DEPARTMENT OF ENERGY

10 CFR Parts 429 and 430

[EERE–2020–BT–TP–0012]

RIN 1904–AE49

Energy Conservation Program: Test Procedure for Battery Chargers

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

ACTION: Final rule.

SUMMARY: In this final rule, the U.S. Department of Energy (''DOE'') amends the existing test procedures for battery chargers to reorganize certain subsections, clarify symbology and references, correct an incorrect cross reference and section title, update the list of battery chemistries, and terminate an existing test procedure waiver because the covered subject models have been discontinued. This final rule also establishes in new appendix Y1 a new a test procedure for battery chargers that expands coverage to include inductive wireless battery chargers and establishes associated definitions and test provisions; establishes a new test procedure approach that relies on separate metrics for active mode, standby mode, and off mode; and updates the EPS selection criteria. The new test procedure Y1 will be used for the evaluation and issuance of updated efficiency standards, as well as to determine compliance with the updated standards, should such standards be established.

DATES: The effective date of this rule is October 11, 2022. The amendments to the current test procedure will be mandatory for product testing starting March 7, 2023. Manufacturers will be required to use the amended test procedure in appendix Y until the compliance date of any final rule establishing amended energy conservation standards based on the newly established test procedure in appendix Y1. At such time, manufacturers will be required to begin using the newly established test procedure in appendix Y1.

The incorporation by reference of certain materials listed in this rule is approved by the Director of the Federal Register on October 11, 2022.

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

A link to the docket web page can be found at *www.regulations.gov/docket/EERE-2020-BT-TP-0012.* The docket web page contains instructions on how to access all documents, including public comments, in the docket.

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

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SUPPLEMENTARY INFORMATION: DOE incorporates by reference the following industry standards into 10 CFR part 430:

ANSI/NEMA WD 6–2016, ''Wiring Devices—Dimensional Specifications;''

IEC 62040–3 Ed. 2.0, ''Uninterruptible power systems (UPS)—Part 3: Method of specifying the performance and test requirements, Edition 2.0, 2011–03;''

IEC 62301, ''Household electrical appliances—Measurement of standby power, (Edition 2.0, 2011–01), (''IEC 62301'')''.

Copies of ANSI/NEMA WD 6–2016 can be obtained from the American National Standards Institute, 25 W 43rd Street, 4th Floor, New York, NY 10036, (212) 642–4900, *webstore.ansi.org.*

Copies of IEC 62040–3 Ed.2.0 and IEC 62301 can be obtained from the International Electrotechnical Commission at 446 Main Street, Sixteenth floor, Worcester, MA 01608, or by going to *www.iec.ch.*, and is available from the American National Standards Institute, 25 W 43rd Street, 4th Floor, New York, NY 10036, (212) 642–4900, or go to *webstore.ansi.org.*

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

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I. Authority and Background

Battery chargers are included among the consumer products for which the U.S. Department of Energy (''DOE'') is authorized to establish and amend energy conservation standards and test procedures. (42 U.S.C. 6295(u)(1)) DOE's energy conservation standards and test procedures for battery chargers are currently prescribed at title 10 CFR 430.32(z) and 10 CFR part 430 subpart B, appendix Y (''appendix Y''), respectively. The following sections discuss DOE's authority to establish test procedures for battery chargers and relevant background information regarding DOE's consideration of test procedures for this product.

A. Authority

The Energy Policy and Conservation Act, as amended (''EPCA''),[1] authorizes

[1] All references to EPCA in this document refer to the statute as amended through the Energy Act

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 B [2] of EPCA established the Energy Conservation Program for Consumer Products Other Than Automobiles, which sets forth a variety of provisions designed to improve energy efficiency. Battery chargers, the subject of this final rule, are products included in the Energy Policy Conservation Program. (42 U.S.C. 6291(32); 42 U.S.C. 6295(u)(1))

The energy conservation program under EPCA consists essentially of four parts: (1) testing, (2) labeling, (3) Federal energy conservation standards, and (4) certification and enforcement procedures. Relevant provisions of EPCA specifically include definitions (42 U.S.C. 6291), test procedures (42 U.S.C. 6293), labeling provisions (42 U.S.C. 6294), energy conservation standards (42 U.S.C. 6295), the authority to require information and reports from manufacturers (42 U.S.C. 6296).

The testing requirements consist of test procedures that manufacturers of covered products must use as the basis for (1) certifying to DOE that their products comply with the applicable energy conservation standards adopted under EPCA (42 U.S.C. 6295(s)), and (2) making other representations about the efficiency of those products (42 U.S.C. 6293(c)). Similarly, DOE must use these test procedures to determine whether the products comply with any relevant standards promulgated under EPCA. (42 U.S.C. 6295(s))

Federal energy efficiency requirements for covered products established under EPCA generally supersede State laws and regulations concerning energy conservation testing, labeling, and standards. (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. 6297(d))

Under 42 U.S.C. 6293, EPCA sets forth the criteria and procedures DOE must follow when prescribing or amending test procedures for covered products. EPCA requires that any test procedures prescribed or amended be reasonably designed to produce test results which measure energy efficiency, energy use or estimated annual operating cost of a covered product during a representative average use cycle or period of use, as determined by the Secretary, and shall not be unduly burdensome to conduct. (42 U.S.C. 6293(b)(3))

EPCA also requires that DOE evaluate test procedures for each type of covered product, including battery chargers, at least once every 7 years to determine whether amended test procedures would more accurately or fully comply with the requirements for the test procedures to be reasonably designed to produce test results that reflect energy efficiency, energy use, and estimated operating costs during a representative average use cycle or period of use and to not be unduly burdensome to conduct. (42 U.S.C. 6293(b)(1)(A); 42 U.S.C. 6293(b)(3))

Additionally, EPCA requires DOE to amend its test procedures for all covered products to include standby mode and off mode energy consumption, with standby mode and off mode energy consumption integrated into the overall energy efficiency, energy consumption, or other energy descriptor unless the Secretary determines that (i) the current test procedures already fully account for and incorporate the standby mode and off mode energy consumption, or (ii) such an integrated test procedure is technically infeasible for a particular covered product. (42 U.S.C. 6295(gg)(2)(A); *see also* 42 U.S.C. 6295(u)(1)(B)(i))) If an integrated test procedure is technically infeasible, DOE must prescribe separate standby mode and off mode energy use test procedures, if separate tests are technically feasible. (*Id.*) Any such amendment must consider the most current versions of the International Electrotechnical Commission (IEC) Standard 62301 [3] and IEC Standard 62087 [4] as applicable. (*Id.*)

If the Secretary determines, on her own behalf or in response to a petition by any interested person, that a test procedure should be prescribed or amended, the Secretary shall promptly publish in the **Federal Register** proposed test procedures and afford interested persons an opportunity to present oral and written data, views, and arguments with respect to such procedures. (42 U.S.C. 6293(b)(2)) The comment period on a proposed rule to amend a test procedure shall be at least 60 days and may not exceed 270 days. *Id.* In prescribing or amending a test procedure, the Secretary shall take into account such information as the Secretary determines relevant to such procedure, including technological developments relating to energy use or energy efficiency of the type (or class) of covered products involved. *Id.* If DOE determines that test procedure revisions are not appropriate, DOE must publish its determination not to amend the test procedures. *Id.*

DOE is publishing this final rule in satisfaction of the 7-year review requirement specified in EPCA. (42 U.S.C. 6293(b)(1)(A))

B. Background

On May 4, 2020, DOE published a request for information (''May 2020 RFI'') seeking comments and data on whether, since the last test procedure update, there have been changes in battery charger testing methodology or new products introduced to the market since the last test procedure update that may necessitate amending the test procedure for battery chargers. 85 FR 26369, 26370. DOE specifically solicited feedback on possible approaches to testing inductive wireless battery chargers not designed for use in a wet environment. 85 FR 26369, 26371. DOE requested comment on the characteristics of the EPSs typically used by manufacturers for testing and certification purposes for battery charger products that require an EPS but do not come prepackaged with one, and the characteristics of the EPS used by consumers in real-world settings. *Id.* DOE also requested comment on whether using a reference EPS for testing would be appropriate in such a situation. *Id.* DOE similarly requested comment on the appropriateness of testing a battery charger using a reference battery load. 85 FR 26369, 26372. DOE further requested comment on whether other parts of the battery charger test procedure need to be updated such as end-of-discharge voltages, prescribed battery chemistries, consumer usage profiles, battery selection criteria, and the battery charger waiver process. 85 FR 26369, 26372–26373.

On November 23, 2021, DOE published a notice of proposed rulemaking (''November 2021 NOPR''), in which DOE responded to comments received in response to the May 2020 RFI and proposed amendments to the test procedures for battery chargers in appendix Y and in a new appendix Y1. 86 FR 66878. DOE's proposed amendments to appendix Y included reorganizing two subsections, clarifying symbology and references, correcting an incorrect cross reference and section title, updating the list of battery chemistries, and terminating an existing test procedure waiver because the

of 2020, Public Law 116–260 (Dec. 27, 2020), which reflect the last statutory amendments that impact Parts A and A–1 of EPCA.

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

[3] IEC 62301, *Household electrical appliances—Measurement of standby power* (Edition 2.0, 2011–01).

[4] IEC 62087, *Audio, video and related equipment—Methods of measurement for power consumption* (Edition 1.0, Parts 1–6: 2015, Part 7: 2018).

covered subject models have been discontinued. 86 FR 66878, 66881, 66885–66886, 66889–66894.

DOE also proposed to establish a new appendix Y1 that, in addition to the changes proposed for appendix Y, would expand the scope of the test procedure to include inductive wireless battery chargers beyond those designed and manufactured to operate in a wet environment (removing that distinction altogether), increase the rated battery energy limit of fixed location wireless chargers in appendix Y1 from ≤5 Wh to ≤100 Wh, establish associated definitions for fixed-location wireless chargers and open-placement wireless chargers and corresponding test provisions; establish a new test procedure approach that relies on separate metrics for active mode, standby mode, and off mode (consequently removing the battery charger usage profiles and single-metric unit energy consumption calculation); and update the EPS selection criteria. 86 FR 66878, 66881, 66883–66885, 66887–66889.

On January 7, 2022, DOE published an extension of the comment period in response to a joint request submitted by some stakeholders.[5] 87 FR 890.

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

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

Commenter(s)	Reference in this final rule	Document No. in docket	Commenter type
American Honda Motor Co., INC	Honda	26	Manufacturer.
Appliance Standards Awareness Project, American Council for an Energy-Efficient Economy, Consumer Federation of America, Natural Resources Defense Council.	Joint Efficiency Advocates	23	Efficiency Organizations.
Association of Home Appliance Manufacturers, Outdoor Power Equipment Institute, Power Tool Institute, Inc.	Joint Trade Associations	24	Trade Associations.
California Investor-Owned Utilities (Pacific Gas and Electric Company, San Diego Gas and Electric, Southern California Edison).	CA IOUs	25	Utilities.
CSA Group	CSA	12	Efficiency Organization.
Delta-Q Technologies	Delta-Q	28	Manufacturer.
Information Technology Industry Council	ITI	20	Trade Association.
Northwest Energy Efficiency Alliance	NEEA	27	Efficiency Organization.
Schumacher Electric Corporation	Schumacher	21	Manufacturer
STIHL	STIHL	16	Manufacturer.
Wireless Power Consortium	WPC	22	Efficiency Organization.

A parenthetical reference at the end of a comment quotation or paraphrase provides the location of the item in the public record.[6]

II. Synopsis of the Final Rule

In this final rule, DOE amends appendix Y by adopting the proposed test procedure changes as follows:

(1) Updates terms used in the battery chemistry table;

(2) Provides further direction regarding the application for a battery charger test procedure waiver when battery energy cannot be directly measured;

(3) Provides more descriptive terms for battery energy and battery voltage values used for determining product class and calculating unit energy; and

(4) Corrects a cross-reference and a table title, further clarifies certain references and terminologies, and reorganizes certain subsections for improved readability.

DOE is also adopting the proposed new appendix Y1, which would generally require that testing be conducted as provided in appendix Y as amended in this final rule, but with the following additional changes:

(1) Establishing definitions associated with inductive wireless power transfer, and differentiating between wireless chargers that incorporate a physical receiver locating feature (*e.g.,* a peg, cradle, dock, locking mechanism, magnet, etc.) for aligning or orienting the position of the receiver (''fixed-location'' wireless chargers) to the transmitter and those that do not (''open-placement'' wireless chargers);

(2) Including within the scope of the test procedure fixed-location inductive wireless battery chargers, and adding a separate no-battery mode test for open-placement wireless chargers;

(3) Removing the unit energy consumption (''UEC'')[7] calculations and usage profiles and instead relying on separate metrics for active mode, standby mode, and off mode using E_a, P_{sb}, and P_{off}, respectively, as measured by the newly established appendix Y1; and

(4) Specifying EPS selection priority and amending selection requirements for battery chargers that do not ship with an EPS and for which one is not recommended by the manufacturer.

Manufacturers would not be required to test according to appendix Y1 until such time as compliance is required with any amended energy conservation standards for battery chargers established after September 8, 2022.

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

[5] The joint request was submitted by the Association of Home Appliance Manufacturers, Consumer Technology Association, Information Technology Industry Council, National Electrical Manufacturers Association, Outdoor Power Equipment Institute, Plumbing Manufacturers Institute, and Power Tool Institute. Comment no. EERE–BT–2020–TP–0012–0017 (available at *www.regulations.gov/comment/EERE-2020-BT-TP-0012-0017*).

[6] The parenthetical reference provides a reference for information located in the docket of DOE's rulemaking to develop test procedures for battery chargers. (Docket No. EERE–2020–BT–TP–0012, 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 UEC represents the annualized amount of the non-useful energy consumed by a battery charger among all tested modes of operation. Non-useful energy is the energy consumed by a battery charger that is not transferred and stored in a battery as a result of charging, *i.e.,* the losses.

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

Current DOE test procedure	Amended test procedure	Applicable test procedure	Attribution
Only those wireless chargers that operate in "wet environments" and have a battery energy of less than or equal to 5 watt-hours (Wh) are in scope of the battery charger test procedure.	Increases the 5 Wh limit to 100Wh and replaces the "wet environment" designation with "fixed-location wireless chargers", such that wireless chargers meant for dry as well as wet environments would be in scope.	Appendix Y1	To reflect changes in the market.
Does not differentiate between types of wireless chargers.	Addresses open-placement wireless chargers and fixed-location wireless chargers, and adds definitions for both.	Appendix Y1	To reflect changes in the market.
Does not provide a test method for open-placement wireless chargers.	Adds a no-battery mode test method for open-placement wireless chargers in a newly created section of the appendix.	Appendix Y1	To reflect changes in the market and to improve representativeness.
Does not provide EPS selection priority for chargers that do have associated EPSs. For those that do not, current test procedure requires DC battery chargers be tested with 5.0 V DC for USB port powered devices, or the midpoint of the rated input voltage range for others.	Adds EPS selection order priority and removes the 5.0V DC input criteria. For battery chargers that do not ship with an EPS and do not have a recommended adapter, requires that the charger be tested using an EPS that is minimally compliant with the applicable energy conservation standard and supplies the rated input voltage and current.	Appendix Y1	To reflect changes in technology and to improve representativeness and comparability of results.
Battery chemistries specified in Table 3.3.2 do not reflect the latest industry naming conventions.	Updates "Lithium Polymer" to "Lithium-Ion Polymer," and changes "Nanophosphate Lithium-Ion" to "Lithium Iron Phosphate".	Appendix Y and Appendix Y1.	To reflect changes in the market.
UEC calculation relies on usage profiles to determine the length of time spent in each mode of operation.	Removes battery charger usage profiles and the UEC calculation; adopts separate metrics, E_a, P_{sb} and P_{off}, for the energy performance of a battery charger in each of the following three modes of operation respectively: active mode, standby mode and off mode.	Appendix Y1	To improve representativeness.
Total test duration might not capture a representative measure of maintenance mode power of certain battery chargers.	Prolongs the test duration until maintenance mode power has been captured representatively, if needed.	Appendix Y1	To improve representativeness.
Manufacturer can report the battery discharge energy and the charging and maintenance mode energy as "Not Applicable" if the measurements cannot be made.	Provides specific direction to apply for a test procedure waiver if the battery energies cannot be directly measured.	Appendix Y and Appendix Y1.	To improve representativeness.
Uses the designation "E_{batt}" for both experimentally measured battery energy and representative battery energy.	Changes the denotations to "Measured E_{batt}" for experimentally measured battery energy, and "Representative E_{batt}" for representative battery energy, with further clarification in the footnotes.	Appendix Y	To improve readability.
Section 3.3.4 incorrectly references section 3.3.2 for instructions on how to discharge batteries.	Corrects the cross-section reference to Table 3.3.2	Appendix Y and Appendix Y1.	To improve readability.
Table 3.3.2 is located after Section 3.3.10 (Determining the 24-hour Energy Consumption) but is required for use in section 3.3.8 (Battery Discharge Energy Test).	Moves Table 3.3.2 to Section 3.3.8	Appendix Y and Appendix Y1.	To improve readability.
Certain sections use terms such as "above" or "below" for references.	Further clarifies the referenced sections	Appendix Y and Appendix Y1.	To improve readability.
Battery charger standby mode and off mode can be inappropriately tested if manufacturer does not follow the test procedure in order.	Reorganizes sections 3.3.11 and 3.3.12 so battery charger standby and off modes can be tested correctly even if the test procedure order is not followed.	Appendix Y and Appendix Y1.	To improve readability.
Column title in Table 3.3.3 states "Special characteristic or rated battery voltage".	Corrects the title to read "Special characteristic or highest rated battery voltage" to clarify that for multi-voltage chargers, the highest battery voltage must be used to determine product class.	Appendix Y and Appendix Y1.	To improve readability.
Uses the term "wall adapters" to refer to external power supplies, which is inconsistent with certification requirements and reporting templates.	Changes the "wall adapter" terms to more technically correct term of "EPSs".	Appendix Y and Appendix Y1.	To improve readability.
Definition of "C-Rate" does not provide a straightforward translation between charge or discharge rate and charge or discharge time.	Adds clarification that a 0.2 C-Rate would translate to a charge or discharge period of 5 hours.	Appendix Y and Appendix Y1.	To improve readability.

DOE has determined that the amendments to appendix Y described in section III and adopted in this document will not alter the measured efficiency of battery chargers, or require retesting or recertification solely as a result of DOE's adoption of the amendments to the test procedure at appendix Y. Additionally, DOE has determined that the amendments will not increase the cost of testing under appendix Y.

DOE has determined that the newly established appendix Y1, which specifies testing with a minimally compliant EPS, increases scope of wireless chargers, and removes the usage profiles and UEC calculation would result in a value for measured energy use that is different from that measured using the current test procedure. However, testing in accordance with the newly established appendix Y1 would not be required until such time as compliance is required with new and amended energy conservation standards, should DOE establish such standards. Additionally, DOE has determined that testing under appendix Y1 would not increase the cost of testing as compared to testing under appendix Y. Discussion of DOE's actions are addressed in detail in section III of this document.

The effective date for the amended test procedures adopted in this final rule is 30 days after publication of this document in the **Federal Register**. Representations of energy use or energy efficiency must be based on testing in accordance with the amended appendix Y test procedures beginning 180 days after the publication of this final rule. Manufacturers will be required to certify compliance using the new appendix Y1 test procedure beginning on the compliance date of any final rule published after the effective date of this final rule that establishes amended energy conservation standards for battery chargers.

III. Discussion

In this battery chargers test procedure final rule, DOE is amending appendix Y and establishing a new appendix Y1 as described throughout the following sections.

EPCA requires DOE to review the test procedure for battery chargers at least once every 7 years and to determine whether amendments to the test procedure would more accurately or fully comply with the requirements for test procedures to be reasonably designed to produce representative test results without undue burden. (42 U.S.C. 6293(b)(1)(A)) In response to the November 2021 NOPR, the Joint Trade Associations stated that DOE proposed several changes that improve the clarity but not representativeness of the test procedure and urged DOE to prioritize other rulemakings. (Joint Trade Associations, No. 24 at p. 1) DOE reiterates that it is undertaking this rulemaking pursuant to the periodic review required by EPCA. As discussed in the following sections, DOE has determined that appendix Y, as amended in this final rule, and appendix Y1 as established in this final rule, more accurately and fully comply with the requirements in EPCA for test procedures to be reasonably designed to produce representative test results without undue burden. (42 U.S.C. 6293(b)(3))

A. Scope of Applicability

1. Battery Chargers

This rulemaking applies to battery chargers, which are devices that charge batteries for consumer products, including battery chargers embedded in other consumer products. (42 U.S.C. 6291(32); 10 CFR 430.2) A battery charger may be wholly embedded in another consumer product, partially embedded in another consumer product, or wholly separate from another consumer product. *Id.* Appendix Y differentiates among different types of battery chargers, including batch chargers, multi-port chargers, and multi-voltage chargers, as well as various battery chemistries. For each type of battery charger, appendix Y specifies test setup requirements and test battery selection, such as battery preparation steps, battery end-of-discharge voltages, and battery charger usage profiles based on the respective product classes. These different specifications are intended to ensure that each battery charger is tested to produce results that measure energy use during a representative average use cycle or period of use.

DOE's current battery charger test procedure applies to battery chargers that operate at either direct current (''DC'') or United States alternating current (''AC'') line voltage (115 Volts (''V'') at 60 Hertz), as well as to uninterruptible power supplies that have an AC output and utilize the standardized National Electrical Manufacturer Association (''NEMA'') plug, 1–15P or 5–15P, as specified in American National Standards Institute (''ANSI'')/NEMA WD 6–2016.

The CA IOUs stated in their comment responding to the November 2021 NOPR that new consumer products powered by batteries require more power, and therefore current battery chargers are more powerful than when DOE initially developed its battery charger standard and test procedure. (CA IOUs, No. 25 at p. 7) These more powerful battery chargers, they claimed, offer larger energy savings potential through energy efficiency standards. *Id.* CA IOUs therefore recommended that DOE clarify the scope of the test procedure, and expand it to cover battery chargers that can operate on either 115V or 230V AC voltage levels. (CA IOUs, No. 25 at p. 7) CA IOUs noted that US residences typically offer AC electricity at both 115V and 230V at 60Hz and that modern battery chargers may be designed for either voltage, and therefore DOE should expand the test procedure to include both voltage levels. *Id.*

DOE notes that AC line voltage for common household electrical outlets in the United States is typically limited to 115V [8] at 60Hz for residential environments, with specialized 230V 60Hz AC line voltage outlets reserved for limited number of heavy-duty applications such as clothes washers, dryers, and electric cooking products. While battery chargers with universal inputs exist (*i.e.,* that support a range of 115V to 230V as input voltage), such products support 230V generally only to facilitate travel outside of the United States without the need for a travel adapter. These products, when used within the United States, operate at 115V and therefore should be tested as such. The scope of the test procedure includes any battery charger capable of operating at either DC or United States AC line voltage without regard to whether it is also capable of operating at other voltages.

The CA IOUs further requested that DOE clarify the extent of DOE's authority on automobile chargers and other products. (CA IOUs, No. 25 at p. 7) CA IOUs stated that DOE possessed the authority to regulate battery chargers embedded in consumer products, and therefore DOE could regulate chargers embedded in automobiles even if DOE cannot regulate the efficiency of electric vehicles themselves. *Id.* CA IOUs asked DOE to clarify its authority under EPCA to set standards for chargers embedded in automobiles, both those that charge other consumer products and those that charge the automobile's internal battery. *Id.* NEEA also encouraged DOE to cover electric vehicle (''EV'') chargers under the test procedure scope, stating that market data and policy trends illustrate the need for EV charger efficiency standards. (NEEA, No. 27 at p. 10) NEEA noted there are three types of energy losses associated with EV charging, and that consumers are paying for these energy losses as though the lost energy were gasoline leaking from the hose as a tank is filled. (NEEA, No. 27 at p. 10) NEEA further suggested that because public policy and market designs are not focusing on promoting higher efficiency charging, EV chargers focus on lower cost and lower weight, and that even small efficiency differences from standards could have large nationwide impacts. (NEEA, No. 27 at p. 11)

DOE notes, however, that due to the definition of battery chargers in EPCA, DOE's authority to regulate battery chargers extends only to battery chargers that charge batteries for consumer products. (42 U.S.C. 6291(32)) As defined by EPCA, ''consumer products'' statutorily excludes automobiles. (42 U.S.C. 6291(1)) Regardless, DOE further notes that its test procedure for battery chargers as established in appendix Y (and newly established appendix Y1) cannot be adapted to measure the energy performance of battery chargers designed to charge electric vehicles without significant modifications that were not proposed in the November 2021 NOPR. Therefore, in this final rule DOE clarifies that this battery charger test procedure does not provide a method for testing electric vehicle battery chargers, and they remain outside the test procedure's scope.

[8] DOE refers to AC line voltage here as 115V, recognizing that United States line voltage is also often referred to as 120V or 110V in some contexts.

Finally, CA IOUs requested clarification regarding whether chargers used by (i) electric trucks, E-bikes, electric motorcycles, electric boats, and other consumer electric vehicles that are not automobiles; (ii) aerial drones and other battery-powered, remotely operated devices marketed to consumers; (iii) battery-powered electric riding lawn mowers and walk-behind lawnmowers sold to consumers; and (iv) battery chargers commonly referred to as ''DC fast chargers'' or ''Level 3 chargers'' (*e.g.,* Wallbox and SETEC) that are not embedded in electric automobiles but are designed to charge batteries in electric automobiles by bypassing the on-board battery charger. (CA IOUs, No. 25 at p. 7)

A manufacturer is best positioned to know the nuances of their model's characteristics and design, which impact how regulations apply. DOE however notes that most battery chargers intended for use with consumer electronics, including E-bikes, aerial drones and lawn mowers are in scope of the battery charger test procedure. While DOE cannot comment on the test procedure's applicability to all the battery chargers for a specific end-use product group, DOE suggests inquiring with the department directly for clarifications on a case-by-case basis.

2. Inductive Wireless Battery Chargers

DOE's current energy conversation standards for battery chargers were established in a final rule published on June 13, 2016 (''June 2016 Final Rule''). The standards cover inductive wireless battery charger products (also referred to as ''wireless power devices'') only to the extent that such products are designed and manufactured to operate in a wet environment (*i.e.,* Product Class 1). 81 FR 38266, 38282; 10 CFR 430.32(z)(1). DOE established standards for these wet-environment inductive wireless battery chargers (*e.g.,* battery chargers found in wireless toothbrushes and electric shavers) after finding that the technology used in those products was mature. *Id.* DOE did not establish standards for other types of inductive wireless battery chargers to avoid restricting the development of newer, less mature inductively charged products. *Id.* Similarly, DOE did not generate usage profiles for other types of inductive wireless chargers at the time because of their nascent state of development and their lack of widespread availability in the marketplace. *Id.* Without usage profiles, a corresponding unit energy consumption value cannot be calculated under the test procedure in appendix Y. *Id.*

In the November 2021 NOPR, DOE proposed to define fixed-location wireless chargers and open-placement wireless chargers in a new appendix Y1 to include these chargers within the scope; and to expand the scope of the proposed appendix Y1 test procedure to cover testing of fixed-location wireless chargers in all modes of operation, as well as testing of open-placement wireless charger in no-battery mode only. 86 FR 66878, 66882–66884. DOE proposed to define the term ''fixed location'' wireless charger in appendix Y1 to refer to inductive wireless battery chargers that incorporate a physical receiver locating feature (*e.g.,* a peg, cradle, dock, locking mechanism, magnet, etc.) to repeatably align or orient the position of the receiver with respect to the transmitter. DOE then proposed to define the term ''open-placement'' wireless chargers in appendix Y1 to address wireless charging products that do not have a physical locating feature (*e.g.,* charging mats). DOE proposed to remove the ''wet environment'' products distinction for wireless chargers, as a result of these changes. 86 FR 66878, 66883.

ITI, the Joint Efficiency Advocates, the Joint Trade Associations, the CA IOUs, NEEA, and Delta-Q expressed general support for DOE's proposed approach to expand the scope in appendix Y1 to remove the wet environment definition and to classify and cover both fixed-location and open-placement wireless chargers. (ITI, No. 20 at p. 2; Joint Efficiency Advocates, No. 23 at pp. 1–2; Joint Trade Associations, No. 24 at p. 8; CA IOUs, No. 25 at pp. 2–3; NEEA, No. 27 at pp. 4–6; Delta-Q, No. 28 at p. 1) However, NEEA urged DOE to adopt technology-neutral definitions for wireless chargers rather than specifying only an inductive connection, to allow future products to be tested and considered under the test procedures regardless of specific product technology used (citing inductive, magnetic resonant, radio frequency as examples) and allow free competition to deliver wireless charging without restriction by technology specific test procedures. (NEEA, No. 27 at pp. 6–7) Instead, NEEA recommended a definition for wireless chargers that defines wireless chargers as those chargers that transmit energy without a wired connection to a receiving device. (NEEA, No. 27 at p. 7) DOE notes that other wireless charging methods beyond those addressed in appendix Y and new appendix Y1 are still nascent and lack widespread availability in the market. Defining such technologies and addressing them in the test procedure at this time could potentially restrict the development of these less mature technologies.

DOE proposed in the November 2021 NOPR to cover fixed-location wireless chargers, having tentatively determined that the physical receiver locating feature would allow accurate and repeatable relative receiver alignment or orientation. 86 FR 66878, 66883. NEEA noted that DOE's proposal for fixed-location wireless chargers addresses the technical challenges associated with physical displacement of the transmitter and receiver, and that wireless charger efficiency depends on the product's horizontal and vertical displacement from the transmitter but that fixed-location charger's magnetic or physical guides ensure proper and consistent positioning. (NEEA, No. 27 at 6). ITI suggested that DOE clarify in its definition that fixed-location wireless chargers should be able to align or orient the receiver position in both vertical and horizontal orientations through the receiver locating feature, whereas open-placement chargers do not incorporate a physical receiver locating feature. (ITI, No. 20 at pp. 1–2) ITI further inquired whether a wireless charger that relies on LED or another form of indication to indicate correct placement in lieu of physical locating features, would be considered as an open-placement one. (ITI, No. 20 at p. 2)

DOE concludes that the definition as proposed, specifying that the locating feature should ''repeatably align or orient the position of the receiver with respect to the transmitter'', to be sufficiently specific without respect to whether such alignment is in the vertical or horizontal (or any other) position. DOE finds that this specification in the definition sufficiently minimizes test to test variation without prescribing additional design constraints. In cases where the charger only employs indication of correct placement, such as by visual indication or audio indication, but does not have physical locating features that ensures repeatable alignment or orientation, DOE notes that relative receiver placement can still vary ever so slightly for such chargers, which causes variation in active mode testing. Therefore, such wireless charger would still be considered as open-placement wireless charger because of the lack of locating feature that can ''repeatably align or orient the position of the receiver with respect to the transmitter.''

NEEA stated that for future fixed-location wireless chargers able to charge a variety of products (interoperable fixed-location chargers), different receiver-battery combinations could result in efficiency differences. (NEEA, No. 27 at p. 6) NEEA suggested that DOE either address these chargers with an active mode test procedure waiver, or further specify that these chargers must be tested with a manufacturer-specified range of receivers but not other products that use the same power transfer standard. (*Id.*) The CA IOUs referred DOE to WPC's comment that fixed-location wireless chargers risk efficiency variations for different receivers, which prevents WPC from releasing a receiver-independent active mode power transfer efficiency metric. (CA IOUs, No. 25 at p. 5) The CA IOUs encouraged DOE to continue to measure performance and regulate fixed-location wireless charging systems under the current approach, and suggested that DOE require combinations of new receiver devices used in conjunction with previous wireless charger models to meet the minimum efficiency requirement. (*Id.*) The CA IOUs further encouraged DOE to clarify that if a change in receiver were to reduce efficiency beyond a nominal threshold for a particular fixed-location wireless charger, then it should be regulated as a new basic model. (*Id.*)

DOE notes that the definitions of ''fixed-location wireless charger'' and ''open-placement wireless charger'' proposed in the November 2021 NOPR and adopted in this final rule indicate that the term ''wireless battery charger'' encompasses both the transmitter (*i.e.,* the charging mat, for example) and the receiver (*i.e.,* the end-use product containing the battery). Neither the transmitter nor the receiver on its own constitutes a ''battery charger.'' As such, each combination of transmitter and receiver [9] that has different electrical, physical, or functional characteristics that affect energy consumption would be considered a different basic model and would be required to be certified accordingly.

ITI further suggested that although ITI is unaware of any type of wireless chargers other than fixed-location or open-placement wireless chargers, DOE should leave open the possibility that future wireless chargers may not fall into either fixed-location or open-placement wireless chargers. (ITI No. 20 at p. 2) DOE agrees with ITI that all current wireless chargers would fall in either fixed-location wireless charger or open-placement wireless charger category. As such, the adopted fixed-location and open-placement wireless charger definitions would capture the current wireless charger market accurately. DOE will make thorough reviews of the battery charger test procedure, should new charger types mature in the market.

The Joint Trade Associations, noting that they support maintaining the UEC approach, also suggested DOE add Table 3.3.3 to a UEC-compatible version of appendix Y1 so that Product Class 1 is preserved with lower battery energy limits, and a new Product Class 1A can be established for higher battery energy inductive chargers. (Joint Trade Associations, No. 24 at p. 8) The Joint Trade Associations stated that it would be appropriate to separate wireless chargers from wired chargers under this approach, and further suggested DOE would need to account for the expanded scope and create a new Product Class 1A for higher energy inductive chargers. (*Id.*) DOE notes that DOE is adopting the proposed multi-metric approach, and under the multi-metric approach, DOE does not need to further separate product classes, as the testing method and calculation steps for determining the tested values are the same for battery chargers in all product classes. To the extent that consideration of different product classes may be warranted, DOE would do so in a future energy conservation standards rulemaking.

ITI inquired as to the applicability of standards to a product that can take either wired or wireless charging; and the applicability of standards to a wireless charger shipped without an end use device. (ITI, No. 20 at p. 6) As stated earlier, different wired/wireless charger and end use product/battery combinations could result in different charging efficiencies. Therefore, they would constitute different battery charger models and would need to be tested and certified separately. DOE notes that manufacturers have already been certifying products in this way under the current test procedure. Furthermore, under the new appendix Y1 test procedure if a consumer product can accept charge either wired or wirelessly, each charging configuration would also need to be tested and certified separately.

The CA IOUs supported DOE expanding coverage to ''combination products'' with integrated wireless chargers such as bedside or desk lamps, clocks, and furniture that has built in wireless chargers. (CA IOUs, No. 25 at pp. 5–6) The CA IOUs suggested that these products are currently not covered under DOE's battery charger test procedure and are expected to significantly displace DOE-regulated battery chargers in some product classes. *Id.* The CA IOUs stated that they are analyzing combination products and recommended DOE establish clear definitions for combination products to clarify what combination products are not covered by DOE's test procedures and standards, so that they can be covered under other energy efficiency regulations or guidelines such as CEC Low Power Mode Roadmap.[10] (CA IOUs, No. 25 at pp. 5–6) The Joint Efficiency Advocates encouraged DOE to expand the no-battery mode only test coverage to include dual-purpose open-placement chargers such as alarm clocks and table lamps with embedded wireless chargers, because they are becoming increasingly common. (Joint Efficiency Advocates, No. 23 at p. 2)

DOE's definition for battery charger includes battery chargers embedded in other consumer products. 10 CFR 430.2. For combination products that have multiple functions, if they do come with a battery charger, then the battery charging component of the combination product would still need to be tested under DOE's battery charger test procedure.

The Joint Trade Associations stated that there was some confusion in DOE's proposal for expanded wireless chargers in appendix Y1, as they noted the preamble proposed a change to Product Class 1 in appendix Y1 to include all fixed-location wireless chargers, but that this change was not present in the regulatory text, and the proposed regulatory text for Table 3.3.3 of appendix Y shows a measured battery energy of 20Wh, a value not discussed anywhere in the preamble. (Joint Trade Associations, No. 24 at p. 8) DOE notes that the reference to 20 Wh in the proposed regulatory text for appendix Y was an error and has been corrected to 5 Wh for this final rule.

In the November 2021 NOPR, DOE proposed to increase the rated battery energy limit of fixed-location wireless chargers in appendix Y1 from ≤5 Wh to 100 Wh. 86 FR 66878, 66883. At the time of the June 2016 Final Rule, all inductive wireless chargers designed for use in wet environments (the prior scope of coverage) had a battery energy under 5 Wh. *Id.* In discussion of the increased limit in the November 2021 NOPR and in light of the removal of the wet environment distinction, DOE stated that it had conducted initial research and found that although most

[9] DOE further notes that applicable to transmitters that can accommodate multiple receivers or batteries, only the manufacturer recommended combinations are tested. *See* section 3.1.4(b) of appendix Y and appendix Y1 as finalized, which specifies testing battery chargers with an EPS recommended by the manufacturer.

[10] CEC Low Power Road Map is available on *www.energy.ca.gov/rules-and-regulations/appliance-efficiency-regulations-title-20/appliance-efficiency-proceedings-6.*

of the fixed-location inductive wireless chargers were designed for batteries with lower energy ratings, typically within 20Wh, there are some fixed-location inductive wireless chargers that can charge products with higher battery energy levels of around 80 Wh, namely inductively charged power tool products. *Id.* The expansion of the limit to 100 Wh was made to accommodate potential future product designs that may have larger battery energies. *Id.* In their response to the November 2021 NOPR, NEEA noted that wireless charging for consumer products is already commonplace and continued growth is expected, along with substantially increased energy use. (NEEA, No. 27 at p. 4) ITI and the Joint Trade Association supported the proposal to expand the scope to include those with battery energies up to 100Wh. (ITI, No. 20 at p. 2, Joint Trade Associations, No. 24 at p. 8)

WPC stated that wireless chargers (referred to as ''wireless power transmitters'' by WPC) should be categorized as external power supplies (''EPSs'') because they can power devices without batteries. (WPC, No. 22 at p. 1) WPC stated that although they believe wireless chargers should be tested as EPSs with appropriate resistive loads, the usage profile is very different from wired chargers, and they are more frequently used for ''top-ups''. (WPC, No. 22 at pp. 1–2)

In the November 2019 NOPR, the department acknowledged that open-placement wireless chargers are sometimes designed to work with third party products, some of which may not be battery operated. DOE's research of the marketplace however shows that the vast majority of these third-party applications continue to be primarily reliant on battery power, with power received from an open-placement charger used to charge that battery. This conclusion is reasonable, considering the inherent limitation in the distance across which wireless power can be transmitted. As such, DOE maintains that the revised battery charger test procedure is appropriate for capturing the energy performance of open-placement wireless chargers in no-battery mode. With regards to WPC's comment that wireless chargers should be measured with resistive loads, DOE notes that testing with a load is only relevant for active mode testing, which DOE did not propose for the reasons stated in section III.B.1 of this final rule. For the reasons discussed in the preceding paragraphs and in the November 2021 NOPR, DOE is adopting the proposals made in the November 2021 NOPR to establish definitions for both fixed-location wireless chargers and open-placement wireless chargers, to increase the rated battery energy limit for fixed-location inductive chargers from <5 Wh to <100 Wh, and, as discussed below to expand the test procedure's scope to cover testing open-placement wireless chargers in no-battery mode only.

B. Test Procedure

1. Wireless Charger Test Procedure

In the November 2021 NOPR, DOE proposed to expand the scope of the proposed appendix Y1 test procedure to cover testing of fixed-location wireless chargers in all modes of operation, and to cover testing of open-placement wireless charger in no-battery mode only. 86 FR 66878, 66882–66884.

The CA IOUs further recommended that DOE collaborate with industry and standards organizations to develop a suitable method of measurement for active mode power for interoperable open placement chargers, such as the approach proposed by WPC that measures active mode power consumption at several key locations on the charging device. (CA IOUs, No. 25 at p. 3) The CA IOUs modeled the savings potential from applying potential standby and active mode power regulations to inductive battery chargers. (CA IOUs, No. 25 at pp. 3–4) The CA IOUs estimated the lifetime unit energy savings from regulating standby mode to be about 1.4 GWh for 5 years of shipments. (*Id.*) The CA IOUs estimated the lifetime unit energy savings from regulating active mode to be about 60 GWh for 5 years of shipments. (*Id.*)

NEEA supported the development of a standby test method for open-placement wireless chargers using International Electrotechnical Commission (IEC) 62301 in appendix Y1 and encouraged DOE to continue developing an active mode test procedure with industry. (NEEA, No. 27 at 6). NEEA further recommended that DOE in the interim retain a placeholder for future active mode or other low power mode testing of open-placement wireless chargers. (NEEA, No. 27 at pp. 6–7). WPC agreed that no appropriate active mode test can be prescribed for open-placement wireless chargers yet, because of varying receiver efficiency and the capability for one open placement charger to simultaneously charge multiple receivers. (WPC, No. 22 at p. 1) However, WPC noted that covering only fixed-location wireless chargers in the active mode test procedures can discourage manufacturers from choosing more efficient fixed-location wireless charger designs. (WPC, No. 22 at pp. 1–2) WPC recommended that DOE extend the no-battery only test to fixed-location chargers designed for receivers that can take open-placement chargers as well (for example, exclude certain wireless charging stands and specific in-car wireless chargers from the active charging test). (WPC, No. 22 at pp. 1–2)

DOE acknowledges the difficulty in establishing a repeatable and representative open-placement wireless charger (including interoperable open-placement wireless charger) test procedure for active mode. As stated in the November 2021 NOPR, first, efficiency of wireless power transfer varies greatly depending on the alignment of the receiver with respect to the transmitter. A test procedure designed to capture the representative energy performance of such a device would need to repeatably measure the average power transfer efficiency across the full range of possible placement positions on the transmitter. Second, representative test load(s) would need to account for all charging scenarios because these open-placement wireless chargers are designed to work with various third-party products. Third, these devices also typically incorporate other non-battery-charging related features inherent to implementing an open-placement design, such as foreign object detection circuits, that may affect charging efficiency. 86 FR 66884. DOE, working in conjunction with industry organizations such as the WPC, has found that mitigating these challenges is difficult. To-date, that work has yielded test methods that either lack repeatability or result in significant test burden. In addition, evaluating whether a particular test procedure measures the energy performance of open-placement wireless chargers during a representative average use cycle, specifically during active mode operation, requires data on consumer usage at the various modes of operation. DOE lacks, and is unaware of, such data. *Id.*

Based on further evaluation and consideration of the comments received, DOE concludes that a representative and repeatable test procedure for measuring the active mode energy performance of open-placement wireless chargers cannot be prescribed at this time without undue burden. DOE will continue its efforts, working with industry bodies, such as WPC, IEC, and ANSI/CTA, to develop an active mode test procedure for open-placement wireless chargers that appropriately addresses the impact of receiver placement on charging efficiency, and will continue to gather relevant consumer usage data. WPC stated that fixed-placement does not necessarily mean battery charger, because the battery management and control circuitry are often placed in the wireless receiver. (WPC, No. 22 at p. 3) WPC agreed that the present ''interoperable'' wireless charger (regardless of open-placement or fixed-location) efficiency testing method is not representative of real-world performance and is likely not repeatable. WPC stated that to make such a test method repeatable would require a placement coordinate table that moves the receiver in 1mm increments within the charging area, developing accurate user placement models, and limiting the receiver to one specific product design. (*Id.*)

For fixed-location wireless battery chargers that can work with multiple end use products, each different wireless charger and end use product/battery combinations could result in different charging efficiencies, therefore, they would constitute as different battery charger models and would need to be tested and certified separately. DOE notes that manufacturers have already been certifying products in this way under the current test procedure. As for open-placement wireless chargers, DOE notes that for even a relatively small wireless charging coil of 30 by 30 square millimeters, to accurately and repeatably capture the overall active mode energy consumption by moving the relative receiver placement in 1mm increments, as described by WPC, would result in 900 iterations. Even if the technician were to measure the efficiency differences across 5mm or 10mm increments, it would still result in dozens of repeated active mode tests, which adds significant undue burden to the test procedure. Additionally, because of the open-placement wireless charger design, it would be virtually impossible to develop representative relative receiver placement models. Therefore, DOE reiterates that a representative and repeatable test procedure for measuring the active mode energy performance of open-placement wireless chargers cannot be prescribed at this time without undue burden.

WPC further suggested that the name for open-placement chargers ''no-battery mode'' test should be changed to ''no receiver mode''. (WPC, No. 22 at p. 2) DOE notes that wirelessly charged devices usually have batteries and receiving circuitry built-in the device; therefore, batteries and receivers cannot be separated without tearing down the product. To maintain test mode language consistency, DOE is not changing the ''no-battery mode'' designation.

DOE appreciates the remainder of WPC's comments and notes that this final rule establishes only a test procedure and not energy conservation standards for fixed-location wireless chargers. DOE does not believe simply providing a method for testing the efficiency of these technologies without a corresponding energy conservation standard would impact manufacturer's design choices.

In this final rule, DOE is finalizing its proposal from the November 2021 NOPR to test fixed-location wireless chargers in all modes of operation, and to capture the no-battery mode energy performance of open-placement wireless chargers in the new appendix Y1. DOE is also adopting the proposal to leave a placeholder section in the new appendix Y1 to be reserved for a potential active mode test procedure for open-placement wireless chargers.

2. External Power Supply Selection

Most battery chargers require the use of an EPS to convert 115-volt (''V'') AC line voltage into a low-voltage DC or AC output suitable for powering the battery charger. DOE's current battery charger test procedure specifies that the battery charger be tested with the EPS packaged with the charger, or the EPS that is sold or recommended by the manufacturer. If an EPS is not packaged with the charger, or if the manufacturer does not sell or recommend an EPS, then the battery charger is tested using a 5.0V DC input for products that draw power from a computer USB port, or using the midpoint of the rated input voltage range for all other products. Appendix Y, sections 3.1.4.(b) and 3.1.4.(c). However, the 5.0 V DC specification for products drawing power from a computer USB port may not be representative for battery chargers designed for operation only on DC input voltage and for which the manufacturer does not package the charger with an EPS or sell or recommend an EPS. The current generation USB specification can support up to 20 V, per the voltage and current provisions of the most recent version of the International Electrotechnical Commission's (''IEC'') ''Universal serial bus interfaces for data and power—Part 1–2: Common components—USB Power Delivery'' (''IEC 62680–1–2'') specification.

To resolve this issue and improve test procedure representativeness and test results comparability, in the November 2021 NOPR DOE proposed to require in appendix Y1 that when an EPS is not pre-packaged with a battery charger (and the charger manufacturer does not sell or recommend a compatible charger), testing would be performed using any commercially-available EPS that is both (i) minimally compliant with DOE's energy conservation standards for EPS found in 10 CFR 430.32(w) and (ii) satisfies the EPS output criteria specified by the battery charger manufacturer. 86 FR 66878, 66885. DOE further proposed that if the certified EPS is no longer available in the market, then for DOE's compliance and enforcement testing DOE would test the battery charger with any compatible minimally compliant EPS that meets the performance criteria. *Id.* Additionally, in appendix Y1, DOE proposed to clarify the EPS selection priority when one is provided or recommended, to maintain test procedure repeatability. *Id.*

In response to these proposals regarding EPSs, DOE received several comments. Schumacher suggested DOE allow manufacturers describe the recommended EPSs in their user manuals for customers' reference and that such recommendations direct the use of an EPS when testing a battery charger that does not ship with one. (Schumacher, No. 21 at p. 5) ITI asked DOE to clarify whether the ''minimally compliant EPS'' language simply means any compliant EPS, currently level VI, and nothing more. (ITI, No. 20 at p. 2) Both the Joint Efficiency Advocates and NEEA suggested DOE further specify the efficiency range for these minimally compliant EPSs to improve reproducibility and maintain a level playing field. (Joint Efficiency Advocates, No. 23 at p. 2; NEEA, No. 27 at pp. 9–10) WPC and the CA IOUs recommended DOE prescribe a standardized EPS when none is recommended. (WPC, No. 22 at p. 2; CA IOUs, No. 25 at p. 6)

The CA IOUs also commented that there is a trend towards shipping chargers without an EPS, and that many consumers are reusing AC to DC EPSs whose efficiency under load contributes to an important part of the battery charger efficiency and should not be eliminated via an adjustment factor approach unless significant experimental validation confirms this model. (CA IOUs, No. 25 at p. 6) The CA IOUs further requested that DOE consider how new battery chargers will typically be powered by older EPSs if current trends continue. (*Id.*)

As an initial matter, DOE will also continue studying the trends of shipping battery chargers without an EPS and the effect of reusing old EPSs. The proposal to require testing with a minimally compliant EPS reflects the wide selection of EPSs readily available and ensures that the battery charger is tested in a configuration representative of actual use, as most battery chargers require the use of an EPS to convert 115V AC line voltage into a low-voltage DC or AC output. By ''minimally compliant EPS'', DOE is referring to EPSs that are minimally compliant with their respective EPS product class energy conservation standard, or in other words, EPSs with Compliance Certification Database (''CCD'') reported efficiencies as close to their respective minimum product class energy conservation standard as possible. Requiring the use of a minimally compliant EPS for testing will help improve test procedure reproducibility. Requiring the use of an EPS with an efficiency as close to the minimum as possible also ensures that manufacturers who do not package, sell, or recommend an EPS for testing with their battery chargers do not get an unfair advantage, by preventing the use of a very efficient third-party EPS for testing. DOE reiterates that the make and model of such minimally compliant EPS used for testing would also need to be reported to CCD, as prescribed by battery charger certification reporting requirements at 10 CFR 429.39. Specifying the use of a minimally compliant EPS results in battery chargers shipped without an EPS being tested with EPSs of comparable efficiency. As such, DOE is not prescribing specific EPSs, or the acceptable range of EPS efficiencies for testing with battery chargers.

The Joint Trade Associations opposed DOE's proposal to test battery chargers with a minimally compliant EPS, when applicable. The Joint Trade Associations claimed that manufacturers do not know which adapters are minimally compliant until after testing them. The Joint Trade Associations instead suggested DOE to continue allow 5V DC input option for conventional USB connections. For other connections, including for USB–PDs, the Joint Trade Associations proposed allowing any other commercially available EPS to be used. The Joint Trade Associations asserted that this would avoid possible circumvention through use of a specially designed adapter, but that DOE should study whether adapters vary enough in efficiency that this approach may cause an increase in unacceptable testing variations. (Joint Trade Associations, No. 24 at p. 9)

DOE clarifies that the ''minimally compliant'' qualification applies to the EPS and compliance with the applicable energy conservation standards applicable to EPSs. By adopting the proposal to test with a minimally compliant EPS for applicable battery chargers, it would further avoid accounting for adapter efficiency differences, leading to unacceptable testing variation. The efficiencies of DOE compliant EPSs can be found on DOE's publicly available CCD. As discussed in the November 2021 NOPR, testing with a 5V DC input is less representative than testing with an EPS. 86 FR 66878, 66885. Additionally, testing with a 5V DC input does not provide as comparable of results with battery chargers that are shipped and tested with an EPS. Therefore, in order to improve the representativeness and comparability of testing, DOE is adopting the provisions discussed in the preceding paragraphs to test with a ''minimally compliant EPS,'' as proposed in the November 2021 NOPR. These battery chargers are operated with an EPS by the consumer and testing the chargers without an EPS is not representative of actual use. DOE is also adopting the proposed enforcement testing change in appendix Y1 from the November 2021 NOPR to address instances in which the certified EPS relied on in testing is no longer available in the market. 86 FR 66878, 66885. In such an instance, DOE will test the battery charger with any compatible minimally compliant EPS that meets the performance criteria.

Regarding DOE's proposal in appendix Y1 to further specify the EPS selection priority when one is provided or recommended, DOE did not receive comments opposing such proposal, with both WPC and the Joint Efficiency Advocates expressing their support for this proposal. (WPC, No. 22 at p. 2; Joint Efficiency Advocates, No. 23 at p. 2) As such, DOE is adopting the proposal that a battery charger would first be tested using the pre-packaged wall adapter; if the battery charger does not include a pre-packaged wall adapter, then the battery charger would be tested with a wall adapter sold and recommended by the manufacturer; if the manufacturer does not recommend a wall adapter that it sells, then the battery charger is to be tested with a wall adapter recommended by the manufacturer. DOE reiterates that only if when the manufacturer does not package, sell, or recommend an EPS to be used with the battery charger, then the battery charger should be tested with a minimally compliant EPS, or in other words, and EPS that is no more efficient than the corresponding baseline EPS standard.

For the reasons presented in the November 2021 NOPR and in the preceding paragraphs, DOE is adopting the proposals from the November 2021 NOPR to specify the EPS selection priority and require applicable battery chargers to test with a minimally compliant EPS in the new appendix Y1.

3. Battery Chemistry and End-of-Discharge Voltages

The battery charger test procedure requires that, as part of the battery discharge energy test, the battery must be discharged at a specified discharge rate until it reaches the specified end-of-discharge voltage stipulated in Table 3.3.2 of appendix Y. Appendix Y, section 3.3.8(c)(2). Table 3.3.2 defines different end-of-discharge voltages for different battery chemistries. A footnote to Table 3.3.2 provides that if the presence of protective circuitry prevents the battery cells from being discharged to the end-of-discharge voltage specified, then the battery cells must be discharged to the lowest possible voltage permitted by the protective circuitry. *Id.*

DOE stated in the November 2021 NOPR that although the presence of protective circuitries allows some batteries to discharge to end-of-discharge voltages that are different from the voltages prescribed in Table 3.3.2 of appendix Y, such circuits are not universal, and accurate values for end-of-discharge voltages are required to ensure batteries are safely and representatively discharged when such circuits are not present. 86 FR 66878, 66886. Therefore, DOE proposed no changes for the footnote regarding protective circuitries. *Id.* However, DOE proposed to update the term used for battery chemistry in Table 3.3.2 from ''Lithium Polymer'' to ''Lithium-Ion Polymer'' and to change ''Nanophosphate Lithium-Ion'' to ''Lithium Iron Phosphate'' in order to reflect changes in the market. 86 FR 66878, 66886.

The Joint Trade Associations supported DOE's proposal to update the battery chemistry terms, and also supported not changing the foot note regarding end-of-discharge voltages. The Joint Trade Associations further stated that they are not aware of new cut off voltages and the new battery chemistries DOE considered are still in their infancy. (Joint Trade Associations, No. 24 at p. 9)

Schumacher requested that DOE add Lead-Carbon based Valve-Regulated Lead Acid (''VRLA'') batteries to the list of batteries, stating that such batteries are quickly developing and are mostly used in Solar Charging and RVs. However, Schumacher indicated that they were not sure of the per-cell rating or end-of-discharge voltage for these batteries. (Schumacher, No. 21 at p. 2) In response to Schumacher's comment, DOE reviewed the Lead-Carbon based VRLA battery market and was not able to find valid data to establish the end-of-discharge voltages for these batteries. At this time, the Lead-Carbon based VRLA battery market appears to still be developing. As such, DOE is not including Lead-Carbon based VRLA batteries in Table 3.3.2 of appendix Y.

Schumacher also suggested DOE provide a tolerance to end-of-discharge voltage to ensure uniformity, because not all test equipment stops the discharge test at the exact voltage. (Schumacher, No. 21 at p. 3) DOE notes that battery voltages can fluctuate during discharge and might drop suddenly around end-of-discharge voltage. Therefore, it would be more accurate for the test equipment and lab technician to determine when exactly should discharge be stopped once it reaches close to DOE specified end-of-discharge voltage. From DOE's own testing according to the current test procedure, the discharge tests are usually terminated by either the battery analyzer at the specified end-of-discharge voltage, or by the built-in battery protection circuitry. DOE does not anticipate the current test procedure language to cause repeatability or reproducibility issues, nor did DOE receive other stakeholder concerns on the current approach.

Delta-Q claimed that the name change from ''Lithium Polymer'' to ''Lithium-Ion Polymer'' does not address the issue that virtually all commercialized lithium-ion batteries have a polymer separator. (Delta-Q, No. 28 at p. 1) Delta-Q further proposed DOE to simply delete ''Lithium Polymer'' from the table to avoid confusion and redundancy. *Id.* DOE notes that although most lithium-ion batteries on the market utilize a polymer separator, there are still potentially some batteries that do not have the polymer separator, and the additional battery chemistry would not cause variation in test results. Therefore, DOE will maintain both the Lithium-Ion Polymer and Lithium-Ion chemistries.

For the reasons discussed in the November 2021 NOPR and in the preceding paragraphs, in this final rule DOE is adopting the proposed updates to the battery chemistry table to update ''Lithium Polymer'' term to ''Lithium-Ion Polymer'' and updating the term ''Nanophosphate Lithium-ion'' to ''Lithium Iron Phosphate''.

4. Battery Selection

Table 3.2.1 of appendix Y specifies battery selection criteria based on the type of charger being tested; specifically, whether the charger is multi-voltage, multi-port, and/or multi-capacity. For multi-capacity chargers, Table 3.2.1 specifies using a battery with the highest charge capacity. Similarly, for multi-voltage chargers, Table 3.2.1 specifies using the highest voltage battery. Section 3.2.3(b)(2) of appendix Y specifies that if the battery selection criteria specified in Table 3.2.1 results in two or more batteries or configurations of batteries with same voltage and capacity ratings, but made of different chemistries, the battery or configuration of batteries that results in the highest maintenance mode power must be used for testing.

Although DOE did not propose to make changes to the current battery selection criteria in the November 2021 NOPR, Schumacher suggested DOE reconsider the battery selection method for automotive chargers. (Schumacher, No. 21 at pp. 1–2) Schumacher stated that it is better to use 12V Absorbent Glass Mat (''AGM'') batteries with Thin Plate Pure Lead (''TPPL'') technology for testing multi-voltage automotive battery chargers because they have lower stratification, do not need electrolytes measurement, are easier to maintain, are safer, have lower losses, and have more repeatable and reproducible results. Schumacher also indicated that these batteries are more popular, with 12V batteries being the most common voltage. Schumacher stated that for multi-voltage automotive battery chargers that can charge 12V batteries, batteries of other voltages should not be required for testing because of their significantly fewer annual volumes. (*Id.*) Schumacher added that these batteries can be reused more times to keep test costs lower. Schumacher further suggested DOE add reusing of automotive batteries and float charging specifications to the test procedure as many automotive battery chargers reuse the same batteries for testing. (Schumacher, No. 21 at p. 2)

DOE reiterates that its current battery selection criteria specifically states that if multiple batteries meet the battery selection criteria, the battery or configuration of batteries with the highest maintenance mode power should be selected for testing. Section 3.2.3.(b)(2) of appendix Y. In real world scenarios, consumers do not always choose the most efficient battery chemistry to use with their battery chargers. Therefore, testing a lead acid charger with more efficient AGM batteries with TPPL technology would not be representative. If a manufacturer can select either a regular AGM battery or an AGM battery with TPPL technology, the battery with higher maintenance mode power would be selected for testing. As for selecting batteries for testing with multi-voltage chargers, Table 3.2.1 of appendix Y specifically states that battery with the highest voltage should be used for testing.

DOE's battery charger test procedure requires manufacturers to use new battery chargers and associated batteries. Section 3.2.2 of appendix Y. Battery charge capacity can vary with number of charge cycles and discharge rates, especially for lead acid batteries. As such, testing a battery charger with a new battery versus with the same battery, but after repeated number of charge and discharge cycles, can result in significant variation that diminishes the accuracy and repeatability of the testing. To determine if a used battery is still suitable for testing would require monitoring and testing of various factors, which can also add undue burden. Therefore, DOE is not changing the requirement that new batteries be used for testing, to maintain test procedure repeatability as well as test result reproducibility and comparability.

5. Mode-Specific Metrics

Currently, DOE's battery charger test procedure is based on the integrated UEC approach. The UEC equation in section 3.3.13 of appendix Y integrates active mode, standby mode, and off mode power measurements by combining certain parameters, including 24-hour energy, measured battery energy, maintenance mode power, standby mode power, off mode power, charge test duration, and usage profiles. Table 3.3.3 specifies the usage profile for each battery charger product class, meaning the values for time spent (in hours per day) in active and maintenance mode, standby mode, off mode; number of charges per day; and threshold charge time (in hours). In incorporating usage profiles into the integrated metric, DOE in the June 2016 Final Rule stated that aggregating the performance parameters of battery chargers into one metric and applying a usage profile would allow manufacturers more flexibility for improving performance during the modes of operation most beneficial to their consumers, rather than being required to improve the performance in each mode of operation, including those which may not provide any appreciable benefit. 81 FR 38266, 38286–38287.

UEC integrates active mode, standby mode, and off mode energy use in order to estimate the amount of non-useful energy (*i.e.,* energy not transferred to the battery) consumed by the battery charger over the course of a year. The UEC approach therefore requires the use of usage profiles to appropriately reflect the period of time a product spends in each mode, in order to maintain the representativeness of the metric for an average use cycle or period of use as required by EPCA. The usage profiles provide a weighted average of application-specific usage for battery chargers within a specific product class. The usage profiles are based on data for a variety of applications from user surveys, metering studies, and stakeholder input that DOE considered in the June 2016 Final Rule. 81 FR 38266, 38287. DOE's product-class specific usage profiles were initially also developed using the shipment-weighted average usage hours of all the applications of battery chargers whose battery voltage and energy met the criteria for each product class. The intended result was for each usage profile to be representative of the usage of the product class as a whole.

EPCA requires that DOE amend its test procedures for all covered products to include standby mode and off mode energy consumption, with such energy consumption integrated into the overall energy efficiency, energy consumption, or other energy descriptor for each covered product, unless the Secretary determines that (i) the current test procedures for a covered product already fully account for and incorporate the standby mode and off mode energy consumption of the covered product; or (ii) such an integrated test procedure is technically infeasible for a particular covered product, in which case the Secretary shall prescribe a separate standby mode and off mode energy use test procedure for the covered product, if technically feasible. (42 U.S.C. 6295(gg)(2)(A)) EPCA requires the use of an integrated metric unless such a test procedure is technically infeasible. If an integrated test procedure is technically infeasible, DOE must prescribe separate standby mode and off mode energy use test procedures, if a separate test is technically feasible. (*Id.*)

However, under EPCA, DOE is required to establish test procedures that are reasonably designed to produce test results which measure energy efficiency and/or energy use of a covered product during a representative average use cycle or period of use, as determined by the Secretary, and such test procedures must not be unduly burdensome to conduct. (42 U.S.C. 6293(b)(3)) The requirement for a representative test procedure that does not impose an undue burden underpins EPCA's ability to develop and enforce standards, and therefore is a fundamental requirement of EPCA. EPCA does not define what is technically infeasible or what it means. But DOE finds it reasonable when considering the technical feasibility of a test procedure that provides for a metric that integrates active mode, standby mode, and off mode energy use to consider the representativeness and burden of a test procedure using that metric. An integrated test procedure metric that cannot be reasonably expected to produce representative test results or that would result in undue burden cannot be considered technically feasible under EPCA, because it is unable to meet the requirements to be a permissible test procedure under the statute—even if an integrated metric is theoretically possible approach were those requirements to not apply.

As explained in the November 2021 NOPR, as the battery charger market continues to evolve, DOE has observed that the relative share of shipments among different types of products within a product class has changed; the types of products within a given product class as well as the usage patterns of the products within a product class have become more varied. 86 FR 66878, 66887. In the November 2021 NOPR DOE presented the example of the current Product Class 2, which includes both smartphones and small capacity home power tools—two products with widely different usage patterns and annual shipments. *Id.* A more recent market review shows that the shipments for certain applications, such as smartphones, cordless phones, wireless headsets, have changed significantly since the usage profiles in appendix Y were originally established. *Id.* Furthermore, there has been a recent but rapid market adoption of smart wearable devices, tablets, consumer drones, and mobility scooters from DOE's internal research. Some of these products would have drastically different usage profiles from their respective product classes, which adversely impacts the representativeness of the corresponding usage profiles. Changes in consumer use of a number of products within a product class or the emergence of new or altered end use products impacts the representativeness of the usage profile for that product class under the UEC metric. DOE anticipates that the battery charger market will continue to change dynamically at a rate that will render usage profiles unrepresentative more quickly than EPCA's review cycles anticipate. Because the UEC metric requires integrating active mode, standby mode, and off mode energy use, which requires representative usage profiles, the need for new or amended usage profiles to maintain representativeness would result in the need to repeatedly and frequently amend test procedures, which in turn potentially would require manufacturers to update representations, increasing undue manufacturer burden.

In an effort to maintain the representativeness of the test procedure for battery chargers in light of the rapidly changing market, while maintaining a consistent test procedure for manufacturers, in the November 2021 NOPR, DOE proposed an approach that does not rely on the UEC equation or usage profiles. 86 FR 66878, 66887. Specifically, DOE proposed in appendix Y1 to establish an approach that relies on a separate metric for each of the following modes of operation: active mode, standby mode, and off mode. *Id.* DOE is not aware and has not been made aware of any other integrated approach that integrates the energy consumption of different battery charger modes of operations.

The Joint Efficiency Advocates and CA IOUs noted in response to DOE's proposal that developing accurate and representative usage profiles has become more difficult with the constant development of new end use product types and changes in consumer usage patterns, risking the market usage assumptions used to calculate UEC becoming obsolete for specific classes of battery chargers unless continuously updated. (*See,* Joint Efficiency Advocates, No. 23 at pp. 2–3; CA IOUs No. 25 at p. 2) The Joint Efficiency Advocates noted that the multi-metric approach presented a more representative method. (Joint Efficiency Advocates, No. 23 at pp. 2–3) The Joint Efficiency Advocates commented that they found it would be more representative to separate the test procedure to three separate metrics for active mode, standby mode, and off mode. (Joint Efficiency Advocates, No. 23 at pp. 2–3) The CA IOUs also supported the development of separate reported metrics for active charge energy, standby mode, and off mode energy use. (CA IOUs, No. 25 at p. 1). The CA IOUs agreed that the evolving nature of battery charger technology tends to quickly make obsolete the market usage assumptions used to calculate UEC obsolete for specific classes of battery chargers. *Id.* The CA IOUs stated that the benefits of the disaggregated metric test procedure have become increasingly relevant for reasons such as products having different usage profiles within the same product class, evolving technology and usage patterns, increases in battery energy density and capacity across products, and variation in charge time profiles. (CA IOUs, No. 25 at p. 2) The CA IOUs stated that as battery charger technologies and markets evolve, an integrated metric becomes less representative of the product classes as currently defined in the test procedure and stated that because DOE's proposed approach does not rely on a UEC equation or usage profiles, it should be more flexible. (CA IOUs, No. 25 at p. 2)

NEEA also supported DOE's proposed multi-metric approach and noted that its research demonstrated that the use of separate active, standby, and off mode metrics aligns with the current battery charger market. (NEEA, No. 27 at p. 2) NEEA noted that battery charger end uses are substantially more varied than when DOE promulgated its UEC metric, citing AHAM's comment that there are hundreds, if not, thousands of battery-charged consumer products in the market. NEEA noted that there are many factors that contribute to this growth, such as price reduction for lithium-ion batteries, increased wireless applications, and smaller charger formats. NEEA stated that this proliferation makes it technically inappropriate to continue using usage profiles to represent the energy use of hundreds of widely varying applications. (*Id.*) NEEA explained as well that markets for and shipments of battery chargers can change rapidly, as products evolve and consumer demand shifts. NEEA listed certain products as examples, such as landlines, smartphones, drones, cameras and MP3 players. *Id.* NEEA stated that while the UEC approach is appropriate for more stable appliance categories such as refrigerators, it is not a useful measure for the continuously evolving array of battery charger end uses. (NEEA, No. 27 at p. 3) In contrast, NEEA noted that there are multiple advantages to DOE's multi-metric approach: increasing representativeness of the range of battery chargers, both now and as the market continues to change; improving harmonization with DOE's EPS test procedure approach; and enabling more detailed standards analysis. (NEEA, No. 27 at p. 3)

ITI suggested, however, that DOE continue using the UEC metric while gathering active charge energy data to fully understand the complexity of these energy use parameters before deciding to switch metrics. (ITI, No. 20 at 3) ITI and the Joint Trade Associations stated that current class groupings are not perfect, but that they were based on objective criteria and still provide a clear indication of which product class a charger should fall into. (ITI, No. 20 at 3; Joint Trade Associations, No. 24 at p. 3) Delta-Q acknowledged the imperfection of the UEC and its usage profiles but did not support replacing the usage profiles-based UEC system with the multi-metric approach, stating that the multi-metric approach will unduly constrain design options to minimize overall energy use while managing trade-offs with cost and customer value. (Delta-Q, No. 28 at p. 1) Delta-Q suggested that the multi-metric approach would cause uncertainty and could require redesigns, increase costs, and remove features that may not reduce energy consumption in real-world usage. *Id.*

DOE does not agree that the multi-metric approach lacks the potential to reduce energy consumption in real-world usage. DOE's UEC metric currently represents the annualized amount of the non-useful energy consumed by a battery charger (*i.e.,* energy losses) among all tested modes of operation. As battery and battery charger technology develops along with change in usage profiles, DOE is noticing that more and more energy losses happen during maintenance mode and no-battery mode, as battery chargers are simply either maintaining the battery at a fully charged state or monitoring the charger circuitry to facilitate active charging when a battery is inserted. In these modes, the battery charger is not doing any useful work to transfer energy into the battery, and because these modes can last indefinitely, they can result in significant energy savings potential if regulated separately from active mode. DOE further notes that the potential redesign and additional costs are not associated with change to multi-metric testing approach, but directly related to the energy conservation standards rulemaking. However, DOE notes that any energy savings potential and cost burdens from increased efficiency levels would be analyzed thoroughly in the separate energy conservation standards rulemaking.

The Joint Trade Associations opposed the proposed multi-metric approach, asserting that the multi-metric approach does not satisfy EPCA's intent or requirements, and it would make savings and energy savings difficult for the consumer to understand as well as for DOE to analyze. (Joint Trade Associations, No. 24 at pp. 1–3) The Joint Trade Associations asserted that DOE failed to demonstrate that its proposals are justified and are not arbitrary and capricious, and that DOE's proposal does not meet the requirements of the Administrative Procedure Act or the Data Quality Act. (Joint Trade Associations, No. 24 at p. 3) The Joint Trade Associations asserted that DOE has not shown that the current approach does not represent an average consumer use cycle, that it cannot be updated to maintain its representativeness of average consumer use, that it is infeasible to integrate active mode and standby mode, or that the current test procedure approach would be unduly burdensome to conduct. (Joint Trade Associations, No. 24 at pp. 2–4) The Joint Trade Associations also noted that the proposed appendix Y1 would add significant burden and is contrary to EPCA's clear preference for aggregated metrics. (Joint Trade Associations, No. 24 at pp. 1–2)

The Joint Trade Associations acknowledged, however, that the current product classes are not perfect and that they have acknowledged their imperfection from the beginning; they acknowledged that there are difficulties in developing product classes for battery chargers, with thousands of different end use products, and that usage and shipments of products within classes differs. (Joint Trade Associations, No. 24 at pp. 2–3) The Joint Trade Associations solution to these issues was not to remove the UEC metric and usage profiles but to update the usage profiles and shipments analysis more regularly, considering the breadth of products in each class from both usage and shipments perspectives. The Joint Trade Associations offered to provide data to assist in that analysis. (Joint Trade Associations, No. 24 at p. 3). The Joint Trade Associations noted that EPCA requires DOE to review and update test procedures at least once every 7 years, and that DOE has further discretion to initiate an early review if usage profiles or shipments for product classes become unrepresentative. (Joint Trade Associations, No. 24 at p. 4) Because DOE is already required to update the test procedures periodically, the Joint Trade Associates could not see how the multi-metric approach solved any issue. The Joint Trade Associations noted that these reviews and updates are critical to DOE's analysis, and it is difficult to understand why it is too challenging to do these as part of the test procedure review. The Joint Trade Associations speculated that DOE did not want to be bothered re-assessing its categorizations and updating usage profiles. *Id.*

DOE is undertaking this rulemaking in compliance with its requirement under EPCA to review and update test procedures at least once every 7 years. However, the issue DOE identified with keeping the current integrated UEC approach was not the need to update the test procedures according to the requirements of EPCA, but the frequency of updates required to maintain the UEC metric as a representative approach to testing as required under EPCA. DOE reiterates that it has determined it would need to update the test procedures more often than the 6- and 7-year standards and test procedure update cycles to maintain the UEC metric; as other commenters also noted, the battery chargers' dynamic market already would warrant far more frequent updates and DOE projects this need to only increase over time. While the Joint Trade Associations pointed out that DOE regularly updates annual use cycles for products such as residential dishwashers, laundry products, and air treatment products based on varying sets of data, DOE notes an approach that is both feasible and representative for some products may not be feasible or representative for others where there are clear and significant differences between the products such as quantity of end use products for battery chargers.

The Joint Trade Associations further stated that DOE failed to present data supporting its conclusions from a recent market review showing that shipments for certain applications have changed significantly since the usage profiles were established, or that market and shipments of battery chargers change quickly as the market and consumer use changes. (Joint Trade Associations, No. 24 at p. 3) The Joint Trade Associations further disputed that the current approach is no longer representative, and that DOE has presented no compelling evidence that the test procedure has become overly burdensome, noting that the simple solution is to simply update the test procedures. They concluded that because the current test procedure has accomplished EPCA's requirements of representative results without undue burden relatively well, DOE cannot show it is infeasible to have an integrated metric representative of consumer use. They therefore also disputed DOE's findings of a repeated need to update leading to increased manufacturer burden and claimed the multi-metric approach would be more burdensome than minor revisions to update usage profiles and shipments. *Id.*

DOE notes that an approach's historical success or validity does not necessarily justify maintaining that approach in the face of changed and changing circumstances. DOE has projected that the battery chargers' market and the variety of consumer end uses make the UEC metric increasingly infeasible and untenable to maintain, both administratively and for regulated parties. The technical requirements to maintain the UEC metric and its attendant usage profiles are no longer feasible to meet. The need to frequently review and update usage profiles, while known in the 2016 rulemaking, was of a different scope than the need for review and updating dictated by the current market for battery chargers. DOE believes this need to update would only increase in rapidity. And as DOE has noted, even if DOE were able to maintain these profiles on its own end the frequent changes to the test procedures and standards would require frequent recertifications for manufacturers and may cause impermissible undue burden.

The Joint Trade Associations disputed that the test procedure must be representative of consumer use at every moment, noting that this is not only impossible, but also unnecessary and not consistent with EPCA's intent. (Joint Trade Associations, No. 24 at p. 4) DOE agrees that this is not the statutory standard, but DOE notes that DOE is required to maintain test procedures reasonably designed to produce representative test results without undue burden. Maintaining the current battery charger test procedure, which DOE reasonably believes will lead to foreseeably unrepresentative test results on a regular basis, is contrary to EPCA's requirements where an alternative test procedure exists to provide more representative results without undue burden. While EPCA expresses a preference for an integrated metric, this preference yields before EPCA's more fundamental need for accurate and representative test results, without which EPCA's standards are undermined.

The Joint Trade Associations also argued that DOE originally grouped products with different usage profiles into the same product class, and that DOE did not present data in the November 2021 NOPR on what has changed since the initial test procedure and standards development. (Joint Trade Associations, No. 24 at p. 2) The Joint Trade Associations stated that DOE was placing the burden of proof for retaining the integrated metric on commenters but claimed that the burden was in fact on DOE to demonstrating that its proposals were justified and not arbitrary and capricious. Joint Trade Associations, No. 24 at p. 3) DOE has acknowledged that it is changing its position on whether the UEC metric can meet the requirements of EPCA but disagrees that it has not explained the basis for this change in position. DOE, and other commenters in response, noted that the changes in the market justified reconsideration and ultimately departure from the UEC and usage profile approach. The market review has shown that the UEC integrated metric approach can no longer feasibly be reasonably expected to produce representative test results as required by EPCA, absent such frequent updates to the test procedures as to constitute undue hardship—which itself would contravene EPCA. DOE is adopting its multi-metric approach because an integrated metric is now infeasible.

The Joint Trade Associations asserted that UEC is a more representative approach because it accounts for consumer usage, whereas DOE's multi-metric approach does not account for the contribution of each to the overall product efficiency. (Joint Trade Associations, No. 24 at p. 7) However, as DOE has noted the representativeness of the UEC approach is dependent on representativeness of the usage profiles and shipment data underpinning the metric, and the current battery chargers market dynamics make maintaining the representativeness of that metric infeasible without incurring undue burden. DOE's UEC approach would only be representative of the annual non-useful energy resulting from battery chargers, provided that the usage profiles are updated frequently and repeatedly. DOE's multi-metric approach would, still representatively but separately, measure and certify the active mode energy, standby mode energy, and off mode energy. As battery charger overall efficiency is highly dependent on usage profiles, the multi-metric approach can further help consumers in learning which battery charger would provide best overall efficiency under that specific consumer's usage profile by providing the separate metrics.

The Joint Trade Associations stated that not only is DOE's proposal inconsistent with EPCA's clear preference for integrated metrics, but it is also inconsistent with DOE's systems approach, which aims to allow flexibility in component designs while ensuring an overall efficiency requirement. The Joint Trade Associations stated that they assumed the proposed appendix Y1 will translate to three separate energy conservation standards requirements and noted that not all products have the capability to reduce energy consumption of a particular mode which may require redesign to meet DOE standards. The Joint Trade Associations commented that by separating active, standby, and off modes into three metrics DOE is requiring the redesign of products and effectively increased design complexity. The Joint Trade Associations stated that manufacturers are allowed flexibility to distribute energy across the different modes with the current UEC compliance requirements. The Joint Trade Associations stated that the integrated UEC approach therefore allows more innovation and flexibility in designs and posited that the burden associated with DOE's multi-metric approach will likely be more significant as it will inhibit innovation inhibit innovation and the ability to differentiate one's products from others in the market. (Joint Trade Associations, No. 24 at pp. 4–6) DOE acknowledges that the original UEC approach provides greater design flexibility because of its integrated nature, and that this was one purpose of the UEC metric. 81 FR 38266, 38286–38287. However, DOE cannot maintain an approach that will not meet EPCA's requirement of representative test procedures or lead to undue burden. Furthermore, DOE's multi-metric approach will still regulate the integrated power draw of battery chargers in standby mode operations, allowing manufacturers to still have significant design flexibility in improving either maintenance mode or no-battery mode efficiency.

The Joint Trade Associations further stated that manufactures have already developed their products to comply with DOE's current standards, which is challenging for some battery chargers, especially the infrequently charged ones. The Joint Trade Associations claimed that if DOE were to change its approach, some products will likely need to be redesigned and the investments manufacturers have made to comply with the current standards would be stranded. (Joint Trade Associations, No. 24 at p. 2)

The Joint Trade Associations commented that they cannot fully comment on DOE's proposal when DOE has not provided more detail on how the product classes or standards would be amended. The Joint Trade Associations stated it is likely that that some currently compliant products may no longer be compliant under the newly proposed approach but with no real savings but only additional costs on consumers and manufacturers. The Joint Trade Associations suggested DOE analyze this further during manufacturer interviews. (Joint Trade Associations, No. 24 at p. 5)

Schumacher stated that if DOE's amended test procedure impacts existing CCD reported models, they recommend the currently compliant products to be grandfathered in under the amended standards or required to be updated several years after the revised standard publication. (Schumacher, No. 21 at p. 6) Schumacher argued that if a newly revised standard was to be put into effect immediately, it would result in higher cost to manufacturers; whereas a buffer period of several years would minimize costs and let manufacturers retest the products or redesign the products. *Id.*

DOE is adopting the mode-specific metric approach as proposed in the December 2021 NOPR and consistent with its authority and duties under EPCA. As previously noted, when considering the feasibility of a test procedure with a metric integrating active mode, standby mode, and off mode energy use, DOE must also consider whether that metric will satisfy the test procedure criteria prescribed by EPCA: the representativeness of the test procedure and whether a test procedure is unduly burdensome. The UEC test procedure approach specifies an integrated metric relying on usage profiles. However, changes in consumer use and the emergence of new products can both impact the representativeness of that usage profile and therefore the UEC metric overall. While the Joint Trade Associations suggested that maintaining the representativeness of the current usage factors is simply a matter of updating the data, as discussed in the November 2021 NOPR the market and shipments of battery chargers has been shown to change over short periods of time as new products that rely on battery chargers emerge and are adopted by the market, and as consumer use of products that rely on battery charger changes. 86 FR 66878, 66887. As an example, DOE noted that the shipments for Digital Audio Players and Digital Cameras have declined significantly with the advent of smart phones that have similar built-in capabilities. *Id.*

Because of the nature of battery chargers, they serve a great variety of end use products, updated on an annual basis. Although DOE collects and reviews usage profiles and shipment data constantly, going through the process of updating the test procedure and energy conservation standards in a similar way would impose undue burden on manufacturers. Needing to update the test procedure in order to avoid reliance on obsolete usage profiles and comply with EPCA's representativeness requirement would in turn require updating the energy conservation standards to reflect the test procedure changes. Manufacturers would then need to frequently retest and recertify their products, creating significant and undue burden.

By regulating the different battery charger operating modes separately, DOE avoids the risk of usage profiles becoming increasingly unrepresentative before having a chance to update them, as the multi-metric approach is not reliant on usage profiles, but rather performance in individual operating modes. The multi-metric approach provides for a more stable regulatory environment, by minimizing the possibility that manufacturers would need to retest and recertify products with changes in the market and the associated usage profiles, thereby reducing potential test burden.

DOE notes that the multi-metric test procedure approach in appendix Y1, adopted in this final rule, would not be required until such time as compliance is required with amended battery chargers energy conservation standards developed based on the new test procedure, should DOE establish such standards. Were DOE to establish amended energy conservation standards reflective of the multi-metrics, DOE would consider, in part, the efficiencies of battery chargers on the current market at each metric and the technologies available to improve the efficiencies at each metric.

DOE reiterates that adoption of the multi-metric test procedure in appendix Y1 itself will not require manufacturers to redesign their products. Moreover, the multi-metric testing approach provides results that more directly correlate to direct testing of a battery charger, as opposed to results that are dependent on shipments data and data regarding consumer usage patterns. As such, the test procedure is less dependent on data that may quickly become obsolete or data that may be unable to fully reflect appropriate market and consumer usage conditions. Therefore, DOE anticipates that it will provide a more stable regulatory environment for manufacturers moving forward.

DOE also notes that it is adopting the alternate active mode test method proposed in the NOPR, which essentially relies on the current active and maintenance modes test method found in appendix Y with only an added step for test technicians to analytically compute the integrated active mode energy from the active mode and maintenance mode test data. DOE estimates the additional time required to perform the active energy calculation would be roughly the same as that for calculating UEC. However, because technicians would no longer need to compute UEC under the multi-metric approach, overall testing burden would be the same between the multi-metric approach and the current UEC approach.

The CA IOUs further recommended that DOE require manufacturers to report values for different operating modes, and that DOE publish these values in the CCD to allow calculations of UECs for specific products in specific use cases. (CA IOUs, No. 25 at p. 2) The CA IOUs stated this performance data would be essential for assessing the impacts of the new test procedure metrics. *Id.* DOE notes that the performance values are already presented on the CCD, and DOE will make necessary amendments to the reporting template to account for the reporting changes under the multi-metric approach.

ITI also requested DOE to consider harmonizing and coordinating the test procedure with Canada so they remain consistent. (ITI, No. 20 at p. 6) DOE notes that Canada's Department of Natural Resources primarily references DOE's existing test procedure for battery chargers, which relies on the consolidated UEC metric. While there is an effort to harmonize with widely and internationally adopted industry standards, DOE is required by EPCA to ensure that its test procedure for a covered product is representative. For the reasons stated above relating to DOE's own UEC-based test procedure metric, DOE is therefore unable to continue harmonizing with Canada's test procedure for battery chargers. DOE notes however that the test procedure's conduct between the current UEC approach and the adopted multi-metric approach still remains largely the same; therefore, DOE does not anticipate there to be significant difference between how tests are conducted in Canada and in the US. DOE will work with international agencies to reduce manufacturer burden to a reasonable extent, where doing so aligns with DOE's statutory requirements under EPCA.

Based on the discussion presented in the November 2021 NOPR and in the preceding paragraphs, DOE has determined that the adopted multi-metric approach more fully meets the representativeness requirements of EPCA without being unduly burdensome. Moving to a multi-metric approach avoids DOE imposing an undue burden on manufacturers by requiring frequent recertification and retesting due to frequent updates to an integrated metric, updates that would be needed to maintain the metric's compliance with EPCA's representativeness requirement in a shifting market landscape. DOE reiterates that testing under the new multi-metric approach would not be required until after DOE's battery charger energy conservation standards have been amended. DOE will also study the potential redesign needs and costs because of the multi-metric approach in the separate standards rulemaking.

6. Active Mode Test

Battery charger active mode is the state (condition) in which the battery charger system is connected to a main electricity supply (main power source) and is actively delivering power to bring the depleted battery to a fully charged state (the charger's main function), as defined in section 2.1 of appendix Y.—(*See also* 42 U.S.C. 6295(gg)(1)(A)(i)) Appendix Y currently tests the active mode power consumption along with battery maintenance mode power [11] to produce a consolidated 24-hour energy consumption value, or E_{24}, which is then used in the UEC calculation. As previously discussed, in the new appendix Y1, DOE is replacing the UEC metric system with a discrete multi-metric approach that determines the energy efficiency and energy use of the active mode, standby mode, and off mode power consumption separately.

In the November 2021 NOPR, DOE proposed to use a charge test in which the test period would begin upon insertion of a depleted battery and would end when the battery is fully charged. 86 FR 66878, 66888. The active mode energy, E_a, would represent the accumulated input energy, meaning the average input power integrated over this test period. Similar to the procedure currently in section 3.3.2 of appendix Y (Determining the Duration of the Charge and Maintenance Mode Test), if a battery charger has an indicator to show that the battery is fully charged, that indicator would be used to terminate the active mode test. *Id.* If no indicator besides the manufacturer's instructions indicates how long it should take to charge the test battery, the active mode test would be conducted for the longest estimated charge time provided in the manufacturer's materials. *Id.* If the battery charger does not have such an indicator and a manufacturer does not provide such a time estimate, the length of the active mode test would be 1.4 multiplied by the rated charge capacity of the battery divided by the maximum charge current. DOE also proposes to arrange sections of appendix Y1 so that the battery discharge test is performed immediately after this active mode test is completed, but prior to the 24-hour charge and maintenance mode test that would then be used to determine maintenance mode power. *Id.*

Joint Trade Associations commented that the November 2021 NOPR preamble stated the battery discharge test would be performed immediately after the active mode test, but the proposed appendix Y1 regulatory text appropriately included a wait period. The Joint Trade Associations urged DOE to retain the wait periods, should DOE continue with the amended test procedure. The Joint Trade Associations expressed concern that going immediately from active mode testing to maintenance mode testing [12] would impact the test because the battery could be hot and stated the wait times are important for reducing test variation. (Joint Trade Associations, No. 24 at p. 7)

DOE's proposed charge test would begin upon insertion of a depleted battery and would end when the battery is fully charged and require that the test be terminated when there is indication that the charge test has ended. DOE's intent was to explain that manufacturers should terminate charging immediately after the battery reaches full charge, rather than wait for the original total charge and maintenance mode test duration to complete. The proposal was not intended to remove the wait period between the charge and discharge test. As such, DOE clarifies in this final rule that it is not removing the wait period between the charge and battery discharge test, and a wait period continues to be included in the newly established appendix Y1.

ITI suggested that the proposed charging test would be challenging to conduct for the following reasons: the maintenance mode power would be difficult to measure under the new approach for products with integrated battery; and if a battery charger does not have charge status indicator, it would be hard to monitor when the battery is fully charged as there many variables that can affect the total charging time, which makes it difficult to develop an automated and consistently accurate process. (ITI, No. 20 at p. 3) ITI suggested DOE collect more power data before proceeding with the new active charge test and reiterated that separating

[11] Maintenance mode is the operation of a battery charger to maintain a battery at full charge while a battery remains in the charger after fully charged. Under the current test procedure the characterization of maintenance mode as active mode or standby mode is less critical because the current test procedure metric integrates the modes. As discussed in the following section, DOE has tentatively characterized maintenance mode as part of standby mode.

[12] As discussed in the following section, in this final rule DOE has determined that energy use during maintenance mode is appropriately assigned to standby mode.

active charge test with maintenance mode test would require significantly longer testing time, and the maintenance mode power would not be possible to measure after battery discharge test for products with integrated batteries. (*Id.*) ITI suggested that DOE also consider the cost associated with potential redesign of battery charger products. (ITI, No. 20 at p. 6)

ITI and the Joint Trade Associations stated that the multi-metric test would either require active technician monitoring or additional special equipment for monitoring, which adds significant time and cost. (ITI, No. 20 at p. 6; (Joint Trade Associations, No. 24 at pp. 5–6) The Joint Trade Associations opposed the proposed active mode test procedure, stating it would significantly increase test burden and incur undue burden. (Joint Trade Associations, No. 24 at p. 5) The Joint Trade Associations stated that because the test takes longer, fewer tests can be conducted. (Joint Trade Associations, No. 24 at pp. 5–6)

CSA commented that the current appendix Y allows laboratory technicians leave the battery charger unattended for 19 hours before having to check on the charging status to determine total test duration, and the batteries will usually be charged within 19 hours for the test to be terminated at the 24-hour mark; this test can be left running overnight and requires very little time and effort from the lab technician. (CSA, No. 12 at p. 1) CSA further commented that if the active charge test needs to be terminated immediately after indication of battery is fully charged, the lab technician would need to continuously monitor the charge indicator and immediately terminate the charge when the fully charged indicator turns on. (CSA, No. 12 at pp. 1–2) Although CSA conceded this could be done by implementing sensors and other controls, CSA stated that it would be more burdensome than the appendix Y test method. *Id.* Similarly, Delta-Q argued that the proposed test procedure change adds test complexity and duration with the addition of the separate maintenance mode test. (Delta-Q, No. 28 at p. 2) Delta-Q also noted that the active mode test procedure was problematic both because it appeared to require constant monitoring and because it reduces battery rest time, which can increase test-to-test variation. *Id.*

NEEA recommended DOE test a wide variety of battery chargers to evaluate appropriateness of the active mode test. (NEEA, No. 27 at pp. 7–8) NEEA asserted that relying on a battery charge indicator may result in different charge levels at the end of the active mode tests, because not all chargers indicate charge status and those that do may signal full charge at different thresholds, which could result in unfair comparisons. (NEEA, No. 27 at pp. 7–8)

DOE notes that battery chargers are typically designed for a specific battery or combination of batteries. Therefore, manufacturers should already have an understanding of the full charge time for each battery and charger combination, making it unlikely that a technician would need to monitor a unit under test during the entire test period.

However, DOE also stated in the November 2021 NOPR that in its experience, it may be possible to analyze the resulting data from the 24-hour charge and maintenance mode energy consumption test and divide it into its constituents: the active mode energy and maintenance mode power. 86 FR 66878, 66888. DOE therefore considered this alternative approach, in which active mode energy consumption, E_a, would be the time series integral of the power consumed from the point when the battery was first inserted (or plugged in for chargers with integrated batteries) until the measured data indicate a drop in power associated with the transition from active charging to maintenance mode. Under this approach, a single test period would provide the necessary measurements for the active mode energy, E_a, from the 24-hour charge and maintenance mode test data. DOE stated that it would consider the discussed alternate approach in the development of the final rule. *Id.* Under this approach, lab technicians do not need to rely on charge status indicator to determine when the battery reaches the full charge, which would ensure that the test battery would always be fully charged at the end of the combined charge and maintenance mode test.

CA IOUs agreed that calculating energy in active mode as the integral of applied power during the charge period is a practical and reasonable approach based on sound physics. (CA IOUs No. 25 at p. 2) The Joint Trade Associations stated the alternative active mode test would not work because battery chargers may have points at which the battery power is turned off, such as a series of pulses at the end where the battery attempts to get full charge. The Joint Trade Associations stated that such instances could be misinterpreted at the end of the appendix Y1 active test, and for products with complex charge profiles, it is difficult to detect the end of active mode given different battery sizes. (Joint Trade Associations, No. 24 at p. 7)

NEEA similarly commented that analyzing charge status based on AC input power is difficult for slower trickle chargers because input power may not indicate a transition from active to battery maintenance mode. (NEEA, No. 27 at p. 8) NEEA also suggested that although additional instrumentation can be used to monitor battery charger output and more accurately determine the state of charge, measuring additional charger DC output may interfere battery and charger communication signals, impacting testing safety; affect the measurement directly; and increase test burden. (NEEA, No. 27 at p. 8–9) NEEA claimed that determining charge status by using AC input power may result in different charge levels for fast chargers because these chargers transition from fast to slow charging with different algorithms. (*Id.*) NEEA encouraged DOE to investigate the issues it identified, and to retain its current appendix Y active and maintenance mode testing approach if the challenges prove difficult to overcome. (*Id.*) NEEA stated that advantages of the appendix Y 24-hour active mode test include reduced test burden for technicians, the ability to address both slow and fast chargers through a uniform approach and eliminating the need to determine/define charge status. (*Id.*)

WPC supported DOE's alternate approach of conducting a single 24-hour charge and maintenance mode test and determining active charge energy based on the data generated. (WPC, No. 22 at pp. 2–3) WPC also commented however that it may be difficult to define the actual transitioning point between active mode and maintenance mode. (*Id.*)

To minimize any potential additional burden that may be associated with an active-mode only test as noted by commenters, DOE is adopting the alternative active charge energy approach discussed in the November 2021 NOPR, under which active mode energy is calculated from the combined charge and maintenance mode test, similar to the test procure in appendix Y. DOE notes that battery chargers may have different charging profiles. Based on DOE's testing, most battery chargers exhibit a distinctive drop off in power indicating a transition to maintenance mode. In certain limited instances, the battery charger shows unstable power consumption towards the end of charging phase. However, such periods would be classified as active charging because the battery is pining the charger to get full charge, and as stated in section 2.1 of appendix Y and the new appendix Y1 active mode is when ''the battery charger is delivering current, equalizing the cells, and performing other one-time or limited-time functions in order to bring the battery to a fully charged state.'' Therefore, by defining the state that would be classified as active mode and by determining when the charger enters maintenance mode, lab technicians can precisely identify the transition point from active mode to maintenance mode and calculate the active charge energy from this alternative approach, as prescribed in sections 3.3.9 and 3.3.10 of appendix Y1.

Schumacher commented that the best way to calculate the efficiency of an automotive battery charger with non-integrated batteries is similar to the calculation used for UPSs. (Schumacher, No. 21 at p. 1) Schumacher further noted that including a non-integrated battery into the efficiency calculation is not an effective measure of the charger's efficiency because different batteries have different losses, and the charger has no control over these batteries. *Id.* Schumacher therefore stated that it is better and more accurate to measure the efficiency of the charger directly, by itself, so that the chargers would not be affected by the battery efficiencies. *Id.* Schumacher stated that lower quality batteries can result in manually reduced charge cycles just to pass the standard, which causes faster battery degrading and adds user costs with greater environmental impact. (*Id.*)

DOE understands that for battery chargers designed for large-capacity lead-acid batteries, manufacturers are less involved in the end use product design and usually cannot pick which battery will be used with their chargers. However, battery performance is a crucial part for measuring battery charger efficiencies. Different battery chemistries have different self-discharge rate, affecting the charge and maintenance modes algorithms. DOE's battery charger test procedure also determines the amount of ''useful energy'' by measuring how much energy the fully charged battery can output.

In this final rule, DOE is adopting the alternate active charge energy approach discussed in the November 2021 NOPR, in which active mode energy is calculated from the combined charge and maintenance mode test that is similar to the test procure in appendix Y.

7. Standby Mode Tests

Standby mode is the condition in which an energy-using product is:

(1) Connected to a main power source; and

(2) Offers 1 or more of the following user-oriented or protective functions:

(aa) To facilitate the activation or deactivation of other functions (including active mode) by remote switch (including remote control), internal sensor, or timer.

(bb) Continuous functions, including information or status displays (including clocks) or sensor-based functions.

(42 U.S.C. 6295(gg)(1)(A)(iii))

Appendix Y defines standby mode for battery chargers as the condition in which a battery charger is connected to mains electricity supply, the battery is not connected to the charger—and for battery chargers with manual on-off switches, all switches are turned on. Section 2.25 of appendix Y. Appendix Y also includes a definition for maintenance mode in section 2.8, to mean the mode of operation in which the battery charger is connected to the main electricity supply and the battery is fully charged but still connected to the charger. In maintenance mode, a battery charger continuously monitors the voltage of the fully charged battery and periodically supplies charge current to maintain the battery at the fully-charged state. As mentioned previously, because the test procedure in appendix Y relies on a metric that integrates active mode, standby mode, and off mode, it is less critical in that context as to whether maintenance mode is characterized as standby mode as compared to the proposed multi-metric approach.

The current ''standby mode'' definition in appendix Y only captures what can be referred to as ''no-battery mode,'' *i.e.,* the condition where a battery charger is connected to a mains power source but a battery itself has not yet been inserted. In the context of the proposed multi-metric approach, DOE tentatively determined in the November 2021 NOPR that maintenance mode is also appropriately characterized as a standby power mode. 86 FR 66878, 66888. In maintenance mode, a battery charger provides continuous monitoring of the battery charge. While a battery charger provides some limited charging in maintenance mode in order to maintain the battery at full charge, it is not charging a depleted battery. Unlike active mode, maintenance mode can persist indefinitely. As an example, DOE referenced power tool chargers in the November 2021 NOPR, which in residential environments routinely spend an indefinite amount of time maintaining batteries that are not regularly used but are required to be fully charged. *Id.* In addition to balancing and mitigating self-discharge of the cells, these chargers also typically provide a status display indicating that the battery is in the fully charged state and ready for use.

In the November 2021 NOPR, DOE tentatively determined that these continuous functions in maintenance mode satisfy both EPCA's and IEC 62301's definition of standby. 86 FR 66878, 66888–66889. To better account for these conditions, DOE proposed to first rename what is currently defined in appendix Y as standby mode to ''no-battery mode'' in appendix Y1 (and reference this term, as appropriate, throughout appendix Y1). *Id.* DOE proposed to then define in appendix Y1 the term ''standby mode'' to include both no-battery mode and maintenance mode. *Id.* Specifically, DOE proposed that in appendix Y1, standby mode power of a battery charger (P_{sb}), would be calculated as the sum of the no-battery mode power (P_{nb}), and maintenance mode power (P_m). *Id.*

The Joint Efficiency Advocates supported DOE's proposal to regulate no-battery mode and maintenance as standby mode. (Joint Efficiency Advocates, No. 23 at p. 3) NEEA supported DOE's proposal to include both battery maintenance mode and no battery mode within standby mode but encouraged DOE to require reporting of these two modes separately to support more accurate standards analysis. (NEEA, No. 27 at p. 3) NEEA also supported DOE's proposal to regulate standby power mode as the sum of maintenance mode power and no battery mode power, as this metric gives manufacturers greater design flexibility. (NEEA, No. 27 at pp. 3–4)

ITI stated that the new proposed test procedure would prolong the maintenance mode test until maintenance mode power has been captured representatively, and that it does not make sense to combine no-battery mode power and maintenance mode power as products spend different time in each of these states. (ITI, No. 20 at p. 3) The CA IOUs, while otherwise supportive, stated that the proposed integrated standby metric does not clearly delineate no-battery and maintenance modes power. (CA IOUs, No. 25 at p. 2) The CA IOUs recommended that the no-battery and maintenance modes power be reported separately as unique values, especially in the case of combination products that provide battery charging in addition to other functions. (CA IOUs, No. 25 at p. 2) The CA IOUs also reiterated their support of using IEC 62301 to develop a no-load standby measurement so that DOE's test procedure can harmonize with industry practices and improve low power factor treatment. (CA IOUs, No. 25 at p. 3) DOE notes that the no-battery mode test procedure was indeed developed based on IEC 62301 test procedure, with resolution parameters for power measurements and uncertainty methodologies, including input crest factor tolerance parameters, referenced directly from IEC 62301.

Honda disagreed with DOE's approach of combining maintenance mode power and no-battery mode power under standby mode power, stating that the approach would not properly evaluate standby power and would result in double evaluation of the power to boot up the battery charger. (Honda, No. 26 at pp. 1–2) Honda additionally asked DOE to monitor the current supply in maintenance mode when calculating standby power, because there can be differences when the charger is ''providing limited charge'' and when the charger is ''not charging''. (*Id.*) DOE reiterates that in maintenance mode operation, the battery charger is only continuously monitoring the fully charged battery's voltage to facilitate limited charging, if the voltage drops below a certain threshold. In no-battery mode, the battery charger is constantly ''scanning'' to determine if a battery has been inserted, or connected, to activate charging. The actual power to boot up the battery charging function to charge the depleted battery would be regulated in active mode itself. Therefore, combining maintenance mode power and no-battery mode power would not be double evaluating the power to boot up the battery charger.

WPC stated that it may be more accurate to determine the start of maintenance mode by measuring the decrease in power rather than using a charge indicator or timed rate of charge, as some device charge indicators may show a premature full charge state when compared to the rated capacity or after a period of maintenance mode charging. (WPC, No. 22 at p. 2) WPC, however, did not agree with DOE's proposal to combine no-battery mode and maintenance mode power into standby mode power for fixed-location wireless chargers, and suggested that focusing on ''no battery'' or ''no receiver'' mode would let DOE focus on standby power reduction. (WPC, No. 22 at p. 3)

DOE is aware of some instances in which battery chargers may enter a low power mode similar to no battery mode prior to entering maintenance mode, which exhibits higher power consumptions in comparison. Therefore, to ensure test procedure repeatability and representativeness, DOE adopts the proposal that the maintenance mode testing period should continue until 5 hours after true maintenance mode has been captured. This ensures that the consumption in the alternate low power mode described above is not being inadvertently captured as maintenance mode. For example, if a battery charger does not enter maintenance mode until the 50th hour of being in the active charge and maintenance mode test, then the total active and maintenance mode test period should be 55 hours, which ends at 5 hours after the charger enters maintenance mode.

EPCA requires DOE to include standby mode and off mode energy consumption, taking into consideration the most current versions of Standards 62301 and 62087 of the IEC, and to integrate such energy consumption into the overall descriptor for each covered product, unless technically infeasible, such as here. However, where integration into an overall metric is infeasible, EPCA directs DOE to prescribe a separate standby mode and off mode energy use test procedure for the covered product, if technically feasible. (42 U.S.C. 6295(gg)(2)(A)) The operation of a battery charger in maintenance mode meets the definition of ''standby mode'' as that term is defined by EPCA. (*See* 42 U.S.C. 6295(gg)(1)(A)(iii)) As discussed, maintenance mode provides the continuous function of maintaining a battery at full charge following active mode until such time as the fully charged battery is removed from the charger by the user. (*Id.*) The energy used during this continuous (and potentially indefinite) mode is distinct from energy use during active mode, the discrete period following placement of a depleted battery on the charger, as the energy used in maintenance mode does not contribute to direct battery charging. Further, because it is providing a user-oriented or protective function, maintenance mode does not meet the definition of off mode, which is defined as the condition in which an energy-using product is connected to a main power source; and is not providing any standby or active mode function. (42 U.S.C. 6295(gg)(1)(A)(ii))

As noted in section III.B.5 of this document, most energy losses happen during maintenance mode and no-battery mode, with the battery charger not doing any useful work to transfer energy into the battery. As these modes can last indefinitely based on different consumer usage and product types, calculating the energy losses based on a weighting factor would not be representative, which is also why DOE is discontinuing the integrated UEC approach. By combining the power draw of battery charger in maintenance mode and no-battery mode, DOE would be able to representatively capture the energy usage metrics for battery chargers in these states regardless of how much time the battery charger spends in each state, while still giving manufacturers freedom in design flexibility. Unlike with the overall UEC metric, DOE would not be reliant on usage profiles and the requisite updates here; therefore, it is not infeasible to combine maintenance mode and no-battery mode. Furthermore, because maintenance mode power computes the average power during at least the last four hours of maintenance mode period, it would not be necessary to separately measure the power of when the battery charger is providing limited charge.

As stated in section III.B.6 of this document, DOE is adopting the NOPR discussed alternative approach that calculates the active mode energy and maintenance mode power analytically from the combined charge and maintenance mode test. DOE reiterates that from extensive internal testing, DOE found that by monitoring battery charger input power, most battery chargers would exhibit a distinctive drop off in power, indicating a clear transition to maintenance mode. In rare instances when the battery charger shows unstable power consumption towards the end of charging phase, DOE notes that technically, they would still be considered as active charging phase as the battery is pining the charger to get full charge. Therefore, DOE does not anticipate there to be obstacles that prevents stakeholders from identifying the maintenance mode power under the alternative approach.

DOE is adopting the NOPR proposal to combine both maintenance mode and no-battery mode under battery charger standby mode. DOE further clarifies that for open-placement chargers, only no-battery mode power would need to be tested, as prescribed in section 5 of appendix Y1.

8. Non-Battery-Charging Related Functions

DOE granted Dyson, Inc. (''Dyson'') a waiver from the current battery charger test procedure for a specified battery charger model (used in a robotic vacuum cleaner) and provided an alternate means for disabling non-battery-charging functions during testing.[13] 82 FR 16580 (Apr. 5, 2017). As described in the petition for waiver, the

[13] Decision and Order Granting a Waiver to Dyson, Inc. From the Department of Energy Battery Charger Test Procedure (Case No. BC–001). Subsequently, DOE issued an Extension of Waiver to Dyson, Inc. to cover an additional basic model (Case No. 2018– 012). 84 FR 12240 (Apr. 1, 2019).

battery charger basic models subject to the waiver have a number of settings and remote management features not associated with the battery charging function but are instead associated with the vacuum cleaner end product that must remain on at all times. 82 FR 16580, 16581. Dyson explained that it would be inappropriate to make these functions user controllable, as they are integral to the function of the robot. *Id.* The DOE test procedure for battery chargers requires that any function controlled by the user and not associated with the battery charging process must be switched off; or, for functions not possible to switch off, be set to the lowest power consuming mode. Section 3.2.4.b of appendix Y. DOE determined that the current test procedure at appendix Y would evaluate the battery charger basic models specified in the Orders granting the waiver and (related waiver extension) in a manner so unrepresentative of its true energy consumption characteristics as to provide materially inaccurate comparatively data. 82 FR 16580, 16581 and 84 FR 12240, 12241. Pursuant to the approved test procedure waiver, the specified basic models must be tested and rated such that power to functions not associated with the battery charging process are disabled by isolating a terminal of the battery pack using isolating tape. *Id.*

In the November 2021 NOPR, DOE reviewed the market and initially determined that the products subject to the waivers granted to Dyson are no longer available; therefore, DOE proposed to not amend the test procedure to include instructions regarding disabling power to functions not associated with the battery charging process that are not consumer controllable, or to allow adders for such functions. 86 FR 66878, 66889–66890. DOE noted that this proposal would also terminate the existing Dyson waivers consistent with 10 CFR 430.27(h)(3) and 10 CFR 430.27(l). *Id.*

In response to DOE's proposal, the Joint Efficiency Advocates supported DOE's proposal to maintain the current approach for disabling power to non-battery-charging related functions, and supported DOE's proposal to terminate Dyson's waivers as these products are no longer available on the market. (Joint Efficiency Advocates, No. 23 at p. 3) NEEA supported maintaining the present approach to waiver petitions, auxiliary functions in the test procedure, and DOE's decision to terminate the existing waiver granted to Dyson. (NEEA, No. 27 at 11)

The Joint Trade Associations asked DOE to provide additional clarity on requirements regarding disabling power to non-battery-charging related functions, because although some functions do not contribute to battery charging, they cannot be disabled directly by the user. The Joint Trade Associations stated that DOE and stakeholders have struggled with how to address these functions in the past and suggested a proposal to allow disabling of these functions but with non-circumventing language. (Joint Trade Associations, No. 24 at p. 10) The Joint Trade Associations suggested DOE to include a publicly viewable column with the CCD so that the public can know when an alternative means is used to isolate the charging function. The Joint Trade Associations further suggested DOE to add a confidential column so manufacturers can report instructions on how to disable the non-battery-charging related functions or set them to the lowest power consuming state. The Joint Trade Associations also proposed to DOE that anti-circumvention language should be added to make the intent that battery-charging related circuit or function cannot be changed in the test procedure clear, as such language has been successful in other appliances categories. (*Id.*) ITI and Delta-Q also supported the joint comments. (ITI, No. 20 at pp. 4–5; Delta-Q, No. 28 at p. 2) Delta-Q further expressed their support of the existing Dyson waiver approach and suggested that DOE integrate allowances to more battery charger models, because it is not always practical or desirable for the user to have the ability to manually disable non-charging-features or reduce their consumption. (Delta-Q, No. 28 at p. 2)

STIHL commented that when STIHL's lawn mower battery is charging, there are some non-battery-charging related functions still running, such as connected functions or safety functions. (STIHL, No. 16 at p. 1) STIHL inquired if these functions can be deactivated or be given appropriate power adders when calculating for energy consumption during testing, because they do not relate to the charging process. *Id.*

DOE's current battery charger test procedure specifically requires non-battery-charging functions to be turned off during testing, unless manufacturers did not provide ways for end user to disable these functions. Section 3.2.4 of appendix Y. DOE notes that, due to the intricate nature of battery charger products, disabling non-battery-charging related functions through non-user-accessible ways can have unexpected effects on the battery charging circuitry, which raises repeatability and reproducibility concerns. Therefore, DOE is not amending the test procedure to allow disabling of non-battery-charging related functions through alternative means. In the case suggested by STIHL's comment, the same requirements would also apply, and the battery charger would only be tested with these non-battery-charging functions on if they cannot be switched off by the end user. Due to the huge variety of non-battery-charging related functions and different ways they can be implemented, DOE is not prescribing power adders for these non-battery-charging related functions.

Schumacher added that there is new automotive battery charger technology that uses internal super capacitors or Li-Ion batteries, which charges the standalone (end-use product's) battery normally, and then the internal battery or supercapacitor, if needed, after charge is complete. (Schumacher, No. 21 at p. 6) Schumacher asked if the charging of these internal batteries should be included into E24 or Pm or some other parts of the standard that are yet to be described. (Schumacher, No. 21 at p. 6) DOE's notes that its battery charger test procedure only measures the energy consumption at the input of the charger. Based on when charging of these super capacitors occur, it could be regulated either under active charge mode or maintenance mode of DOE's test procedure.

C. Corrections and Non-Substantive Changes

Since the publication of DOE's current battery charger test procedure and energy conservation standards, DOE has received numerous stakeholder inquiries regarding various topics involving battery charger testing and certification. Based on these inquiries, DOE identified the need for certain minor corrections. These corrections are addressed in the following sections. Additionally, in the interest of improving overall clarity, DOE will include a flowchart in the docket outlining the required testing and certification process with this final rule.

1. Certification Flowcharts

In the November 2021 NOPR, DOE proposed to include certification flowcharts in the docket upon publication of the final rule, shown in Figure III.C.1 and Figure III.C.2,[14] to

[14] Figures III.C.1 and III.C.2 are included to clarify the process in this rulemaking only. Manufacturers should not rely solely on the flowcharts as substantive guides for testing and compliance.

help manufacturers better understand the battery charger testing and certification process. The flowcharts provide an overview of the testing and certification process, including an overview of the basic model definition, the scope of DOE's battery charger test procedure; the required sample size, the difference between a rated value, a represented value, and a certified rating, and the statistical criteria for determining compliance with energy conservation standards. The flowcharts are not intended to address all aspects of the testing and certification requirements, but instead provide a general-level guide to the process. As such, manufacturers should not rely solely on the flowcharts for testing and compliance. Manufacturers of battery chargers are required to comply with the applicable provisions under 10 CFR parts 429 and 430.

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Figure III.C.1 Appendix Y Battery Charger Certification Testing and Certification Flowchart

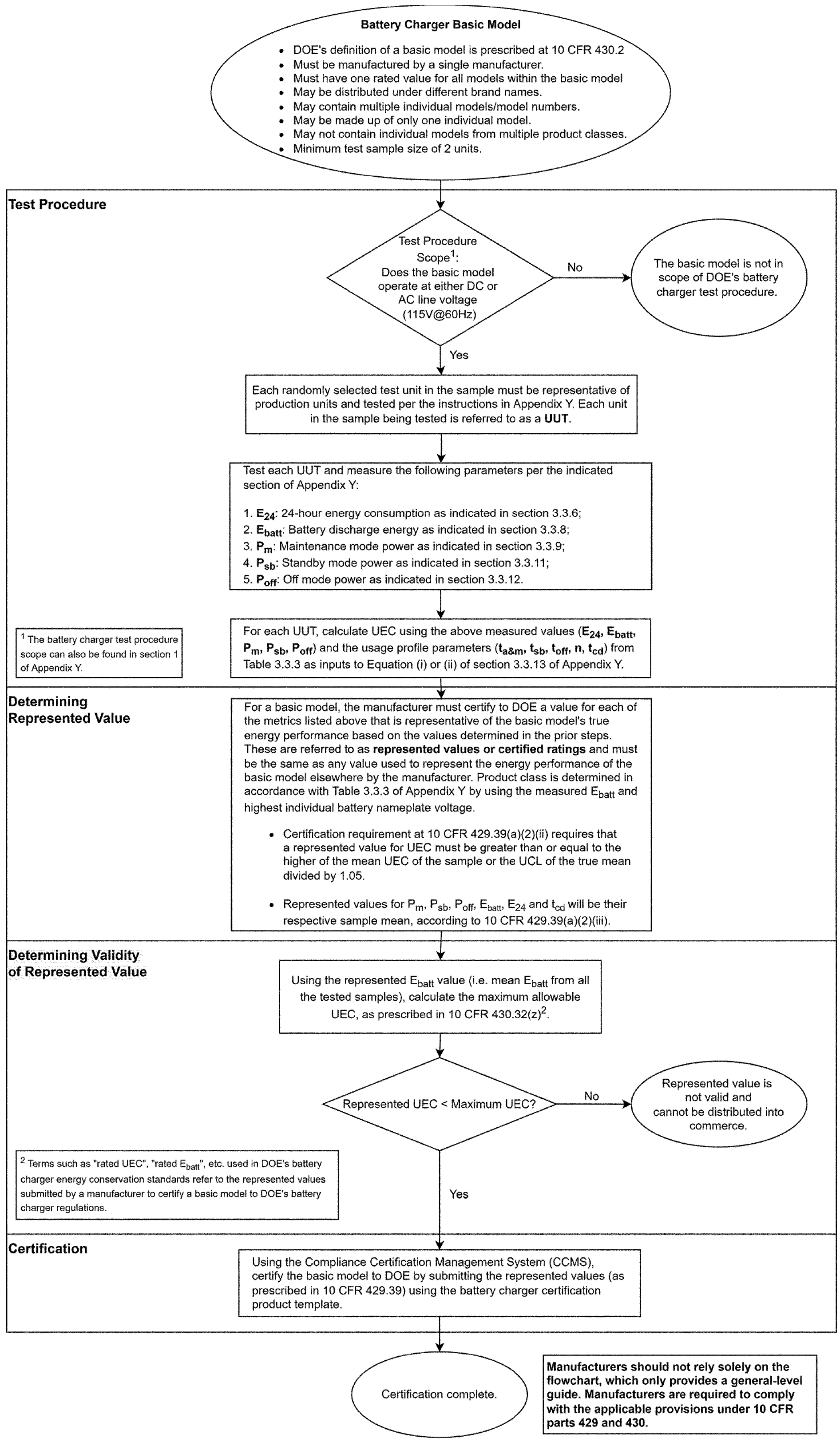
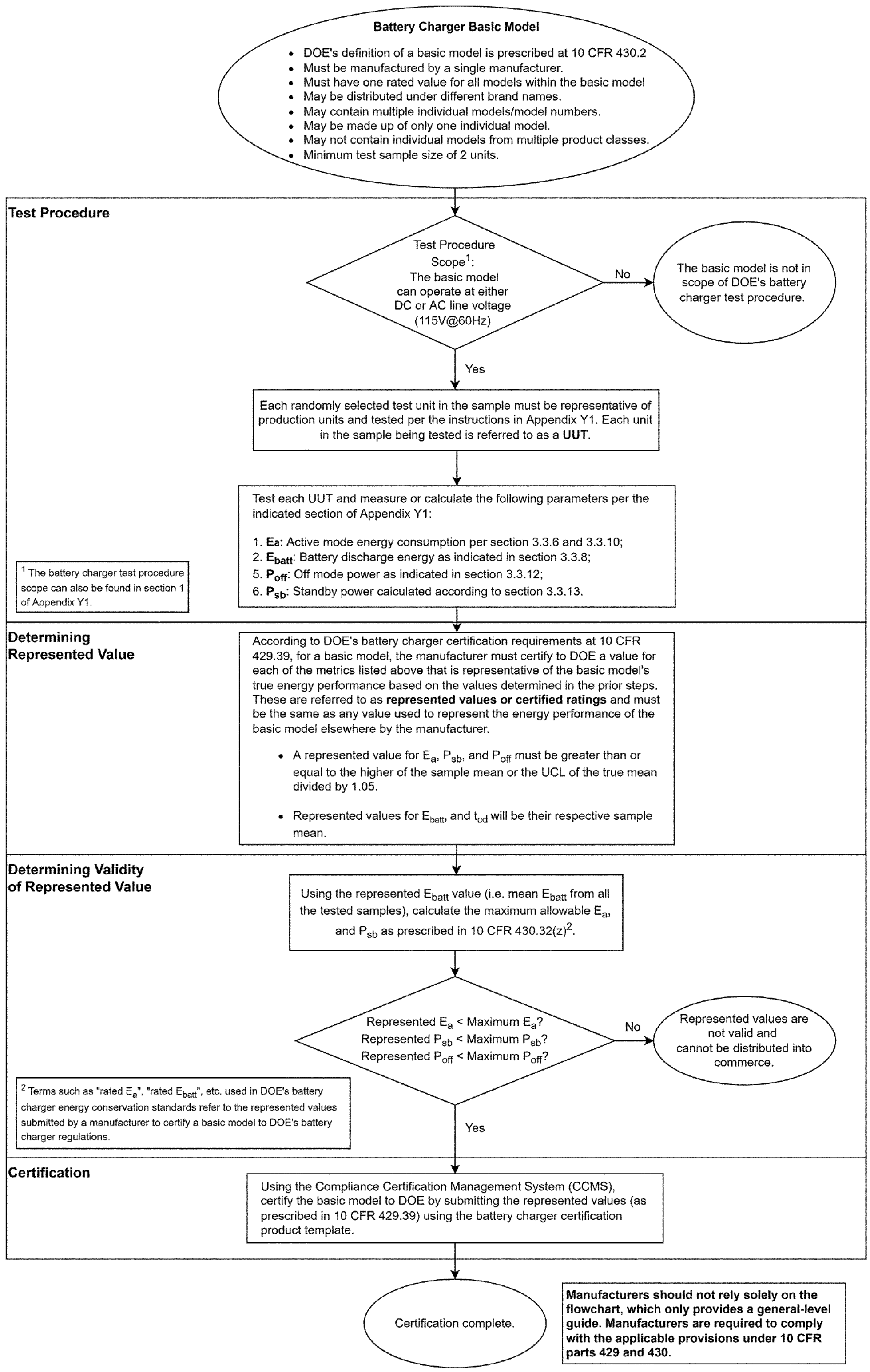


Figure III.C.2 Appendix Y1 Battery Charger Testing and Certification Flowchart[15]



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The Joint Trade Associations suggested that DOE consistently update the flowcharts as needed and make it clear that the regulatory text would override anything in the flowcharts because many manufacturers will rely on these flowcharts, if finalized. (Joint Trade Associations, No. 24 at p. 11) ITI also supported this comment. (ITI, No. 20 at p. 6)

15 Appendix Y1 test procedure would not be effective until after energy conservation standards have been amended to account for the multi-metric approach.

DOE acknowledges these comments and will ensure that the flowcharts are updated as necessary. DOE also reemphasizes that the regulatory text would override anything in the flowcharts.

2. Testing and Certification Clarifications

DOE's current battery charger UEC calculation is prescribed in section 3.3.13 of appendix Y, with product specific certification requirements prescribed in 10 CFR 429.39. DOE proposed clarifications in the November 2021 NOPR, based on stakeholder comments.

a. Measured vs. Rated Battery Energy

The product class distinctions provided in Table 3.3.3 of appendix Y are based in part on rated battery energy as determined in 10 CFR 429.39(a), which in turn references the represented value of battery discharge energy. 10 CFR 429.39(a)(1). The calculation of UEC in section 3.3.13 of appendix Y is based in part on the tested (measured) battery energy.

In the November 2021 NOPR, DOE proposed to further clarify the nomenclature in appendix Y by modifying the ''E_{batt}'' term used in the UEC calculation and usage profile selection in Table 3.3.3 to ''Measured E_{batt}''. As for the proposed appendix Y1, DOE noted that all of the instructions rely on measured E_{batt}, making it unnecessary to distinguish between measured and rated E_{batt}. 86 FR 66878, 66893.

Delta-Q supported the extra clarifications on measured and nameplate nomenclature. (Delta-Q, No. 28 at p. 2)

The Joint Trade Associations stated that it is not clear whether measured or rated values for battery energy should be used, and they would support DOE's proposal to update the nomenclature if coupled with an enforcement provision that allows for tolerance, as there could be inherent variations in test and production that affect how standard and product class applies. The Joint Trade Associations stated that their proposed approach is consistent with DOE's enforcement approach for other appliances, such as measured volume for refrigerators, freezers, clothes washers, dehumidifiers, etc. (Joint Trade Associations, No. 24 at p. 11) ITI supported this comment and further requested DOE to continue using the term ''rated'' instead of ''represented'', unless DOE can provide a clear definition on when should the ''represented'' term be used. (ITI, No. 20 at p. 5)

DOE recognizes the inherent variations in testing and production, especially for tested battery energies. However, DOE notes that due to the nature of how battery energy differs even for the same models from the same batch, when determining compliance through enforcement testing DOE would be looking at the individual sample performance more closely and determine compliance based on per sample basis, if necessary. DOE will also ensure that its battery charger energy conservation standards would show comparable standards for battery chargers that fall on the border of two neighboring product classes.

DOE notes that under the term ''rated'', some manufacturers might confuse it with ''nameplate'' values, which can differ for batteries. Therefore, to ensure test procedure repeatability and reproducibility, DOE is avoiding using the term ''rated'', and is updating the terms to ''represented'', ''nameplate'', and ''measured'' instead.

b. Other Nomenclatures

Schumacher stated that appendix Y's specified 5-hour discharge time resulted from the 0.2 C-rate, and conflicts with real world automotive battery ratings which are usually based on 10-to-20-hour rates. Schumacher stated that the 5-hour discharge time results in a much lower rating than the nameplate rating because of energy loss through heat. *(Schumacher, No. 21 at p. 2)* Schumacher proposed DOE to clarify the 0.2C C-rate means a 5-hour discharge rate to ensure manufacturers are conducting the tests correctly and reporting correctly. (Schumacher, No. 21 at pp.2–3)

DOE notes that discharge rates will vary by end-use application. It would be infeasible and add burden if DOE was to prescribe a unique discharge rate for each type of application in the test procedure. DOE's specified 0.2C discharge rate offers a practical and repeatable solution for different applications with either slow or fast discharge rates. By maintaining the same discharge rate, it would also improve comparability in results. For batteries that serve the same end-use application, although the tested value may differ from manufacturer designed ratings, they would still be comparable to other batteries from the same application.

The definition for C-rate is prescribed at section 2.10 of appendix Y, which specifies that the C-rate is calculated by dividing the charge or discharge current by the nameplate battery charge capacity of the battery. DOE has not received stakeholder comments suggesting that the current 0.2 discharge C-rate causes confusion prior to Schumacher's comment. DOE is also unaware of any manufacturer discharging the batteries differently than the prescribed 0.2C discharge rate. However, to further improve test procedure language clarity, DOE will amend the C-rate definition in both appendix Y and appendix Y1 to give an example that time needed to charge or discharge with a 0.2 C-rate would equal 5 hours.

Schumacher stated that the term used to refer to ''Product Classes'' and ''wall adapters'' are not consistent between the standard, test procedure, and CCD report template. (Schumacher, No. 21 at pp. 4–5) Schumacher commented that making consistent use of terms would avoid ambiguity and DOE should clarify that wall adapters indeed refer to EPSs. *Id.*

DOE's mention of wall adapters in the test procedure was to facilitate understanding and readability of the test procedure. In most cases, the term ''wall adapter'' can be used interchangeably with ''EPS''. To further improve language consistency, DOE is changing the ''wall adapter'' terms used in appendices Y and Y1 to the more technically appropriate term ''EPSs''. As for the term ''Product Classes'', DOE notes that in the CCD reporting template, they are referred to as ''Product Group Codes'', which should not cause confusion as the ''Product Group Codes'' worksheet details the product groups with matching product classes.

c. Alternate Test Method for Small Electronic Devices

In the November 2021 NOPR, DOE did not propose to amend the test procedure to rely on the measured battery energy value for the purpose of the testing and certification, because DOE has observed several occasions in which the measured battery energy was lower than the marked nameplate energy, which could lead to unrepresentative value of UEC or active energy consumption. 86 FR 66878, 66893.

ITI reiterated their recommendation for DOE to simplify the test procedure for small electronics by relying on the nameplate battery energy so that testers would not need to obtain special standalone battery samples or solder on tiny terminals. (ITI, No. 20 at pp. 6–7) ITI suggested DOE to reconsider its stance on these devices because inconsistencies caused by these small energy batteries would have negligible impact on overall results. (*Id.*) ITI also requested DOE to review data from small electronics as they normally have passed the UEC standard with large margins, but with maintenance mode energy contributing to majority of energy consumption. (*Id.*) NEEA expressed general support for DOE's assertion that rated and measured battery capacities can differ substantially, and that requiring measurement ensures fair competition under the standard. (NEEA, No. 27 at p. 11)

DOE reemphasizes that DOE's battery charger test procedure relies on the tested battery energy to carry out UEC calculation. DOE has encountered several occasions where the actual battery energy differs from the rated battery energy. Relying on the rated battery energy to test the product therefore would result in inaccurate measurements and certifications, contrary to EPCA's requirement that DOE adopt test procedures reasonably designed to produce representative results. Therefore, DOE is not prescribing any alternative test methods for small electronics.

d. Inability To Directly Measure Battery Energy

Section 3.2.5.(f) of appendix Y states that when the battery discharge energy and the charging and maintenance mode energy cannot be measured directly due to any of the following conditions: (1) inability to access the battery terminals; (2) access to the battery terminals destroys charger functionality; or (3) inability to draw current from the test battery, the battery discharge energy and the charging and maintenance mode energy shall be reported as ''Not Applicable.'' In such cases, the test procedure does not provide instruction on how to proceed with the remainder of the test, and an alternate test method must be used to measure battery discharge energy and the charging and maintenance mode energy.

DOE therefore proposed to update section 3.2.5(f) of appendix Y to explicitly state that if any of the aforementioned conditions are applicable, preventing the measurement of the battery discharge energy and the charging and maintenance mode energy, a manufacturer must submit a petition for a test procedure waiver in accordance with 10 CFR 430.27. The same provision would also be included as part of the new appendix Y1. 86 FR 66878, 66893. DOE did not receive comments on this topic and is adopting the proposed changes in this final rule.

e. Determining Battery Voltage

The product class distinctions provided in Table 3.3.3 of appendix Y are based in part on ''battery voltage'' in addition to rated battery energy or special charging characteristics, as described previously. Section 3.3.1 of appendix Y specifies recording the nameplate battery voltage of the test battery. Section 2.21 of appendix Y defines ''nameplate battery voltage'' as specified by the battery manufacturer and typically printed on the label of the battery itself. If there are multiple batteries that are connected in a series, the nameplate battery voltage of the batteries is the total voltage of the series configuration—that is, the nameplate voltage of each battery multiplied by the number of batteries connected in series. Connecting multiple batteries in parallel does not affect the nameplate battery voltage. Section 2.21 of appendix Y.

Additionally, for a multi-voltage charger, the battery with the highest battery voltage must be selected for testing, as prescribed by Table 3.2.1 of appendix Y. Consequently, the highest supported battery voltage should also be used to determine product class, which is not reflected by the current term ''battery voltage'' in Table 3.3.3. Updating the language in Table 3.3.3 would avoid the potential for future confusion with regard to multi-voltage products.

In the November 2021 NOPR, DOE proposed to amend Table 3.3.3 of appendices Y and Y1 by replacing the term ''battery voltage'' with ''highest nameplate battery voltage'' to provide clearer direction that the battery voltage used to determine product class is based on its nameplate battery voltage, and that for multi-voltage products, the highest voltage is used. 86 FR 66878, 66893–66894. The Joint Trade Associations supported DOE's proposal to clarify that the highest nameplate battery voltage should be used in determining product class. (Joint Trade Associations, No. 24 at p. 12)

In this final rule, DOE is adopting the proposed editorial change on battery voltage specification in Table 3.3.3.

f. UEC and Reporting Discrepancies

Schumacher noted that Ebatt and UEC allow 3 decimal places for entry, while the other measured, calculated, and determined values only allow 2 decimal places, which sometimes creates calculation errors. (Schumacher, No. 21 at p. 3) Schumacher proposed that DOE change all finished calculated values to 3 decimal places, except for UEC and max UEC which should be 2 decimal places; and all the constants provided by DOE to change from 2 decimal places to 5 or with fractions to reduce rounding errors, which sometimes prevents submission. (Schumacher, No. 21 at p. 3) Schumacher claimed that the UEC calculation selection formula can have discrepancies from the use of only 2 decimal places. For example, a battery charger with 64.271 hours of total charge time can use either UEC equation (i) or (ii) from the selection formula. (*Id.*) Schumacher stated that increasing the decimal places to 5 for constants and rounding the finished results to 3 decimal places or keeping the constants in fractions would reduce these discrepancies. (Schumacher, No. 21 at pp. 3–4)

DOE's CCD already allows manufacturers to report values with multiple decimal places. DOE notes that it cannot change the constants provided in appendix Y to more decimal places or fractions, as doing so could affect the currently CCD reported basic models. For example, even a slight change in usage profiles or threshold charge time could cause numerous currently reported basic models to have slightly different UEC. This change would also result in unnecessary need for manufacturers to recertify their basic models. DOE's CCD reporting form does not specifically look for rounding errors, and it was not clear from Schumacher's comment on how the submission rejection occurred. However, if stakeholders continue to have submission related questions, stakeholders can contact DOE's Compliance Certification Management System directly for help.

Schumacher also included a chart to illustrate that there is a 5-hour transition shift between UEC formula (i) and (ii), which does not lead to a smooth transition and asked DOE to provide some explanation. (Schumacher, No. 21 at p. 4) UEC equation (i) was developed based on usage profiles. To account for chargers that takes significantly longer to charge than DOE's threshold charge time, DOE developed UEC equation (ii) with close reference to equation (i). Because DOE's UEC equation (ii) accounts for the prolonged charge time that exceeds DOE's standard threshold charge time, it could negatively impact a battery charger's UEC in very limited cases.

g. Testing Setup

Schumacher suggested that the DOE battery charger test procedure should reference appendix Z or add greater detail on test measurement setup with proper connection sequence, to provide a more uniform standard and ensure reproducibility. (Schumacher, No. 21 at p. 5) Schumacher suggested that the sense leads should be placed directly on the battery terminals and not the charger terminals to ensure voltage loss of the charger terminals are measured and should be repeated for discharge measurement so that the terminal connection losses can be accounted for, which ensures a more uniform standard. (Schumacher, No. 21 at pp. 5–6)

Battery charger testing setup can vary significantly depending on different product configurations. DOE has already prescribed language in section 3.2.1 for manufacturers to set up the battery chargers according to manufacturer instructions or the default settings. DOE notes that the measurement setup figure used in appendix Z is for reference only and has language indicating that actual test setup may vary pursuant to appendix Z requirements. DOE has not encountered scenarios in which manufacturers cannot successfully set up measurement for battery charger testing; therefore, DOE is not providing greater detail on how manufacturers should set up test measurement.

DOE's battery charger test procedure measures the charging efficiency as a whole. Therefore, DOE is not adding requirements for manufacturers to measure the charger input at battery terminals, because adding the battery input terminal measurements would not representatively measure the useful energy being put into the battery and would add undue burden. Furthermore, battery chargers can have different designs that impact how discharge tests can be performed. As such, DOE is not prescribing additional requirements on where the battery output connections should be made for measurement to avoid undue burden.

3. Cross-Reference Corrections

Section 3.3.4 of appendix Y, ''Preparing the Battery for Charge Testing,'' specifies that the test battery shall be fully discharged for the duration specified in section 3.3.2 of appendix Y, or longer using a battery analyzer. However, DOE's intention was to instruct the user to discharge a test battery not for a set duration but until it reaches the end of discharge voltages listed in Table 3.3.2 of appendix Y. While a battery would be fully discharged with either set of instructions, current instructions would lead to a battery preparation step that is significantly longer. Additionally, there are several instances in appendix Y of which DOE used generic terms such as ''specified above'' or ''noted below''. While these generic reference terms are referring to the test procedure sections immediately preceding or following, identifying the specific referenced sections would improve the test procedure clarity. Therefore, DOE proposed to further clarify these cross-references in appendix Y, and incorporate this same change into proposed appendix Y1, to reduce test burden and avoid potential confusion. To further streamline the readability of appendix Y, DOE proposed to move the end-of-discharge Table 3.3.2 so that it immediately follows the battery discharge energy test at section 3.3.8. 86 FR 66878, 66894.

Honda suggested that the proposed Table 3.1.1 for appendix Y1 includes incorrect subsection references. (Honda, No. 26 at p. 1) Honda also stated that the proposed Table 4.3.1 of appendix Y1 appears to have a typographical error and that it should remain the same for current appendix Y Table 4.3.1. (Honda, No. 26 at p. 2)

DOE appreciates Honda's comment. The incorrect subsection references were unintentional typographical errors. For the proposed Table 4.3.1 of appendix Y1, it was incorrectly formatted upon publication. Table 4.3.1 should still remain the same as the one in appendix Y. DOE is correcting these two typographical errors in this final rule. DOE is also adopting the rest of the proposed cross-reference corrections.

4. Sub-Section Corrections

Sections 3.3.11(b) and 3.3.12(b) of appendix Y provide instructions for testing the standby and off mode power consumption, respectively, of a battery charger with integral batteries. Section 2.6 of appendix Y describes an integral battery as a battery that is contained within the consumer product and is not removed from the consumer product for charging purposes. Sections 3.3.11(c), 3.3.11(d), 3.3.12(c), and 3.3.12(d) provide instructions applicable to products containing ''integrated power conversion and charging circuitry,'' which is intended to refer to products with integral batteries for which the circuitry is integrated within the battery charger, in contrast to being integrated within a cradle or an external adapter (as referred to in sections 3.3.11(b) and 3.3.12(b)).

To improve the readability of the test procedure and avoid potential confusion as to the applicability of sections 3.3.11(c), 3.3.11(d), 3.3.12(c), and 3.3.12(d) in relation to sections 3.3.11(b) and 3.3.12(b), DOE in the November 2021 NOPR proposed to reorder these sections of appendix Y such that section 3.3.11(b) would include only the statement that standby mode may also apply to products with integral batteries. 86 FR 66878, 66894. The remainder of current section 3.3.11(b), as well as 3.3.11(c) and 3.3.11(d) would be reorganized as subsections (1) through (3) subordinate to section 3.3.11(b), to provide clearer indication that these three subsections refer to three different types of products with integral batteries. The same structure would be applied in section 3.3.12(b) for off mode. 86 FR 66878, 66894.

ITI requested DOE to further explain how sections 3.3.11 and 3.3.12 will be reorganized. (ITI, No. 20 at p. 6)

In the November 2021 NOPR, DOE stated in the preamble and in the proposed appendix Y and Y1 regulatory text section that subsections 3.3.11.(b) through (d) would be reorganized as subsections (1) through (3) subordinate to section 3.3.11(b), to provide clearer indication that these three subsections refer to three different types of products with integral batteries. The same structure would be applied in section 3.3.12(b) for off mode. 86 FR 66878, 66894. These would improve readability and DOE does not anticipate any impacts to current test procedure from these reorganizations. Therefore, DOE is adopting the proposed subsection corrections.

D. Effective and Compliance Dates

The effective date for the adopted test procedure amendment will be 30 days after publication of this final rule in the **Federal Register**. EPCA prescribes that all representations of energy efficiency and energy use, including those made on marketing materials and product labels, must be made in accordance with an amended test procedure, beginning 180 days after publication of the final rule in the **Federal Register**. (42 U.S.C. 6293(c)(2)) EPCA provides an allowance for individual manufacturers to petition DOE for an extension of the 180-day period if the manufacturer would experience undue hardship in meeting the deadline. (42 U.S.C. 6293(c)(3)) 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.*) To the extent the modified test procedure adopted in this final rule is required only for the evaluation and issuance of updated efficiency standards, compliance with the amended test procedure does not require use of such modified test procedure provisions until the compliance date of updated standards.

Upon the compliance date of test procedure provisions in this final rule, waivers that had been previously issued to Dyson (Case No. BC–001 and Case No. 2018–012) are terminated. 10 CFR 430.27(h)(3). Because these Dyson products are no longer distributed in the market, DOE does not anticipate further testing for these products.

E. Test Procedure Costs

In this final rule, DOE incorporates some editorial changes in the preceding test procedure for battery chargers at appendix Y to: (1) update battery chemistry table to improve representativeness; (2) explicitly refer manufacturers to the test procedure waiver provisions when battery energy cannot be measured; and (3) provide more descriptive designation of the different battery energy and battery voltage values used for determining product class and calculating unit energy consumption. The changes to appendix Y also include minor cross reference corrections and test procedure organization improvements. DOE is also terminating the existing Dyson test procedure waiver.

Appendix Y1 would include all the changes previously listed, as well as: (1) remove the ''wet environment'' designation and expand the 5 Wh battery energy limit to 100 Wh for fixed-location wireless chargers; (2) add definitions for ''fixed-location'' and ''open-placement'' wireless chargers; (3) introduce a new no-battery mode only test for open-placement wireless chargers; (4) amend the wall adapter selection for chargers that do not come with one; and (5) establish an approach that relies on separate metrics for active mode, standby mode, and off mode, in place of the UEC calculation in appendix Y. DOE has determined that these proposed amendments would not be unduly burdensome for manufacturers to conduct.

Appendix Y Test Procedure Amendments

The amendments specific to appendix Y would not alter the scope of applicability or the measured energy use of basic models currently certified to DOE. DOE does not anticipate that the proposals specific to appendix Y would cause any manufacturer to re-test any currently covered battery chargers or incur any additional testing costs.

Appendix Y1 Test Procedure Proposal

All the amendments specific to appendix Y1 would not be required to be used until DOE amends energy conservation standards for battery chargers in a future rulemaking and requires battery charger manufacturers to rate their products using appendix Y1. DOE is aware that certain manufacturers may be voluntarily reporting under state programs the energy efficiency as determined under appendix Y of a limited number of fixed-location wireless chargers that are not currently subject to the DOE test procedure. DOE is not aware of such representations being included in manufacturer literature. Given that such reporting appears limited to state programs and manufacturers are not otherwise making representations of the energy efficiency or energy use of such products, DOE is unable to estimate the extent of such reporting. Beginning 180 days following the final rule requiring the use of appendix Y1, were manufacturers to continue such voluntary reporting any such representations would have to be based on the DOE test procedure as amended. To the extent there is a limited number of models for which manufacturers are making voluntary representations, such models may require re-testing. Further details regarding the cost impact of the proposed amendments for when battery charger manufacturers are required to test their products using appendix Y1 are presented in the following paragraphs.

Appendix Y1—Wireless Chargers

The amendment to remove the ''wet environment'' designation and increase the battery energy limit will increase the scope of the existing battery charger test procedure to include wireless battery chargers other than those with inductive connection and designed for use in a wet environment.

DOE has estimated the testing cost associated to test these fixed-location and open-placement wireless chargers in accordance with the test procedure. DOE estimates that it would take approximately 40 hours to conduct testing for one fixed-location wireless charger unit and 2.2 hours to conduct the no-battery mode only test for one open-placement wireless charger unit. These tests do not require the wireless charger unit being tested to be constantly monitored by a lab technician. DOE estimates that a lab technician would spend approximately 2.5 hours to test a fixed-location wireless charger unit and 1 hour to test an open-placement wireless charger unit.

Based on data from the Bureau of Labor Statistics' (''BLS's'') Occupational Employment and Wage Statistics, the mean hourly wage for electrical and electronic engineering technologist and technician is $32.84.[16] DOE also used data from BLS's Employer Costs for Employee Compensation to estimate the percent that wages comprise the total compensation for an employee. DOE estimates that wages make up 70.4 percent of the total compensation for private industry employees.[17] Therefore, DOE estimates that the total hourly compensation (including all fringe benefits) of a technician performing these tests is approximately $46.65.[18] Using these labor rates and time estimates, DOE estimates that it would cost wireless charger manufacturers approximately $117 to conduct a single test on a fixed-location wireless charger unit and approximately $47 to conduct a single test on an open-placement wireless charger unit.[19]

DOE requires that at least two units be tested for each basic model prior to certifying a rating. Therefore, DOE estimates that manufacturers would incur testing costs of approximately $234 per fixed-location wireless charger basic model and approximately $94 per open-placement wireless charger basic model, when testing these wireless chargers. However, this amendment to remove the ''wet environment'' designation and increase the battery energy limit for wireless battery chargers would only be applicable for appendix Y1, and manufacturers would not be required to use appendix Y1 for wireless battery chargers that are not currently covered by appendix Y until DOE amends the energy conservation standards for battery chargers as part of a future rulemaking. DOE will further address the expected costs to industry if and when DOE establishes energy conservation standards for wireless chargers.

Appendix Y1—EPS Selection

The update to require the use of a minimally compliant power supply selection criteria for battery chargers that are not sold with one ensures that these products are tested in a manner that is representative of actual use, as required by EPCA. This update would not create additional cost or require additional time as compared to the prior test procedure, as these battery chargers

[16] DOE used the mean hourly wage of the ''17–3023 Electrical and Electronic Engineering Technologists and Technicians'' from the most recent BLS Occupational Employment and Wage Statistics (May 2020) to estimate the hourly wage rate of a technician assumed to perform this testing. *See https://www.bls.gov/oes/2020/may/oes173023.htm.* Last accessed on July 22, 2021.

[17] DOE used the March 2021 ''Employer Costs for Employee Compensation'' to estimate that for ''Private Industry Workers,'' ''Wages and Salaries'' are 70.4 percent of the total employee compensation. *See www.bls.gov/news.release/archives/ecec_06172021.pdf.* Last accessed on July 22, 2021.

[18] $32.84 ÷ 0.704 = $46.65.

[19] Fixed-location wireless charger: $46.65 × 2.5 hours = $116.63 (rounded to $117).

Open-placement wireless charger: $46.65 × 1 hour = $46.65 (rounded to $47).

currently require a low voltage input; this change will only specify how the low voltage input must be provided and is not expected to result in additional costs. DOE also anticipates this update to impact the measured energy consumption of battery chargers, but only for scenarios where the manufacturer previously certified the product using an EPS that is either not minimally compliant or used a bench power supply and failed to include its energy consumption as part of the battery charger system.

However, the amended test procedure would only apply to the new appendix Y1, meaning it would not be required for testing until DOE amends energy conservation standards and requires manufacturers to use appendix Y1. Based on DOE's market research, DOE estimates that most battery charger models do not remain on the market for more than four years because of frequent battery charger model updates and retirement of old models. Therefore, DOE anticipates that most battery chargers required to use appendix Y1 will likely be introduced into the market after this test procedure amendment is finalized.[20] Should the use of appendix Y1 be required due to amended energy conservation standards, battery chargers introduced prior to this test procedure's finalization would likely no longer be on the market and therefore DOE does not anticipate manufacturers needing to re-test those charger models. Battery chargers introduced into the market after this test procedure takes effect will have the option to test those models using the new power supply selection criteria. Battery charger manufacturers using the proposed selection criteria of a power supply would not incur any additional testing costs compared to the current battery charger testing costs. Any manufacturer seeking to avoid any risk of retesting costs can choose to comply with the new selection criteria of a power supply earlier than required. If a manufacturer chooses this option, they would incur the same testing costs when using the new selection criteria as they currently incur and would not have to retest those battery chargers after appendix Y1 is required. DOE will examine the potential retesting costs of manufacturers continuing to test battery charger models that do not use the new power supply selection criteria in any future energy conservation standard.

[20] For this cost analysis DOE estimates that the battery charger test procedures will be finalized in 2022. Similarly, amended energy conservation standards, if justified, would be finalized in 2024 with an estimated 2026 compliance date.

Appendix Y1—Modes of Operation

DOE has also estimated the testing costs associated with battery charger testing under appendix Y1. Removing usage profiles and switching the UEC metric to the active, standby, and off modes multi-metric system in appendix Y1 will cause battery charger manufacturers to re-test their products when DOE amends energy conservation standards requiring manufacturers to test their products using appendix Y1. Under appendix Y1, if the manufacturer has (i) already tested and certified the battery charger basic model under the current appendix Y and (ii) still has the original testing data from the appendix Y testing available for standby power calculation, those battery charger basic models would only need to be recertified with the active charge energy and standby power data analysis. For these battery charger basic models, DOE estimates an extra labor time of 10 minutes would be needed to reanalyze the test results. Using the previously calculated fully-burdened labor rate of $46.65 per hour for an employee conducting these tests, DOE estimates manufacturers would incur approximately $7.78 to analyze the test results for these battery chargers. DOE requires at least two units be tested per basic model. Therefore, DOE estimates manufacturers would incur approximately $15.56 per battery charger basic model for these battery chargers.

Basic models that will either be newly covered under the expanded scope or that are missing the original test data from their appendix Y testing would need to be fully tested under appendix Y1. DOE estimates a total testing time of approximately 40 hours would be needed, with 2.5 hours of technician intervention required to test each additional battery charger unit. Using the previously calculated fully-burdened labor rate of $46.65 for an electrical technician to conduct these tests, manufacturers would incur approximately $116.63 per unit. DOE requires at least two units be tested per basic model. Therefore, DOE estimates manufacturers would incur approximately $233.25 per battery charger basic model to conduct the complete testing under appendix Y1.

All Other Test Procedure Amendments

The remainder of the final rule would add additional detail and instruction to improve the readability of the test procedure. The cross-reference corrections, sub-section corrections and reorganizations also help improve the test procedure readability and clarity without modifying or adding any steps to the test method. As such, these amendments will not result in increased test burden.

IV. Procedural Issues and Regulatory Review

A. Review Under Executive Orders 12866 and 13563

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

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

B. Review Under the Regulatory Flexibility Act

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

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

1. Description of Reasons Why Action Is Being Considered

DOE is amending the existing DOE test procedures for battery chargers. DOE shall amend test procedures with respect to any covered product, if the Secretary determines that amended test procedures would more accurately produce test results which measure energy efficiency, energy use, or estimated annual operating cost of a covered product during a representative average use cycle or period of use. (42 U.S.C. 6293(b)(1)(A))

2. Objective of, and Legal Basis for, Rule

DOE is required to review existing DOE test procedures for all covered products every 7 years. (42 U.S.C. 6293(b)(1)(A))

3. Description and Estimate of Small Entities Regulated

For manufacturers of battery chargers, the Small Business Administration (''SBA'') has set a size threshold, which defines those entities classified as ''small businesses'' for the purposes of the statute. The size standards are listed by North American Industry Classification System (''NAICS'') code and industry description and are available at: *www.sba.gov/document/support-table-size-standards.* Battery charger manufacturing is classified under NAICS 335999, ''All Other Miscellaneous Electrical Equipment and Component Manufacturing.'' The SBA sets a threshold of 500 employees or fewer for an entity to be considered as a small business in this category.

DOE used the SBA's small business size standards to determine whether any small entities would be subject to the requirements of the proposed rule. 13 CFR part 121. DOE reviewed the test procedures in this final rule under the provisions of the Regulatory Flexibility Act and the procedures and policies published on February 19, 2003.

Wired Battery Chargers

DOE used data from DOE's publicly available Compliance Certification Database (''CCD'') [21] and the California Energy Commission's Modernized Appliance Efficiency Database System (''MAEDbS'').[22] DOE identified over 2,000 companies that submitted entries for Federally regulated battery chargers.[23] DOE screened out companies that do not meet the SBA definition of a ''small entity'' or are foreign-owned and operated. DOE identified approximately 294 potential small businesses that currently certify battery chargers or applications using battery chargers to DOE's CCD. These 294 potential small businesses manufacture approximately 3,456 unique basic models of battery chargers or applications using battery chargers. The number of battery charger models made by each potential small business ranges from 1 model to 263 models, with an average of approximately 12 unique basic models.

Wireless Battery Chargers

DOE used publicly available data from the Wireless Power Consortium and the aforementioned manufacturer list generated from the CCD and MAEDbS databases to estimate the number of wireless battery charger manufacturers and number of wireless battery charger models.[24] The majority of these companies are foreign owned and operated, as most wireless battery charger manufacturing is done abroad. DOE identified 13 potential domestic small businesses that manufacture approximately 327 wireless battery charger models. The number of wireless battery charger models made by each potential small business ranges from 1 model to 183 models, with an average of approximately 25 models.

4. Description and Estimate of Compliance Requirements

Wired Battery Chargers

DOE assumes that each small business's regulatory costs would depend on the number of unique basic battery charger models and applications using a battery charger that small business manufactures. It is likely that some unique applications using a battery charger may use the same battery charging component as another unique application listed in DOE's CCD, meaning the cost of testing would be double counted in this analysis. However, DOE has conservatively estimated the cost associated with re-testing each unique application using a battery charger. Additionally, while some battery charger manufacturers could partially rely on previous testing conducted under appendix Y for their battery chargers (as described in section III.E of this document), DOE conservatively estimates each small business would need to conduct the entire test under appendix Y1 for each unique basic model they manufacture.

As discussed in section III.E of this document, battery chargers would only need to be tested under appendix Y1 when DOE sets future energy conservation standards for battery chargers that require appendix Y1. DOE estimates that the total time for conducting testing under appendix Y1 would be approximately 40 hours, and that it would require approximately 2.5 hours of technician intervention to test each additional battery charger unit. Using the previously calculated fully-burdened labor rate of $46.65 for an electrical technician to conduct these tests,[25] manufacturers would incur approximately $116.63 of testing costs per unit. DOE requires at least two units be tested per basic model. Therefore, DOE estimates manufacturers would incur approximately $233.25 of testing costs per battery charger basic model to conduct the complete testing under appendix Y1.

DOE estimates that all small businesses combined would incur

[21] *See www.regulations.doe.gov/certification-data.* Last accessed on August 11, 2021.

[22] *See cacertappliances.energy.ca.gov/Pages/ApplianceSearch.aspx.* Last accessed on August 11, 2021.

[23] These entities consist of both battery charger manufacturers and manufacturers of devices that use a battery charger (*e.g.,* toys or small electronic devices that have a battery charger embedded in the product).

[24] *See www.wirelesspowerconsortium.com/products.* Last accessed on September 8, 2021.

[25] Based on data from the BLS's Occupational Employment and Wage Statistics, the mean hourly wage for an electrical and electronic engineering technologist and technician is $32.84 (*www.bls.gov/oes/current/oes173023.htm*). Additionally, DOE used data from BLS's Employer Costs for Employee Compensation to estimate the percent that wages comprise the total compensation for an employee. DOE estimates that wages make up 70.4 percent of the total compensation for private industry employees (*www.bls.gov/news.release/archives/ecec_06172021.pdf*). *$32.84 ÷ 0.704 = $46.65.*

approximately $0.81 million[26] if these small businesses re-tested all their unique basic models of battery chargers or applications using battery chargers under appendix Y1. The potential range of testing costs for an individual small business would be between $233.25 (to re-test one basic model to) and approximately $61,340 (to re-test 263 basic models,), with an average cost of approximately $2,799 to re-test 12 basic models (the average number of models) under appendix Y1. As noted in section III.E of this document, manufacturers could alternatively keep their original test data and extract an active charge energy metric for appendix Y1, which would avoid retesting costs for newly introduced basic models. As DOE estimated previously, most battery chargers will not stay on the market for more than four years, accordingly, small business manufacturers may be able to avoid most retesting costs by analyzing and keeping record of the active charge energy data, while conducting tests according to appendix Y.

DOE was able to find annual revenue estimates for 289 of the 294 small businesses DOE identified. DOE was not able to identify any reliable annual revenue estimates for the remaining five small businesses. Based on the number of unique basic models of battery chargers or applications using battery chargers each small business manufactures, DOE estimates that the $233.25 per model potential re-testing cost would represent less than 2 percent of annual revenue for 286 of the 289 small businesses. DOE estimates that three small businesses could incur re-testing costs that would exceed 2.0 percent of their annual revenue.[27]

Wireless Battery Chargers

DOE assumed that each small business's regulatory costs would depend on the number of wireless battery charger models that each small business manufactures. As discussed in section III.E, wireless battery chargers would only need to be tested under appendix Y1 when DOE sets future energy conservation standards for battery chargers. DOE estimates that a total testing time for conducting testing under appendix Y1 for wireless battery chargers would take approximately 40 hours to conduct the test for one fixed-location wireless charger unit, and 2.2 hours to conduct the no-battery mode only test for one open-placement wireless charger unit. These tests do not require the wireless charger unit being tested to be constantly monitored by a lab technician. DOE estimates that a lab technician would spend approximately 2.5 hours to test a fixed-location wireless charger unit and 1 hour to test an open-placement wireless charger unit.

The Wireless Power Consortium database does not identify if the wireless charger is a fixed-location or an open-placement wireless charger. Based on DOE's market research, the vast majority of wireless chargers are open-placement wireless chargers. Therefore, DOE is estimating the costs to small businesses using the estimated per unit open-placement wireless charger testing costs.

Using the previously calculated fully-burdened labor rate of $46.65 for an electrical technician to conduct these tests, manufacturers would incur approximately $47 per unit. DOE requires at least two units be tested per basic model. Therefore, DOE estimates manufacturers would incur approximately $94 to conduct the no-battery mode test for one open-placement wireless charger unit under appendix Y1.

DOE estimates that all small businesses combined would incur approximately $31,000 to test all their wireless chargers under appendix Y1.[28] The potential range of testing costs for an individual small business would be between $94 (to test one wireless charger model) to approximately $17,200 (to test 183 wireless charger models), with an average cost of approximately $2,350 to test 25 wireless charger models (the average number of models) under appendix Y1.

DOE was able to find annual revenue estimates for 12 of the 13 wireless charger small businesses DOE identified. DOE was not able to identify any reliable annual revenue estimates for the remaining wireless charger small businesses DOE identified. Based on the number of wireless charger models each small business manufactures, DOE estimates that the $94 per model testing cost would represent less than 2 percent of annual revenue for all 12 of the wireless charger small businesses that DOE found annual revenue estimates for.

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 final rule.

6. Significant Alternatives to the Rule

As previously stated in this section, DOE is required to review existing DOE test procedures for all covered products every 7 years. Additionally, DOE shall amend test procedures with respect to any covered product, if the Secretary determines that amended test procedures would more accurately produce test results which measure energy efficiency, energy use, or estimated annual operating cost of a covered product during a representative average use cycle or period of use. (42 U.S.C. 6293(b)(1)(A)) DOE has determined that appendix Y1 would more accurately produce test results to measure the energy efficiency of battery chargers.

While DOE recognizes that requiring that battery charger manufacturers use appendix Y1 to comply with future energy conservation standards would cause manufacturers to re-test some battery charger models or test some wireless chargers, for most battery charger manufacturers it will be inexpensive to re-test or test these models. Additionally, some manufacturers might be able to partially rely on previous test data used manufacturers tested their wired battery chargers under appendix Y.

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

Additional compliance flexibilities may be available through other means. EPCA provides that a manufacturer whose annual gross revenue from all of its operations does not exceed $8 million may apply for an exemption from all or part of an energy conservation standard for a period not longer than 24 months after the effective date of a final rule establishing the standard. (42 U.S.C. 6295(t)) Additionally, section 504 of the Department of Energy Organization Act, 42 U.S.C. 7194, provides authority for the Secretary to adjust a rule issued

[26] $233.25 (testing cost per basic model) × 3,456 (number of unique basic models manufactured by all small businesses) = $806,112.

[27] One small business manufactures eight unique basic models, which if all basic models were re-tested could cost up to $3,136. This small business has an estimated annual revenue of $52,000, meaning testing costs could comprise up to 6.0 percent of their annual revenue. Another small business manufactures six basic models, which if all basic models were re-tested could cost up to $2,352. This small business has an estimated annual revenue of $94,000, meaning testing costs could comprise up to 2.5 percent of their annual revenue. The remaining small business manufactures five basic models, which if all basic models were re-tested could cost up to $1,960. This small business has an estimated annual revenue of $68,400, meaning testing costs could comprise up to 2.9 percent of their annual revenue.

[28] $94 (testing cost per model) × 327 (number of wireless charger models manufactured by all small businesses) = $30,738.

under EPCA in order to prevent ''special hardship, inequity, or unfair distribution of burdens'' that may be imposed on that manufacturer as a result of such rule. Manufacturers should refer to 10 CFR part 430, subpart E, and 10 CFR part 1003 for additional details.

C. Review Under the Paperwork Reduction Act of 1995

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

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

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

D. Review Under the National Environmental Policy Act of 1969

In this final rule, DOE establishes test procedure amendments that it expects will be used to develop and implement future energy conservation standards for battery chargers. DOE has determined that this rule falls into a class of actions that are categorically excluded from review under the National Environmental Policy Act of 1969 (42 U.S.C. 4321 *et seq.*) and DOE's implementing regulations at 10 CFR part 1021. Specifically, DOE has determined that adopting test procedures for measuring energy efficiency of consumer products and industrial equipment is consistent with activities identified in 10 CFR part 1021, appendix A to subpart D, A5 and A6. Accordingly, neither an environmental assessment nor an environmental impact statement is required.

E. Review Under Executive Order 13132

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

F. Review Under Executive Order 12988

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

G. Review Under the Unfunded Mandates Reform Act of 1995

Title II of the Unfunded Mandates Reform Act of 1995 (''UMRA'') requires each Federal agency to assess the effects of Federal regulatory actions on State, local, and Tribal governments and the private sector. Public Law 104–4, sec. 201 (codified at 2 U.S.C. 1531). For a regulatory action resulting in a rule that may cause the expenditure by State, local, and Tribal governments, in the aggregate, or by the private sector of $100 million or more in any one year (adjusted annually for inflation), section 202 of UMRA requires a Federal agency to publish a written statement that estimates the resulting costs, benefits, and other effects on the national economy. (2 U.S.C. 1532(a), (b)) The UMRA also requires a Federal agency to develop an effective process to permit timely input by elected officers of State, local, and Tribal governments on a proposed ''significant intergovernmental mandate,'' and requires an agency plan for giving notice and opportunity for timely input to potentially affected small governments before establishing any requirements that might significantly or uniquely affect small governments. On March 18, 1997, DOE published a statement of policy on its process for intergovernmental consultation under UMRA. 62 FR 12820; also available at *www.energy.gov/gc/office-general-counsel.* DOE examined this final rule according to UMRA and its statement of policy and determined that the rule contains neither an intergovernmental mandate, nor a mandate that may result in the expenditure of $100 million or more in any year, so these requirements do not apply.

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

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

I. Review Under Executive Order 12630

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

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

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

K. Review Under Executive Order 13211

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

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

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

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

The modifications to the test procedure for battery chargers adopted in this final rule incorporates testing methods contained in certain sections of IEC 62301, IEC 62040–3, and ANSI/NEMA WD 6–2016. DOE has evaluated these standards and is unable to conclude whether it fully complies with the requirements of section 32(b) of the FEAA (*i.e.,* whether it was developed in a manner that fully provides for public participation, comment, and review.) DOE has consulted with both the Attorney General and the Chairman of the FTC about the impact on competition of using the methods contained in these standards and has received no comments objecting to their use.

M. Congressional Notification

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

N. Description of Materials Incorporated by Reference

In this final rule, DOE incorporates by reference the following industry standards into the new appendix Y1:

1. ANSI/NEMA WD 6–2016, ''Wiring Devices—Dimensional Specifications,'' ANSI approved February 11, 2016. Appendix Y1 references the input plug requirements in Figure 1–15 and Figure 5–15 of ANSI/NEMA WD 6–2016. ANSI/NEMA WD 6–2016 is an industry standard that covers the plugs, receptacles, and wall plates used in most electrical installations in residential, commercial, and industrial buildings.

2. IEC 62040–3, ''Uninterruptible power systems (UPS)—Part 3: Methods of specifying the performance and test requirements,'' Edition 2.0, 2011–03. Appendix Y1 references various sections from IEC 62040 for test requirements of uninterruptible power supplies. IEC 62040 is an international test standard that specifies the performance and test requirements applied to movable, stationary, and fixed electronic uninterruptible power systems.

3. IEC 62301, ''Household electrical appliances—Measurement of standby power, (Edition 2.0, 2011–01)'' into the new appendix Y1. Appendix Y1 references various sections from IEC 62301 for test conditions, standby power measurement, and measurement uncertainty determination. IEC 62301 is an international test standard that specifies methods of measurement of electrical power consumption of household electrical appliances in standby mode(s) and other low power modes, as applicable.

Copies of ANSI/NEMA WD 6–2016 can be obtained from American National Standards Institute, 25 W 43rd Street, 4th Floor, New York, NY 10036, (212) 642–4900, or by going to *www.ansi.org.*

Copies of IEC 62040–3 and IEC 62301 can be obtained from the International Electrotechnical Commission at 446 Main Street, Sixteenth floor, Worcester, MA 01608, or by going to *www.iec.ch.,* and are also available from the American National Standards Institute, 25 W 43rd Street, 4th Floor, New York, NY 10036, (212) 642–4900, or go to *webstore.ansi.org.*

V. Approval of the Office of the Secretary

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

List of Subjects

10 CFR Part 429

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

10 CFR Part 430

Administrative practice and procedure, Confidential business information, Energy conservation, Household appliances, Imports, Incorporation by reference, Intergovernmental relations, Small businesses.

Signing Authority

This document of the Department of Energy was signed on August 25, 2022, Dr. Geraldine L. Richmond, Undersecretary of Science and Innovation, pursuant to delegated authority from the Secretary of Energy. That document with the original signature and date is maintained by DOE. For administrative purposes only, and in compliance with requirements of the Office of the Federal Register, the undersigned DOE Federal Register Liaison Officer has been authorized to sign and submit the document in electronic format for publication, as an official document of the Department of Energy. This administrative process in no way alters the legal effect of this document upon publication in the **Federal Register**.

Signed in Washington, DC, on August 25, 2022.

Treena V. Garrett,

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

For the reasons stated in the preamble, DOE amends parts 429 and 430 of Chapter II of Title 10, Code of Federal Regulations as set forth below:

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

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

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

■ 2. Section 429.134 is amended by adding paragraph (u) to read as follows:

§ 429.134 Product specific enforcement provisions.

* * * * *

(u) *Battery chargers—verification of reported represented value obtained from testing in accordance with appendix Y1 of 10 CFR part 430 subpart B when using an external power supply.* If the battery charger basic model requires the use of an external power supply (''EPS''), and the manufacturer reported EPS is no longer available on the market, then DOE will test the battery charger with any compatible EPS that is minimally compliant with DOE's energy conservation standards for EPSs as prescribed in § 430.32(w) of this subchapter and that meets the battery charger input power criteria.

PART 430—ENERGY CONSERVATION PROGRAM FOR CONSUMER PRODUCTS

■ 3. The authority citation for part 430 continues to read as follows:

Authority: 42 U.S.C. 6291–6309; 28 U.S.C. 2461 note.

§ 430.3 [Amended]

■ 4. Section 430.3 is amended by:

■ a. In paragraph (e)(22) introductory text, removing the text ''Appendix Y'', and adding in its place the text ''appendices Y and Y1'';

■ b. In paragraph (p)(3) introductory text, removing the text ''appendix Y'', and adding in its place the text ''appendices Y and Y1''; and

■ c. In paragraph (p)(6), removing the text ''Y, Z,'', and adding in its place the text ''Y, Y1, Z''.

■ 5. Section 430.23 is amended by revising paragraph (aa) to read as follows:

§ 430.23 Test procedures for the measurement of energy and water consumption.

* * * * *

(aa) *Battery Chargers.* (1) For battery chargers subject to compliance with the relevant standard at § 430.32(z) as that standard appeared in the January 1, 2022, edition of 10 CFR parts 200–499:

(i) Measure the maintenance mode power, standby power, off mode power, battery discharge energy, 24-hour energy consumption and measured duration of the charge and maintenance mode test for a battery charger other than uninterruptible power supplies in accordance with appendix Y to this subpart;

(ii) Calculate the unit energy consumption of a battery charger other than uninterruptible power supplies in accordance with appendix Y to this subpart;

(iii) Calculate the average load adjusted efficiency of an uninterruptible power supply in accordance with appendix Y to this subpart.

(2) For a battery charger subject to compliance with any amended relevant standard provided in § 430.32 that is published after September 8, 2022:

(i) Measure active mode energy, maintenance mode power, no-battery mode power, off mode power and battery discharge energy for a battery charger other than uninterruptible power supplies in accordance with appendix Y1 to this subpart.

(ii) Calculate the standby power of a battery charger other than uninterruptible power supplies in accordance with appendix Y1, to this subpart.

(iii) Calculate the average load adjusted efficiency of an uninterruptible power supply in accordance with appendix Y1 to this subpart.

* * * * *

■ 6. Appendix Y to subpart B of part 430 is amended by:

■ a. Revising the introductory note and introductory text;

■ b. Revising sections 2.1.0, 3.1.4.(b), 3.2.5.(f), 3.3.4, 3.3.6.(c)(5), and 3.3.8.;

■ c. Revising Table 3.3.2 to section 3.3.10.; and

■ d. Revising sections 3.3.11. through 3.3.13.

The revisions read as follows:

Appendix Y to Subpart B of Part 430—Uniform Test Method for Measuring the Energy Consumption of Battery Chargers

Note: Manufacturers must use the results of testing under appendix Y to determine compliance with the relevant standard from § 430.32(z) as that standard appeared in the January 1, 2022, edition of 10 CFR parts 200–499. Specifically, before March 7, 2023 representations must be based upon results generated either under this appendix or under appendix Y as it appeared in the 10 CFR parts 200–499 edition revised as of January 1, 2022.

For any amended standards for battery chargers published after September 8, 2022, manufacturers must use the results of testing under appendix Y1 to determine compliance. Representations related to energy consumption must be made in accordance with the appropriate appendix that applies (*i.e.,* appendix Y or appendix Y1) when determining compliance with the relevant standard. Manufacturers may also use appendix Y1 to certify compliance with amended standards, published after September 8, 2022, prior to the applicable compliance date for those standards.

* * * * *

2.10. *C-Rate (C)* is the rate of charge or discharge, calculated by dividing the charge or discharge current by the nameplate battery charge capacity of the battery. For example, a 0.2 C-rate would result in a charge or discharge period of 5 hours.

* * * * *

3.1.4. Verifying the UUT's Input Voltage and Input Frequency

* * * * *

(b) If a charger is powered by a low-voltage DC or AC input, and the manufacturer packages the charger with an external power supply (''EPS''), sells, or recommends an optional EPS capable of providing that low voltage input, then the charger shall be tested using that EPS and the input reference source shall be 115 V at 60 Hz. If the EPS cannot be operated with AC input voltage at 115 V at 60 Hz, the charger shall not be tested.

* * * * *

3.2.5. Accessing the Battery for the Test

* * * * *

(f) If any of the following conditions noted immediately below in sections 3.2.5.(f)(1) to 3.2.5.(f)(3) are applicable, preventing the measurement of the Battery Discharge Energy and the Charging and Maintenance Mode Energy, a manufacturer must submit a petition for a test procedure waiver in accordance with § 430.27:

(1) Inability to access the battery terminals;

(2) Access to the battery terminals destroys charger functionality; or

(3) Inability to draw current from the test battery.

* * * * *

3.3.4. Preparing the Battery for Charge Testing

Following any conditioning prior to beginning the battery charge test (section 3.3.6 of this appendix), the test battery shall be fully discharged to the end of discharge voltage prescribed in Table 3.3.2 of this appendix, or until the UUT circuitry terminates the discharge.

* * * * *

3.3.6. Testing Charge Mode and Battery Maintenance Mode

* * * * *

(c) * * *

(5) Connect the test battery to the battery charger within 3 minutes of beginning logging. For integral battery products, connect the product to a cradle or EPS within 3 minutes of beginning logging;

* * * * *

3.3.8. Battery Discharge Energy Test

(a) If multiple batteries were charged simultaneously, the discharge energy is the sum of the discharge energies of all the batteries.

(1) For a multi-port charger, batteries that were charged in separate ports shall be discharged independently.

(2) For a batch charger, batteries that were charged as a group may be discharged individually, as a group, or in sub-groups connected in series and/or parallel. The position of each battery with respect to the other batteries need not be maintained.

(b) During discharge, the battery voltage and discharge current shall be sampled and recorded at least once per minute. The values recorded may be average or instantaneous values.

(c) For this test, the technician shall follow these steps:

(1) Ensure that the test battery has been charged by the UUT and rested according to sections 3.3.6. and 3.3.7 of this appendix.

(2) Set the battery analyzer for a constant discharge rate and the end-of-discharge voltage in Table 3.3.2 of this appendix for the relevant battery chemistry.

(3) Connect the test battery to the analyzer and begin recording the voltage, current, and wattage, if available from the battery analyzer. When the end-of-discharge voltage is reached or the UUT circuitry terminates the discharge, the test battery shall be returned to an open-circuit condition. If current continues to be drawn from the test battery after the end-of-discharge condition is first reached, this additional energy is not to be counted in the battery discharge energy.

(d) If not available from the battery analyzer, the battery discharge energy (in watt-hours) is calculated by multiplying the voltage (in volts), current (in amperes), and sample period (in hours) for each sample, and then summing over all sample periods until the end-of-discharge voltage is reached.

* * * * *

TABLE 3.3.2—REQUIRED BATTERY DISCHARGE RATES AND END-OF-DISCHARGE BATTERY VOLTAGES

Battery chemistry	Discharge rate (C)	End-of-discharge voltage * (volts per cell)
Valve-Regulated Lead Acid (VRLA)	0.2	1.75
Flooded Lead Acid	0.2	1.70
Nickel Cadmium (NiCd)	0.2	1.0
Nickel Metal Hydride (NiMH)	0.2	1.0
Lithium-Ion (Li-Ion)	0.2	2.5
Lithium-Ion Polymer	0.2	2.5
Lithium Iron Phosphate	0.2	2.0
Rechargeable Alkaline	0.2	0.9
Silver Zinc	0.2	1.2

* If the presence of protective circuitry prevents the battery cells from being discharged to the end-of-discharge voltage specified, then discharge battery cells to the lowest possible voltage permitted by the protective circuitry.

3.3.11. Standby Mode Energy Consumption Measurement

The standby mode measurement depends on the configuration of the battery charger, as follows:

(a) Conduct a measurement of standby power consumption while the battery charger is connected to the power source. Disconnect the battery from the charger, allow the charger to operate for at least 30 minutes, and record the power (*i.e.,* watts) consumed as the time series integral of the power consumed over a 10-minute test period, divided by the period of measurement. If the battery charger has manual on-off switches, all must be turned on for the duration of the standby mode test.

(b) Standby mode may also apply to products with integral batteries, as follows:

(1) If the product uses a cradle and/or adapter for power conversion and charging, then ''disconnecting the battery from the charger'' will require disconnection of the end-use product, which contains the batteries. The other enclosures of the battery charging system will remain connected to the main electricity supply, and standby mode power consumption will equal that of the cradle and/or adapter alone.

(2) If the product is powered through a detachable AC power cord and contains integrated power conversion and charging circuitry, then only the cord will remain connected to mains, and standby mode power consumption will equal that of the AC power cord (*i.e.,* zero watts).

(3) If the product contains integrated power conversion and charging circuitry but is powered through a non-detachable AC power cord or plug blades, then no part of the system will remain connected to mains, and standby mode measurement is not applicable.

3.3.12. Off Mode Energy Consumption Measurement

The off mode measurement depends on the configuration of the battery charger, as follows:

(a) If the battery charger has manual on-off switches, record a measurement of off mode energy consumption while the battery charger is connected to the power source.

Remove the battery from the charger, allow the charger to operate for at least 30 minutes, and record the power (*i.e.,* watts) consumed as the time series integral of the power consumed over a 10-minute test period, divided by the period of measurement, with all manual on-off switches turned off. If the battery charger does not have manual on-off switches, record that the off mode measurement is not applicable to this product.

(b) Off mode may also apply to products with integral batteries, as follows:

(1) If the product uses a cradle and/or adapter for power conversion and charging, then ''disconnecting the battery from the charger'' will require disconnection of the end-use product, which contains the batteries. The other enclosures of the battery charging system will remain connected to the main electricity supply, and off mode power consumption will equal that of the cradle and/or adapter alone.

(2) If the product is powered through a detachable AC power cord and contains integrated power conversion and charging circuitry, then only the cord will remain connected to mains, and off mode power consumption will equal that of the AC power cord (*i.e.,* zero watts).

(3) If the product contains integrated power conversion and charging circuitry but is powered through a non-detachable AC power cord or plug blades, then no part of the system will remain connected to mains, and off mode measurement is not applicable.

3.3.13. Unit Energy Consumption Calculation

Unit energy consumption (UEC) shall be calculated for a battery charger using one of the two equations (equation (i) or equation (ii)) listed in this section. If a battery charger is tested and its charge duration as determined in section 3.3.2 of this appendix minus 5 hours is greater than the threshold charge time listed in Table 3.3.3 of this appendix (*i.e.* $(t_{cd} - 5) * n > t_{a\&m}$), equation (ii) shall be used to calculate UEC; otherwise a battery charger's UEC shall be calculated using equation (i).

$$\text{(i) } UEC = 365\left(n(E_{24} - 5P_m - Measured\ E_{batt})\frac{24}{t_{cd}} + \left(P_m(t_{a\&m} - (t_{cd} - 5)n)\right) + (P_{sb}t_{sb}) + \left(P_{off}t_{off}\right)\right) \text{ or,}$$

$$\text{(ii) } UEC = 365\left(n(E_{24} - 5P_m - Measured\ E_{batt})\frac{24}{(t_{cd} - 5)} + (P_{sb}t_{sb}) + \left(P_{off}t_{off}\right)\right)$$

Where:

E_{24} = 24-hour energy as determined in section 3.3.10 of this appendix,

$Measured\ E_{batt}$ = Measured battery energy as determined in section 3.3.8. of this appendix,

P_m = Maintenance mode power as determined in section 3.3.9. of this appendix,

P_{sb} = Standby mode power as determined in section 3.3.11. of this appendix,

P_{off} = Off mode power as determined in section 3.3.12. of this appendix,

t_{cd} = Charge test duration as determined in section 3.3.2. of this appendix, and

$t_{a\&m}$, n, t_{sb}, and t_{off}, are constants used depending upon a device's product class and found in Table 3.3.3:

TABLE 3.3.3—BATTERY CHARGER USAGE PROFILES

Product class				Hours per day ***			Charges (n)	Threshold charge time *
Number	Description	Measured battery energy (measured E_{batt}) **	Special characteristic or highest nameplate battery voltage	Active + maintenance ($t_{a\&m}$)	Standby (t_{sb})	Off (t_{off})	Number per day	Hours
1	Low-Energy	≤5 Wh	Inductive Connection ****.	20.66	0.10	0.00	0.15	137.73
2	Low-Energy, Low-Voltage.	<100 Wh	<4 V	7.82	5.29	0.00	0.54	14.48
3	Low-Energy, Medium-Voltage.		4–10 V	6.42	0.30	0.00	0.10	64.20
4	Low-Energy, High-Voltage.		>10 V	16.84	0.91	0.00	0.50	33.68
5	Medium-Energy, Low-Voltage.	100–3000 Wh	<20 V	6.52	1.16	0.00	0.11	59.27
6	Medium-Energy, High-Voltage.		≥20 V	17.15	6.85	0.00	0.34	50.44
7	High-Energy	>3000 Wh		8.14	7.30	0.00	0.32	25.44

* If the duration of the charge test (minus 5 hours) as determined in section 3.3.2. of this appendix exceeds the threshold charge time, use equation (ii) to calculate UEC otherwise use equation (i).

** Measured E_{batt} = Measured battery energy as determined in section 3.3.8.

*** If the total time does not sum to 24 hours per day, the remaining time is allocated to unplugged time, which means there is 0 power consumption and no changes to the UEC calculation needed.

**** Fixed-location inductive wireless charger only.

* * * * *

■ 7. Appendix Y1 to subpart B of part 430 is added to read as follows:

Appendix Y1 to Subpart B of Part 430—Uniform Test Method for Measuring the Energy Consumption of Battery Chargers

Note: Manufacturers must use the results of testing under this appendix Y1 to determine compliance with any amended standards for battery chargers provided in § 430.32 that are published after September 8, 2022. Representations related to energy or water consumption must be made in accordance with the appropriate appendix that applies (*i.e.,* appendix Y or appendix Y1) when determining compliance with the relevant standard. Manufacturers may also use appendix Y1 to certify compliance with amended standards, published after September 8, 2022, prior to the applicable compliance date for those standards.

1. Scope

This appendix provides the test requirements used to measure the energy consumption of battery chargers, including fixed-location wireless chargers designed for charging batteries with less than 100 watt-hour battery energy and open-placement wireless chargers, operating at either DC or United States AC line voltage (nominally 115V at 60Hz). This appendix also provides the test requirements used to measure the energy efficiency of uninterruptible power supplies as defined in section 2 of this appendix that utilize the standardized National Electrical Manufacturer Association (NEMA) plug, 1–15P or 5–15P, as specified in ANSI/NEMA WD 6–2016 (incorporated by reference, see § 430.3) and have an AC output. This appendix does not provide a method for testing back-up battery chargers.

2. Definitions

The following definitions are for the purposes of explaining the terminology associated with the test method for measuring battery charger energy consumption.[1]

[1] For clarity on any other terminology used in the test method, please refer to IEEE 1515–2000, (Sources for information and guidance, see § 430.4).

2.1. *Active mode* or *charge mode* is the state in which the battery charger system is connected to the main electricity supply, and the battery charger is delivering current, equalizing the cells, and performing other one-time or limited-time functions in order to bring the battery to a fully charged state.

2.2. *Active power* or *real power* (P) means the average power consumed by a unit. For a two terminal device with current and voltage waveforms i(t) and v(t), which are periodic with period T, the real or active power P is:

$$P = \frac{1}{T}\int_0^T v(t)i(t)dt$$

2.3. *Ambient temperature* is the temperature of the ambient air immediately surrounding the unit under test.

2.4. *Apparent power (S)* is the product of root-mean-square (RMS) voltage and RMS current in volt-amperes (VA).

2.5. *Batch charger* is a battery charger that charges two or more identical batteries simultaneously in a series, parallel, series-parallel, or parallel-series configuration. A batch charger does not have separate voltage or current regulation, nor does it have any separate indicators for each battery in the batch. When testing a batch charger, the term ''battery'' is understood to mean, collectively, all the batteries in the batch that are charged together. A charger can be both a batch charger and a multi-port charger or multi-voltage charger.

2.6. *Battery* or *battery pack* is an assembly of one or more rechargeable cells and any integral protective circuitry intended to provide electrical energy to a consumer product, and may be in one of the following forms:

(a) Detachable battery (a battery that is contained in a separate enclosure from the consumer product and is intended to be removed or disconnected from the consumer product for recharging); or

(b) Integral battery (a battery that is contained within the consumer product and is not removed from the consumer product for charging purposes). The word ''intended'' in this context refers to whether a battery has been designed in such a way as to permit its removal or disconnection from its associated consumer product.

2.7. *Battery energy* is the energy, in watt-hours, delivered by the battery under the specified discharge conditions in the test procedure.

2.8. *Battery maintenance mode* or *maintenance mode,* is a subset of standby mode in which the battery charger is connected to the main electricity supply and the battery is fully charged, but is still connected to the charger.

2.9. *Battery rest period* is a period of time between discharge and charge or between charge and discharge, during which the battery is resting in an open-circuit state in ambient air.

2.10. *C-Rate* (C) is the rate of charge or discharge, calculated by dividing the charge or discharge current by the nameplate battery charge capacity of the battery. For example, a 0.2 C-rate would result in a charge or discharge period of 5 hours.

2.11. *Cradle* is an electrical interface between an integral battery product and the rest of the battery charger designed to hold the product between uses.

2.12. *Energy storage system* is a system consisting of single or multiple devices designed to provide power to the UPS inverter circuitry.

2.13. *Equalization* is a process whereby a battery is overcharged, beyond what would be considered ''normal'' charge return, so that cells can be balanced, electrolyte mixed, and plate sulfation removed.

2.14. *Instructions* or *manufacturer's instructions* means the documentation packaged with a product in printed or electronic form and any information about the product listed on a website maintained by the manufacturer and accessible by the general public at the time of the test. It also includes any information on the packaging or on the product itself. ''Instructions'' also includes any service manuals or data sheets that the manufacturer offers to independent service technicians, whether printed or in electronic form.

2.15. *Measured charge capacity of a battery* is the product of the discharge current in amperes and the time in decimal hours required to reach the specified end-of-discharge voltage.

2.16. *Manual on-off switch* is a switch activated by the user to control power reaching the battery charger. This term does not apply to any mechanical, optical, or electronic switches that automatically disconnect mains power from the battery charger when a battery is removed from a cradle or charging base, or for products with non-detachable batteries that control power to the product itself.

2.17. *Multi-port charger* means a battery charger that charges two or more batteries (which may be identical or different) simultaneously. The batteries are not connected in series or in parallel but with each port having separate voltage and/or current regulation. If the charger has status indicators, each port has its own indicator(s). A charger can be both a batch charger and a multi-port charger if it is capable of charging two or more batches of batteries simultaneously and each batch has separate regulation and/or indicator(s).

2.18. *Multi-voltage charger* is a battery charger that, by design, can charge a variety of batteries (or batches of batteries, if also a batch charger) that are of different nameplate battery voltages. A multi-voltage charger can also be a multi-port charger if it can charge two or more batteries simultaneously with independent voltages and/or current regulation.

2.19. *Normal mode* is a mode of operation for a UPS in which:

(a) The AC input supply is within required tolerances and supplies the UPS,

(b) The energy storage system is being maintained at full charge or is under recharge, and

(c) The load connected to the UPS is within the UPS's specified power rating.

2.20. *Off mode* is the condition, applicable only to units with manual on-off switches, in which the battery charger:

(a) Is connected to the main electricity supply;

(b) Is not connected to the battery; and

(c) All manual on-off switches are turned off.

2.21. *Nameplate battery voltage* is specified by the battery manufacturer and typically printed on the label of the battery itself. If there are multiple batteries that are connected in series, the nameplate battery voltage of the batteries is the total voltage of the series configuration—that is, the nameplate voltage of each battery multiplied by the number of batteries connected in series. Connecting multiple batteries in parallel does not affect the nameplate battery voltage.

2.22. *Nameplate battery charge capacity* is the capacity, claimed by the battery manufacturer on a label or in instructions, that the battery can store, usually given in ampere-hours (Ah) or milliampere-hours (mAh) and typically printed on the label of the battery itself. If there are multiple batteries that are connected in parallel, the nameplate battery charge capacity of the batteries is the total charge capacity of the parallel configuration, that is, the nameplate charge capacity of each battery multiplied by the number of batteries connected in parallel. Connecting multiple batteries in series does not affect the nameplate charge capacity.

2.23. *Nameplate battery energy capacity* means the product (in watts-hours (Wh)) of the nameplate battery voltage and the nameplate battery charge capacity.

2.24. *No-battery mode* is a subset of standby mode and means the condition in which:

(a) The battery charger is connected to the main electricity supply;

(b) The battery is not connected to the charger; and

(c) For battery chargers with manual on-off switches, all such switches are turned on.

2.25. *Reference test load* is a load or a condition with a power factor of greater than 0.99 in which the AC output socket of the UPS delivers the active power (W) for which the UPS is rated.

2.26. *Standby mode* means the condition in which the battery charge is either in maintenance mode or no battery mode as defined in this appendix.

2.27. *Total harmonic distortion* (THD), expressed as a percent, is the root mean square (RMS) value of an AC signal after the fundamental component is removed and interharmonic components are ignored, divided by the RMS value of the fundamental component.

2.28. *Uninterruptible power supply* or *UPS* means a battery charger consisting of a combination of convertors, switches and energy storage devices (such as batteries), constituting a power system for maintaining continuity of load power in case of input power failure.

2.28.1. *Voltage and frequency dependent UPS* or *VFD UPS* means a UPS that produces an AC output where the output voltage and frequency are dependent on the input voltage and frequency. This UPS architecture does not provide corrective functions like those in voltage independent and voltage and frequency independent systems.

Note to 2.28.1: VFD input dependency may be verified by performing the AC input failure test in Section 6.2.2.7 of IEC 62040–3 Ed. 2.0 (incorporated by reference, see § 430.3) and observing that, at a minimum, the UPS switches from normal mode of operation to battery power while the input is interrupted.

2.28.2. *Voltage and frequency independent UPS,* or *VFI UPS,* means a UPS where the device remains in normal mode producing an AC output voltage and frequency that is independent of input voltage and frequency variations and protects the load against adverse effects from such variations without depleting the stored energy source.

Note to 2.28.2: VFI input dependency may be verified by performing the steady state input voltage tolerance test and the input frequency tolerance test in Sections 6.4.1.1 and 6.4.1.2 of IEC 62040–3 Ed. 2.0 respectively, and observing that, at a minimum, the UPS produces an output voltage and frequency within the specified output range when the input voltage is varied by ±10 percent of the rated input voltage and the input frequency is varied by ±2 percent of the rated input frequency.

2.28.3. *Voltage independent UPS* or *VI UPS* means a UPS that produces an AC output within a specific tolerance band that is independent of under-voltage or over-voltage variations in the input voltage without depleting the stored energy source. The output frequency of a VI UPS is dependent on the input frequency, similar to a voltage and frequency dependent system.

Note to 2.28.3: VI input dependency may be verified by performing the steady state input voltage tolerance test in Section 6.4.1.1 of IEC 62040–3 Ed. 2.0 and ensuring that the UPS remains in normal mode with the output voltage within the specified output range when the input voltage is varied by ±10% of the rated input voltage.

2.29. *Unit under test* (UUT) in this appendix refers to the combination of the battery charger and battery being tested.

2.30. *Wireless charger* is a battery charger that can charge batteries inductively.

2.30.1. *Fixed-location wireless charger* is an inductive wireless battery charger that incorporates a physical receiver locating feature (*e.g.,* by physical peg, cradle, locking mechanism, magnet, etc.) to repeatably align or orient the position of the receiver with respect to the transmitter.

2.30.2. *Open-placement wireless charger* is an inductive wireless charger that does not incorporate a physical receiver locating feature (*e.g.,* by a physical peg, cradle, locking mechanism, magnet etc.) to repeatably align or orient the position of the receiver with respect to the transmitter.

3. Testing Requirements for all Battery Chargers Other Than Uninterruptible Power Supplies and Open-Placement Wireless Chargers

3.1. Standard Test Conditions

3.1.1. General

The values that may be measured or calculated during the conduct of this test procedure have been summarized for easy reference in Table 3.1.1 of this appendix.

TABLE 3.1.1—LIST OF MEASURED OR CALCULATED VALUES

Name of measured or calculated value	Reference
1. Duration of the Charge and Maintenance Modes test	Section 3.3.2.
2. Battery Discharge Energy (E_{batt})	Section 3.3.8.
3. Initial time and power (W) of the input current of connected battery	Section 3.3.6.
4. Active and Maintenance Modes Energy Consumption	Section 3.3.6.
5. Maintenance Mode Power (P_m)	Section 3.3.9.
6. Active mode Energy Consumption (E_a)	Section 3.3.10.
7. No-Battery Mode Power (P_{nb})	Section 3.3.11.
8. Off Mode Power (P_{off})	Section 3.3.12.
9. Standby Mode Power (P_{sb})	Section 3.3.13.

3.1.2. Verifying Accuracy and Precision of Measuring Equipment

Any power measurement equipment utilized for testing must conform to the uncertainty and resolution requirements outlined in Section 4, ‘‘General conditions for measurement’’, as well as Annexes B, ‘‘Notes on the measurement of low-power modes’’, and D, ‘‘Determination of uncertainty of measurement’’, of IEC 62301 (incorporated by reference, see § 430.3).

3.1.3. Setting Up the Test Room

All tests, battery conditioning, and battery rest periods shall be carried out in a room with an air speed immediately surrounding the UUT of ≤0.5 m/s. The ambient temperature shall be maintained at 20 °C ± 5 °C throughout the test. There shall be no intentional cooling of the UUT such as by use of separately powered fans, air conditioners, or heat sinks. The UUT shall be conditioned, rested, and tested on a thermally non-conductive surface. When not undergoing active testing, batteries shall be stored at 20 °C ± 5 °C.

3.1.4. Verifying the UUT's Input Voltage and Input Frequency

(a) If the UUT is intended for operation on AC line-voltage input in the United States, it shall be tested at 115 V at 60 Hz. If the UUT is intended for operation on AC line-voltage input but cannot be operated at 115 V at 60 Hz, it shall not be tested.

(b) If a battery charger is powered by a low-voltage DC or AC input and the manufacturer packages the battery charger with an external power supply (‘‘EPS’’), test the battery charger using the packaged EPS; if the battery charger does not include a pre-packaged EPS, then test the battery charger with an EPS sold and recommended by the manufacturer; if the manufacturer does not recommend an EPS that it sells, test the battery charger with an EPS that the manufacturer recommends for use in the manufacturer materials. The input reference source shall be 115 V at 60 Hz. If the EPS cannot be operated with AC input voltage at 115 V at 60 Hz, the charger shall not be tested.

(c) If a battery charger is designed for operation only on DC input voltage and if the provisions of section 3.1.4.(b) of this appendix do not apply, test the battery charger with an external power supply that minimally complies with the applicable energy conservation standard and meets the external power supply parameters specified by the battery charger manufacturer. The input voltage shall be within ±1 percent of the battery charger manufacturer specified voltage.

(d) If the input voltage is AC, the input frequency shall be within ±1 percent of the specified frequency. The THD of the input voltage shall be ≤2 percent, up to and including the 13th harmonic. The crest factor of the input voltage shall be between 1.34 and 1.49.

(e) If the input voltage is DC, the AC ripple voltage (RMS) shall be:

(1) ≤0.2 V for DC voltages up to 10 V; or

(2) ≤2 percent of the DC voltage for DC voltages over 10 V.

3.2. Unit Under Test Setup Requirements

3.2.1. General Setup

(a) The battery charger system shall be prepared and set up in accordance with the manufacturer's instructions, except where those instructions conflict with the requirements of this test procedure. If no instructions are given, then factory or ''default'' settings shall be used, or where there are no indications of such settings, the UUT shall be tested in the condition as it would be supplied to an end user.

(b) If the battery charger has user controls to select from two or more charge rates (such as regular or fast charge) or different charge currents, the test shall be conducted at the fastest charge rate that is recommended by the manufacturer for everyday use, or, failing any explicit recommendation, the factory-default charge rate. If the charger has user controls for selecting special charge cycles that are recommended only for occasional use to preserve battery health, such as equalization charge, removing memory, or battery conditioning, these modes are not required to be tested. The settings of the controls shall be listed in the report for each test.

3.2.2. Selection and Treatment of the Battery Charger

The UUT, including the battery charger and its associated battery, shall be new products of the type and condition that would be sold to a customer. If the battery is lead-acid chemistry and the battery is to be stored for more than 24 hours between its initial acquisition and testing, the battery shall be charged before such storage.

3.2.3. Selection of Batteries To Use for Testing

(a) For chargers with integral batteries, the battery packaged with the charger shall be used for testing. For chargers with detachable batteries, the battery or batteries to be used for testing will vary depending on whether there are any batteries packaged with the battery charger.

(1) If batteries are packaged with the charger, batteries for testing shall be selected from the batteries packaged with the battery charger, according to the procedure in section 3.2.3(b) of this appendix.

(2) If no batteries are packaged with the charger, but the instructions specify or recommend batteries for use with the charger, batteries for testing shall be selected from those recommended or specified in the instructions, according to the procedure in section 3.2.3(b) of this appendix.

(3) If no batteries are packaged with the charger and the instructions do not specify or recommend batteries for use with the charger, batteries for testing shall be selected from any that are suitable for use with the charger, according to the procedure in section 3.2.3(b) of this appendix.

(b)(1) From the detachable batteries specified in section 3.2.3.(a) of this appendix, use Table 3.2.1 of this appendix to select the batteries to be used for testing, depending on the type of battery charger being tested. The battery charger types represented by the rows in the table are mutually exclusive. Find the single applicable row for the UUT, and test according to those requirements. Select only the single battery configuration specified for the battery charger type in Table 3.2.1 of this section.

(2) If the battery selection criteria specified in Table 3.2.1 of this appendix results in two or more batteries or configurations of batteries of different chemistries, but with equal voltage and capacity ratings, determine the maintenance mode power, as specified in section 3.3.9 of this appendix, for each of the batteries or configurations of batteries, and select for testing the battery or configuration of batteries with the highest maintenance mode power.

(c) A charger is considered as:

(1) Single-capacity if all associated batteries have the same nameplate battery charge capacity (see definition) and, if it is a batch charger, all configurations of the batteries have the same nameplate battery charge capacity.

(2) Multi-capacity if there are associated batteries or configurations of batteries that have different nameplate battery charge capacities.

(d) The selected battery or batteries will be referred to as the ''test battery'' and will be used through the remainder of this test procedure.

TABLE 3.2.1—BATTERY SELECTION FOR TESTING

Type of charger			Tests to perform
Multi-voltage	Multi-port	Multi-capacity	Battery selection (from all configurations of all associated batteries)
No	No	No	Any associated battery.
No	No	Yes	Highest charge capacity battery.
No	Yes	Yes or No	Use all ports. Use the maximum number of identical batteries with the highest nameplate battery charge capacity that the charger can accommodate.
Yes	No	No	Highest voltage battery.
Yes	Yes to either or both		Use all ports. Use the battery or configuration of batteries with the highest individual voltage. If multiple batteries meet this criteria, then use the battery or configuration of batteries with the highest total nameplate battery charge capacity at the highest individual voltage.

3.2.4. Limiting Other Non-Battery-Charger Functions

(a) If the battery charger or product containing the battery charger does not have any additional functions unrelated to battery charging, this section may be skipped.

(b) Any optional functions controlled by the user and not associated with the battery charging process (*e.g.,* the answering machine in a cordless telephone charging base) shall be switched off. If it is not possible to switch such functions off, they shall be set to their lowest power-consuming mode during the test.

(c) If the battery charger takes any physically separate connectors or cables not required for battery charging but associated with its other functionality (such as phone lines, serial or USB connections, Ethernet, cable TV lines, etc.), these connectors or cables shall be left disconnected during the testing.

(d) Any manual on-off switches specifically associated with the battery charging process shall be switched on for the duration of the charge, maintenance, and no-battery mode tests, and switched off for the off mode test.

3.2.5. Accessing the Battery for the Test

(a) The technician may need to disassemble the end-use product or battery charger to gain access to the battery terminals for the Battery Discharge Energy Test in section 3.3.8 of this appendix. If the battery terminals are not clearly labeled, the technician shall use a voltmeter to identify the positive and negative terminals. These terminals will be the ones that give the largest voltage difference and are able to deliver significant current (0.2 C or 1/hr) into a load.

(b) All conductors used for contacting the battery must be cleaned and burnished prior to connecting in order to decrease voltage drops and achieve consistent results.

(c) Manufacturer's instructions for disassembly shall be followed, except those instructions that:

(1) Lead to any permanent alteration of the battery charger circuitry or function;

(2) Could alter the energy consumption of the battery charger compared to that experienced by a user during typical use, *e.g.,* due to changes in the airflow through the enclosure of the UUT; or

(3) Conflict requirements of this test procedure.

(d) Care shall be taken by the technician during disassembly to follow appropriate safety precautions. If the functionality of the device or its safety features is compromised, the product shall be discarded after testing.

(e) Some products may include protective circuitry between the battery cells and the remainder of the device. If the manufacturer provides a description for accessing the connections at the output of the protective circuitry, these connections shall be used to discharge the battery and measure the discharge energy. The energy consumed by the protective circuitry during discharge shall not be measured or credited as battery energy.

(f) If any of the following conditions specified in sections 3.2.5.(f)(1) to 3.2.5.(f)(3) of this appendix are applicable, preventing the measurement of the Battery Discharge Energy and the Charging and Maintenance Mode Energy, a manufacturer must submit a petition for a test procedure waiver in accordance with § 430.27:

(1) Inability to access the battery terminals;

(2) Access to the battery terminals destroys charger functionality; or

(3) Inability to draw current from the test battery.

3.2.6. Determining Charge Capacity for Batteries With No Rating

(a) If there is no rating for the battery charge capacity on the battery or in the instructions, then the technician shall determine a discharge current that meets the following requirements. The battery shall be fully charged and then discharged at this constant-current rate until it reaches the end-of-discharge voltage specified in Table 3.3.2 of this appendix. The discharge time must be not less than 4.5 hours nor more than 5 hours. In addition, the discharge test (section 3.3.8 of this appendix) (which may not be starting with a fully-charged battery) shall reach the end-of-discharge voltage within 5 hours. The same discharge current shall be used for both the preparations step (section 3.3.4 of this appendix) and the discharge test (section 3.3.8 of this appendix). The test report shall include the discharge current used and the resulting discharge times for both a fully-charged battery and for the discharge test.

(b) For this section, the battery is considered as ''fully charged'' when either: it has been charged by the UUT until an indicator on the UUT shows that the charge is complete; or it has been charged by a battery analyzer at a current not greater than the discharge current until the battery analyzer indicates that the battery is fully charged.

(c) When there is no capacity rating, a suitable discharge current must generally be determined by trial and error. Since the conditioning step does not require constant-current discharges, the trials themselves may also be counted as part of battery conditioning.

3.3. Test Measurement

The test sequence to measure the battery charger energy consumption is summarized in Table 3.3.1 of this appendix, and explained in detail in this appendix. Measurements shall be made under test conditions and with the equipment specified in sections 3.1 and 3.2 of this appendix.

TABLE 3.3.1—TEST SEQUENCE

Step/description	Equipment needed					
	Data taken?	Test battery	Charger	Battery analyzer or constant-current load	AC power meter	Thermometer (for flooded lead-acid battery chargers only)
1. Record general data on UUT; Section 3.3.1.	Yes	X	X			
2. Determine Active and Maintenance Modes Test duration; Section 3.3.2.	No					
3. Battery conditioning; Section 3.3.3	No	X	X	X		
4. Prepare battery for Active Mode test; Section 3.3.4.	No	X	X			
5. Battery rest period; Section 3.3.5	No	X				X
6. Conduct Active and Maintenance Modes Test; Section 3.3.6.	Yes	X	X		X	
7. Battery Rest Period; Section 3.3.7	No	X				X
8. Battery Discharge Energy Test; Section 3.3.8.	Yes	X		X		
9. Determine the Maintenance Mode Power; Section 3.3.9.	Yes	X	X		X	
10. Determine Active Charge Energy; Section 3.3.10.	Yes	X	X		X	
11. Conduct No-Battery Mode Test; Section 3.3.11.	Yes		X		X	
12. Conduct Off Mode Test; Section 3.3.12.	Yes		X		X	
13. Calculating Standby Mode Power; Section 3.3.13.	Yes					

3.3.1. Recording General Data on the UUT

The technician shall record:

(a) The manufacturer and model of the battery charger;

(b) The presence and status of any additional functions unrelated to battery charging;

(c) The manufacturer, model, and number of batteries in the test battery;

(d) The nameplate battery voltage of the test battery;

(e) The nameplate battery charge capacity of the test battery; and

(f) The nameplate battery charge energy of the test battery.

(g) The settings of the controls, if battery charger has user controls to select from two or more charge rates.

3.3.2. Determining the Duration of the Charge and Maintenance Modes Test

(a) The charge and maintenance modes test, described in detail in section 3.3.6 of this appendix, shall be 24 hours in length or longer, as determined by the items in sections 3.3.2.(a)(1) to 3.3.2.(a)(3) of this appendix. Proceed in order until a test duration is determined. In case when the battery charger does not enter its true battery maintenance mode, the test shall continue until 5 hours after the true battery maintenance mode has been captured.

(1) If the battery charger has an indicator to show that the battery is fully charged, that indicator shall be used as follows: if the indicator shows that the battery is charged after 19 hours of charging, the test shall be terminated at 24 hours. Conversely, if the full-charge indication is not yet present after 19 hours of charging, the test shall continue until 5 hours after the indication is present.

(2) If there is no indicator, but the manufacturer's instructions indicate that charging this battery or this capacity of battery should be complete within 19 hours, the test shall be for 24 hours. If the instructions indicate that charging may take longer than 19 hours, the test shall be run for the longest estimated charge time plus 5 hours.

(3) If there is no indicator and no time estimate in the instructions, but the charging current is stated on the charger or in the instructions, calculate the test duration as the longer of 24 hours or:

$$Duration = 1.4 * \frac{RatedChargeCapacity(Ah)}{ChargeCurrent(A)} + 5h$$

(b) If none of section 3.3.2.(a) applies, the duration of the test shall be 24 hours.

3.3.3. Battery Conditioning

(a) No conditioning is to be done on lithium-ion batteries. The test technician shall proceed directly to battery preparation, section 3.3.4 of this appendix, when testing chargers for these batteries.

(b) Products with integral batteries will have to be disassembled per the instructions in section 3.2.5 of this appendix, and the battery disconnected from the charger for discharging.

(c) Batteries of other chemistries that have not been previously cycled are to be conditioned by performing two charges and two discharges, followed by a charge, as sections 3.3.3.(c)(1) to 3.3.3.(c)(5) of this appendix. No data need be recorded during battery conditioning.

(1) The test battery shall be fully charged for the duration specified in section 3.3.2 of this appendix or longer using the UUT.

(2) The test battery shall then be fully discharged using either:

(i) A battery analyzer at a rate not to exceed 1 C, until its average cell voltage under load reaches the end-of-discharge voltage specified in Table 3.3.2 of this appendix for the relevant battery chemistry; or

(ii) The UUT, until the UUT ceases operation due to low battery voltage.

(3) The test battery shall again be fully charged per step in section 3.3.3(c)(1) of this appendix.

(4) The test battery shall again be fully discharged per step in section 3.3.3(c)(2) of this appendix.

(5) The test battery shall be again fully charged per step in section 3.3.3(c)(1) of this appendix.

(d) Batteries of chemistries, other than lithium-ion, that are known to have been through at least two previous full charge/discharge cycles shall only be charged once per step in section 3.3.3(c)(5) of this appendix.

3.3.4. Preparing the Battery for Charge Testing

Following any conditioning prior to beginning the battery charge test (section 3.3.6 of this appendix), the test battery shall be fully discharged to the end of discharge voltage prescribed in Table 3.3.2 of this appendix, or until the UUT circuitry terminates the discharge.

3.3.5. Resting the Battery

The test battery shall be rested between preparation and the battery charge test. The rest period shall be at least one hour and not exceed 24 hours. For batteries with flooded cells, the electrolyte temperature shall be less than 30 °C before charging, even if the rest period must be extended longer than 24 hours.

3.3.6. Testing Active Charge Mode and Battery Maintenance Mode

(a) The Active Charge and Battery Maintenance Modes test measures energy consumed during charge mode and some time spent in the maintenance mode of the UUT. Functions required for battery conditioning that happen only with some user-selected switch or other control shall not be included in this measurement. (The technician shall manually turn off any battery conditioning cycle or setting.) Regularly occurring battery conditioning or maintenance functions that are not controlled by the user will, by default, be incorporated into this measurement.

(b) During the measurement period, input power values to the UUT shall be recorded at least once every minute.

(1) If possible, the technician shall set the data logging system to record the average power during the sample interval. The total energy is computed as the sum of power samples (in watts) multiplied by the sample interval (in hours).

(2) If this setting is not possible, then the power analyzer shall be set to integrate or accumulate the input power over the measurement period and this result shall be used as the total energy.

(c) The technician shall follow these steps:

(1) Ensure that the user-controllable device functionality not associated with battery charging and any battery conditioning cycle or setting are turned off, as instructed in section 3.2.4 of this appendix;

(2) Ensure that the test battery used in this test has been conditioned, prepared, discharged, and rested as described in sections 3.3.3. through 3.3.5. of this appendix;

(3) Connect the data logging equipment to the battery charger;

(4) Record the start time of the measurement period, and begin logging the input power;

(5) Connect the test battery to the battery charger within 3 minutes of beginning logging. For integral battery products, connect the product to a cradle or EPS within 3 minutes of beginning logging;

(6) After the test battery is connected, record the initial time and power (W) of the input current to the UUT. These measurements shall be taken within the first 10 minutes of active charging;

(7) Record the input power for the duration of the ''Maintenance Mode Test'' period, as determined by section 3.3.2. of this appendix. The actual time that power is connected to the UUT shall be within ±5 minutes of the specified period; and

(8) Disconnect power to the UUT, terminate data logging, and record the final time.

3.3.7. Resting the Battery

The test battery shall be rested between charging and discharging. The rest period shall be at least 1 hour and not more than 4 hours, with an exception for flooded cells. For batteries with flooded cells, the electrolyte temperature shall be less than 30 °C before charging, even if the rest period must be extended beyond 4 hours.

3.3.8. Battery Discharge Energy Test

(a) If multiple batteries were charged simultaneously, the discharge energy (E_{batt}) is the sum of the discharge energies of all the batteries.

(1) For a multi-port charger, batteries that were charged in separate ports shall be discharged independently.

(2) For a batch charger, batteries that were charged as a group may be discharged individually, as a group, or in sub-groups connected in series and/or parallel. The position of each battery with respect to the other batteries need not be maintained.

(b) During discharge, the battery voltage and discharge current shall be sampled and recorded at least once per minute. The values recorded may be average or instantaneous values.

(c) For this test, the technician shall follow these steps:

(1) Ensure that the test battery has been charged by the UUT and rested according to the procedures prescribed in sections 3.3.6 and 3.3.7 of this appendix.

(2) Set the battery analyzer for a constant discharge rate and the end-of-discharge voltage in Table 3.3.2 of this appendix for the relevant battery chemistry.

(3) Connect the test battery to the analyzer and begin recording the voltage, current, and wattage, if available from the battery analyzer. When the end-of-discharge voltage is reached or the UUT circuitry terminates the discharge, the test battery shall be returned to an open-circuit condition. If current continues to be drawn from the test battery after the end-of-discharge condition is first reached, this additional energy is not to be counted in the battery discharge energy.

(d) If not available from the battery analyzer, the battery discharge energy (in watt-hours) is calculated by multiplying the voltage (in volts), current (in amperes), and sample period (in hours) for each sample, and then summing over all sample periods until the end-of-discharge voltage is reached.

TABLE 3.3.2—REQUIRED BATTERY DISCHARGE RATES AND END-OF-DISCHARGE BATTERY VOLTAGES

Battery chemistry	Discharge rate (C)	End-of-discharge voltage* (volts per cell)
Valve-Regulated Lead Acid (VRLA)	0.2	1.75
Flooded Lead Acid	0.2	1.70
Nickel Cadmium (NiCd)	0.2	1.0
Nickel Metal Hydride (NiMH)	0.2	1.0
Lithium-ion (Li-Ion)	0.2	2.5
Lithium-ion Polymer	0.2	2.5
Lithium Iron Phosphate	0.2	2.0
Rechargeable Alkaline	0.2	0.9
Silver Zinc	0.2	1.2

*If the presence of protective circuitry prevents the battery cells from being discharged to the end-of-discharge voltage specified, then discharge battery cells to the lowest possible voltage permitted by the protective circuitry.

3.3.9. Determining the Maintenance Mode Power

After the measurement period is complete, the technician shall determine the average maintenance mode power consumption (P_m) by examining the power-versus-time data from the charge and maintenance mode test and:

(a) If the maintenance mode power is cyclic or shows periodic pulses, compute the average power over a time period that spans a whole number of cycles and includes at least the last 4 hours.

(b) Otherwise, calculate the average power value over the last 4 hours.

3.3.10. Determining the Active Charge Energy

After the measurement period is complete, the technician shall determine the total active charge energy (E_a) by examining the power-versus-time data from the charge and maintenance mode test and:

(a) First determine when the battery charger enters maintenance mode by examining the power-versus-time data to identify when the input power enters either a steady state or a cyclic state with average power for that period being the same as the maintenance mode power determined in section 3.3.9. of this appendix.

(b) The accumulated energy or the average input power, integrated over the test period from the initial recorded input time up until when the battery charger enters maintenance mode would be the active charge energy, E_a.

3.3.11. No-Battery Mode Energy Consumption Measurement

The no-battery mode measurement depends on the configuration of the battery charger, as follows:

(a) Conduct a measurement of no-battery power consumption while the battery charger is connected to the power source. Disconnect the battery from the charger, allow the charger to operate for at least 30 minutes, and record the power (*i.e.,* watts) consumed as the time series integral of the power consumed over a 10-minute test period, divided by the period of measurement. If the battery charger has manual on-off switches, all must be turned on for the duration of the no-battery mode test.

(b) No-battery mode may also apply to products with integral batteries, as follows:

(1) If the product uses a cradle and/or adapter for power conversion and charging, then ''disconnecting the battery from the charger'' will require disconnection of the end-use product, which contains the batteries. The other enclosures of the battery charging system will remain connected to the main electricity supply, and no-battery mode power consumption will equal that of the cradle and/or adapter alone.

(2) If the product is powered through a detachable AC power cord and contains integrated power conversion and charging circuitry, then only the cord will remain connected to mains, and no-battery mode power consumption will equal that of the AC power cord (*i.e.,* zero watts).

(3) If the product contains integrated power conversion and charging circuitry but is powered through a non-detachable AC power cord or plug blades, then no part of the system will remain connected to mains, and no-battery mode measurement is not applicable.

3.3.12. Off Mode Energy Consumption Measurement

The off mode measurement depends on the configuration of the battery charger, as follows:

(a) If the battery charger has manual on-off switches, record a measurement of off mode energy consumption while the battery charger is connected to the power source. Remove the battery from the charger, allow the charger to operate for at least 30 minutes, and record the power (*i.e.,* watts) consumed as the time series integral of the power consumed over a 10-minute test period, divided by the period of measurement, with all manual on-off switches turned off. If the battery charger does not have manual on-off switches, record that the off mode measurement is not applicable to this product.

(b) Off mode may also apply to products with integral batteries, as follows:

(1) If the product uses a cradle and/or adapter for power conversion and charging, then ''disconnecting the battery from the charger'' will require disconnection of the end-use product, which contains the batteries. The other enclosures of the battery charging system will remain connected to the main electricity supply, and off mode power consumption will equal that of the cradle and/or adapter alone.

(2) If the product is powered through a detachable AC power cord and contains integrated power conversion and charging circuitry, then only the cord will remain connected to mains, and off mode power consumption will equal that of the AC power cord (*i.e.,* zero watts).

(3) If the product contains integrated power conversion and charging circuitry but is powered through a non-detachable AC power cord or plug blades, then no part of the

system will remain connected to mains, and off mode measurement is not applicable.

3.3.13. Standby Mode Power

The standby mode power (P_{sb}) is the summation power of battery maintenance mode power (P_m) and no-battery mode power (P_{nb}).

4. Testing Requirements for Uninterruptible Power Supplies

4.1. Standard Test Conditions

4.1.1. Measuring Equipment

(a) The power or energy meter must provide true root mean square (r.m.s) measurements of the active input and output measurements, with an uncertainty at full rated load of less than or equal to 0.5 percent at the 95 percent confidence level notwithstanding that voltage and current waveforms can include harmonic components. The meter must measure input and output values simultaneously.

(b) All measurement equipment used to conduct the tests must be calibrated within the measurement equipment manufacturer specified calibration period by a standard traceable to International System of Units such that measurements meet the uncertainty requirements specified in section 4.1.1(a) of this appendix.

4.1.2. Test Room Requirements

All portions of the test must be carried out in a room with an air speed immediately surrounding the UUT of ≤0.5 m/s in all directions. Maintain the ambient temperature in the range of 20.0 °C to 30.0 °C, including all inaccuracies and uncertainties introduced by the temperature measurement equipment, throughout the test. No intentional cooling of the UUT, such as by use of separately powered fans, air conditioners, or heat sinks, is permitted. Test the UUT on a thermally non-conductive surface.

4.1.3. Input Voltage and Input Frequency

The AC input voltage and frequency to the UPS during testing must be within 3 percent of the highest rated voltage and within 1 percent of the highest rated frequency of the device.

4.2. Unit Under Test Setup Requirements

4.2.1. General Setup

Configure the UPS according to Section J.2 of Annex J of IEC 62040–3 Ed. 2.0 with the following additional requirements:

(a) UPS Operating Mode Conditions. If the UPS can operate in two or more distinct normal modes as more than one UPS architecture, conduct the test in its lowest input dependency as well as in its highest input dependency mode where VFD represents the lowest possible input dependency, followed by VI and then VFI.

(b) Energy Storage System. The UPS must not be modified or adjusted to disable energy storage charging features. Minimize the transfer of energy to and from the energy storage system by ensuring the energy storage system is fully charged (at the start of testing) as follows:

(1) If the UUT has a battery charge indicator, charge the battery for 5 hours after the UUT has indicated that it is fully charged.

(2) If the UUT does not have a battery charge indicator but the user manual shipped with the UUT specifies a time to reach full charge, charge the battery for 5 hours longer than the time specified.

(3) If the UUT does not have a battery charge indicator or user manual instructions, charge the battery for 24 hours.

(c) DC output port(s). All DC output port(s) of the UUT must remain unloaded during testing.

4.2.2. Additional Features

(a) Any feature unrelated to maintaining the energy storage system at full charge or delivery of load power (*e.g.,* LCD display) shall be switched off. If it is not possible to switch such features off, they shall be set to their lowest power-consuming mode during the test.

(b) If the UPS takes any physically separate connectors or cables not required for maintaining the energy storage system at full charge or delivery of load power but associated with other features (such as serial or USB connections, Ethernet, etc.), these connectors or cables shall be left disconnected during the test.

(c) Any manual on-off switches specifically associated with maintaining the energy storage system at full charge or delivery of load power shall be switched on for the duration of the test.

4.3. Test Measurement and Calculation

Efficiency can be calculated from either average power or accumulated energy.

4.3.1. Average Power Calculations

If efficiency calculation are to be made using average power, calculate the average power consumption (P_{avg}) by sampling the power at a rate of at least 1 sample per second and computing the arithmetic mean of all samples over the time period specified for each test as follows:

$$P_{avg} = \frac{1}{n}\sum_{i=1}^{n} P_i$$

Where:

P_{avg} = average power
P_i = power measured during individual measurement (i)
n = total number of measurements

4.3.2. Steady State

Operate the UUT and the load for a sufficient length of time to reach steady state conditions. To determine if steady state conditions have been attained, perform the following steady state check, in which the difference between the two efficiency calculations must be less than 1 percent:

(a)(1) Simultaneously measure the UUT's input and output power for at least 5 minutes, as specified in section 4.3.1 of this appendix, and record the average of each over the duration as P_{avg_in} and P_{avg_out}, respectively; or,

(2) Simultaneously measure the UUT's input and output energy for at least 5 minutes and record the accumulation of each over the duration as E_{in} and E_{out}, respectively.

(b) Calculate the UUT's efficiency, Eff_1, using one of the following two equations:

(1)

$$Eff = \frac{P_{avg\_out}}{P_{avg\_in}}$$

Where:

Eff is the UUT efficiency
P_{avg_out} is the average output power in watts
P_{avg_in} is the average input power in watts

(2)

$$Eff = \frac{E_{out}}{E_{in}}$$

Where:

Eff is the UUT efficiency
E_{out} is the accumulated output energy in watt-hours
E_{in} in the accumulated input energy in watt-hours

(c) Wait a minimum of 10 minutes.

(d) Repeat the steps listed in paragraphs (a) and (b) of section 4.3.2 of this appendix to calculate another efficiency value, Eff_2.

(e) Determine if the product is at steady state using the following equation:

$$Percentage\ difference = \frac{|Eff_1 - Eff_2|}{Average(Eff_1, Eff_2)}$$

If the percentage difference of Eff_1 and Eff_2 as described in the equation, is less than 1 percent, the product is at steady state.

(f) If the percentage difference is greater than or equal to 1 percent, the product is not at steady state. Repeat the steps listed in paragraphs (c) to (e) of section 4.3.2 of this appendix until the product is at steady state.

4.3.3. Power Measurements and Efficiency Calculations

Measure input and output power of the UUT according to Section J.3 of Annex J of IEC 62040–3 Ed. 2.0, or measure the input and output energy of the UUT for efficiency calculations with the following exceptions:

(a) Test the UUT at the following reference test load conditions, in the following order: 100 percent, 75 percent, 50 percent, and 25 percent of the rated output power.

(b) Perform the test at each of the reference test loads by simultaneously measuring the UUT's input and output power in Watts (W), or input and output energy in Watt-Hours (Wh) over a 15 minute test period at a rate of at least 1 Hz. Calculate the efficiency for that reference load using one of the following two equations:

(1)

$$Eff_{n\%} = \frac{P_{avg\_out\ n\%}}{P_{avg\_in\ n\%}}$$

Where:

$Eff_{n\%}$ = the efficiency at reference test load n%

$P_{avg\_out\ n\%}$ = the average output power at reference load n%

$P_{avg\_in\ n\%}$ = the average input power at reference load n%

(2)

$$Eff_{n\%} = \frac{E_{out\ n\%}}{E_{in\ n\%}}$$

Where:

$Eff_{n\%}$ = the efficiency at reference test load n%

$E_{out\ n\%}$ = the accumulated output energy at reference load n%

$E_{in\ n\%}$ = the accumulated input energy at reference load n%

4.3.4. UUT Classification

Optional Test for determination of UPS architecture. Determine the UPS architecture by performing the tests specified in the definitions of VI, VFD, and VFI (sections 2.28.1 through 2.28.3 of this appendix).

4.3.5. Output Efficiency Calculation

(a) Use the load weightings from Table 4.3.1 to determine the average load adjusted efficiency as follows:

$$Eff_{avg} = (t_{25\%} \times Eff|_{25\%}) + (t_{50\%} \times Eff|_{50\%}) + (t_{75\%} \times Eff|_{75\%}) + (t_{100\%} \times Eff|_{100\%})$$

Where:

Eff_{avg} = the average load adjusted efficiency

$t_{n\%}$ = the portion of time spent at reference test load n% as specified in Table 4.3.1

$Eff|_{n\%}$ = the measured efficiency at reference test load n%

TABLE 4.3.1—LOAD WEIGHTINGS

Rated output power (W)	UPS architecture	Portion of time spent at reference load: 25%	50%	75%	100%
P ≤ 1500 W	VFD	0.2	0.2	0.3	0.3
	VI or VFI	0*	0.3	0.4	0.3
P > 1500 W	VFD, VI, or VFI	0*	0.3	0.4	0.3

* Measuring efficiency at loading points with 0 time weighting is not required.

(b) Round the calculated efficiency value to one tenth of a percentage point.

5. Testing Requirements for Open-Placement Wireless Chargers

5.1. Standard Test Conditions and UUT Setup Requirements

The technician will set up the testing environment according to the test conditions as specified in sections 3.1.2, 3.1.3, and 3.1.4 of this appendix. The unit under test will be configurated according to section 3.2.1 and all other non-battery charger related functions will be turned off according to section 3.2.4.

5.2. Active Mode Test

[Reserved]

5.3. No-Battery Mode Test

(a) Connect the UUT to mains power and place it in no-battery mode by ensuring there are no foreign objects on the charging surface (*i.e.,* without any load).

(b) Monitor the AC input power for a period of 5 minutes to assess the stability of the UUT. If the power level does not drift by more than 1percent from the maximum value observed, the UUT is considered stable.

(c) If the AC input power is not stable, follow the specifications in Section 5.3.3. of IEC 62301 for measuring average power or accumulated energy over time for the input. If the UUT is stable, record the measurements of the AC input power over a 5-minute period.

(d) Power consumption calculation. The power consumption of the no-battery mode is equal to the active AC input power (W).

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