3333;

$P_{in,i\_reduced}$ = driver power input at reduced rotating speed of the circulator pump at each test point i (hp) determined in accordance with section II.C.1.2 of this appendix; and

i = test point(s) corresponding to 25, 50, and 75 percent of the flow at BEP with head at or above the reference system curve.

III. Testing and Calculation of CER for Circulator Pumps With Manual Speed Controls

A. *Scope.*

A.1 This section III applies only to circulator pumps sold with manual speed controls.

B. *Determination of circulator pump driver power input.*

B.1 Determine the driver power input at 25, 50, and 75 percent of the measured BEP flow rate at maximum speed (as determined according to section I.E.2 of this appendix) of the tested circulator pump in accordance with Appendix E of HI 40.6–2021.

B.2 Determine the driver power input at 100 percent of BEP flow at maximum speed and at 25, 50, and 75 percent of the BEP flow rate at reduced speed by manually setting the speed of the circulator pump and measuring the driver power input at those flow rates with the following additional requirements:

B.2.1 The tested control curve must:

(1) Be available to the end-user,

(2) Produce a head equal to or greater than 25 percent of BEP head at a minimum of one test point, and

(3) Achieve 100 percent BEP flow of the reference system curve defined in section I.E.3 of this appendix.

B.2.2 All tested flow values must be within ±5 percent of the target flow load points as specified by the reference system curve.

B.2.3 For tested head values that are at or above the head load points specified by the reference system curve, adjust the tested driver power input to the specified flow point using the following equation:

$$P_{in,i_{reduced}} = \left(\frac{Q_{R,i}}{Q_{T,j}} \right) P_{T,i}$$

Where:

$P_{in,i\_reduced}$ = 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

$P_{T,i}$ = the tested driver power input at load point i (hp).

B.2.4 For tested head values that are below the head load points specified by the reference system curve, adjust the tested driver power input to the specified flow and head point using the following equation:

$$P_{in,i_{reduced}} = \left(\frac{H_{R,i}}{H_{T,j}} \right) \left(\frac{Q_{R,i}}{Q_{T,j}} \right) P_{T,j}$$

Where:

$P_{in,i\_reduced}$ = 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).

C. *Calculating the circulator energy rating.* Determine the CER of each tested circulator pump using the following equation:

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

Where:

CER = circulator energy rating (hp);

z_{max} = speed factor weight of 0.75;

P_{in_max} = weighted average input power at maximum rotating speed of the circulator pump (hp), calculated in accordance with section III.C.1 of this appendix;

$z_{reduced}$ = speed factor weight of 0.25;

$P_{in\_reduced}$ = weighted average input power at reduced rotating speeds of the circulator pump (hp), calculated in accordance with section III.C.2 of this appendix.

C.1 Determine the weighted average input power at maximum speed using the following equation:

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

Where:

P_{in_max} = weighted average input power at maximum speed of the circulator pump (hp);

ω_{i_max} = 0.25;

P_{in,i_max} = driver power input at maximum rotating speed of the circulator pump at each test point i (hp) determined in accordance with section III.B.1; and

i = test point(s) corresponding to 25, 50, 75, and 100 percent of the flow at BEP and maximum speed.

C.2 Determine the weighted average input power at reduced speeds of the circulator pump using the following equation:

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

Where:

$P_{in\_reduced}$ = weighted average input power at reduced speeds of the circulator pump (hp);

$\omega_{i\_reduced}$ = 0.3333;

$P_{in,i\_reduced}$ = driver power input at reduced rotating speed of the circulator pump at each test point i (hp) determined in accordance with section III.B.2 of this appendix; and

i = test point(s) corresponding to 25, 50, and 75 percent of the flow at BEP and reduced speed.

IV. Testing and Calculation of CER for Circulator Pumps With Pressure Controls

A. *Scope.*

A.1 This section IV applies only to circulator pumps sold with pressure controls, including adaptive pressure controls.

B. *Determination of circulator pump driver power input.*

B.1 Determine the driver power input at 25, 50, 75, and 100 percent of the BEP flow rate (as determined according to section I.E.2 of this appendix) by measuring the driver power input at those flow rates with the following additional requirements.

B.1.1 For pressure controls that are not adaptive pressure controls, select the control settings according to section B.1.1.1 of this appendix, and evaluate the load points at 25, 50, and 75 percent of BEP flow using one of the methods specified in section B.1.1.2 of this appendix.

B.1.1.1 If the minimum and/or maximum head values on the control curve can be adjusted, adjust the maximum head value to 100 percent of BEP head at maximum speed and the minimum head value to 20 percent of BEP head at maximum speed. If the maximum head values on the control curve cannot be adjusted, select a control curve that meets the following requirements:

The tested control curve must:

(1) Be available to the end-user,

(2) Produce a head equal to or greater than 25 percent of BEP head at a minimum of one test point, and

(3) Achieve 100 percent BEP flow of the reference system curve defined in section I.E.3 of this appendix.

B.1.1.2 Adjust the speed of the pump at flow rates of 25, 50, and 75 percent of BEP flow using one of the methods specified in sections B.1.1.3.1 through B.1.1.3.3 of this appendix. Only one control setting may be evaluated.

B.1.1.2.1 Throttle the pump to the desired flow rate and allow the selected pressure control to automatically reduce the speed according to the control curve for the control setting being evaluated.

B.1.1.2.2 Manually adjust the speed of the pump and throttle the pump as needed to achieve speed settings equivalent to those that would be generated by the control setting being evaluated.

B.1.1.2.3 Provide a simulated pressure signal and throttle the pump as needed to achieve speed settings equivalent to those that would be generated by the control setting being evaluated.

B.1.2 For pressure controls that are adaptive pressure controls, select the control settings and adjust the speed of the pump according to section B.1.2.1 or B.1.2.2 of this appendix. Adaptive pressure controls may be manually adjusted to achieve 100 percent BEP flow and head point at max speed.

B.1.2.1 If the pump can be manually controlled, adjust the speed manually to achieve the load point flow rates with head values at or above the greater of the reference system curve and the minimum thresholds for head specified in the manufacturer literature.

B.1.2.2 If the pump does not have a manual control mode available, adjust the speed based on the pressure control mode with the lowest head at each load point. If the selected pressure control mode results in a head value below the reference system curve, the pump may be throttled to achieve a head value at or above the reference system curve.

B.1.3 All tested flow values must be within ±5 percent of the target flow load points as specified by the reference system curve equation in section I.E.3 of this appendix.

B.1.4 For tested head values that are at or above the head load points specified by the reference system curve, adjust the tested driver power input to the specified flow point using the following equation:

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

Where:

$P_{in,i}$ = 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).

B.1.5 For tested head values that are below the head load points specified by the reference system curve, adjust the tested driver power input to the specified flow and head point using the following equation:

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

Where:

$P_{in,i}$ = 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).

C. *Calculating the circulator energy rating.* Determine the CER of each tested circulator pump using the following equation:

$$CER = \sum_i \omega_i \left(P_{in,i}\right)$$

Where:

CER = circulator energy rating (hp);

ω_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;

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

i = test point(s) corresponding to 25, 50, 75, and 100 percent of BEP flow.

V. Testing and Calculation of CER for Circulator Pumps With Temperature Controls

A. *Scope.*

A.1 This section V applies only to circulator pumps sold with temperature controls.

B. *Determination of circulator pump driver power input.*

B.1 Adjust the speed of the pump using a manual speed adjustment or a simulated temperature signal to activate the temperature control to achieve flow rates of 25, 50, 75, and 100 percent of the BEP flow rate (as determined according to section I.E.2 of this appendix) with head values that are at or above the reference system curve (defined in section I.E.3 of this appendix). Measure the driver power input at those flow rates.

B.1.1 All tested flow values must be within ±5 percent of the target flow load points as specified by the reference system curve.

B.1.2 For tested head values that are more than 10 percent above the reference system curve, adjust the tested driver power input to the specified flow point using the following equation:

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

Where:

$P_{in,i}$ = 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).

B.1.3 For tested head values within ±10 percent of the head load points specified by the reference system curve, adjust the tested driver power input to the specified flow and head point using the following equation:

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

Where:

$P_{in,i}$ = 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).

B.1.4 If the tested head value is below the head load point specified by the reference system curve by more than 10 percent, the test point must be retested.

C. *Calculating the circulator energy rating.* Determine the CER of each tested circulator pump using the following equation:

$$\mathrm{CER} = \sum_i \omega_i (P_{in,i})$$

Where:

CER = circulator energy rating (hp);
ω_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;
$P_{in,i}$ = driver power input at each test point i (hp); and
i = test point(s) corresponding to 25, 50, 75, and 100 percent of BEP flow.

VI. Testing and Calculation of CER for Circulator Pumps Without External Input Signal, Manual, Pressure, or Temperature Controls (Full Speed Test)

A. *Scope.*

A.1 This section VI applies only to circulator pumps sold without external input signal, manual, pressure, or temperature controls, or to any conduct of a full speed test.

B. *Determination of circulator pump driver power input.* At maximum speed of rotation, determine the driver power input at 25, 50, 75, and 100 percent of the measured BEP flow rate (as determined according to section I.E.2 of this appendix) of the tested circulator pump in accordance with Appendix E of HI 40.6–2021.

C. *Calculating the circulator energy rating.* Determine the CER of each tested circulator pump using the following equation:

$$CER = \sum_i \omega_i (P_{in,i})$$

Where:

CER = circulator energy rating (hp);
ω_i = 0.25;
$P_{in,i}$ = driver power input at each test point i (hp); and
i = test point(s) corresponding to 25, 50, 75, and 100 percent of BEP flow.

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