[6450-01-P]

DEPARTMENT OF ENERGY

10 CFR Parts 429 and 430

[Docket No. EERE-2015-BT-TP-0014]

RIN 1904-AC74

Energy Conservation Program: Test Procedure for Compact Fluorescent Lamps

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

ACTION: Final rule.

SUMMARY: This final rule amends the U.S. Department of Energy's (DOE) test procedures for medium base compact fluorescent lamps (MBCFLs) and adopts test procedures for new metrics for all CFLs including hybrid CFLs and CFLs with bases other than medium screw base. In this final rule, DOE replaces references to ENERGY STAR® testing requirements with references to the latest versions of the relevant industry standard test methods referenced by the ENERGY STAR testing requirements, with certain modifications. In addition, DOE adopts new test procedures to support the ongoing energy conservation standards rulemaking for general service lamps (GSLs), the recently revised final test procedure and energy conservation standards for ceiling fan light kits (CFLKs), and the labeling requirements specified by the Federal Trade Commission (FTC). The test procedures will also support the ENERGY STAR program requirements for lamps and luminaires. Specifically, this final rule adopts test methods for new metrics including color rendering index (CRI), correlated color temperature (CCT), power factor,

and start time. DOE also adopts test procedures for additional CFL categories, including non-integrated CFLs and integrated CFLs that are not MBCFLs. This final rule also revises the sampling plan for performance metrics and incorporates methods to measure standby mode power.

DATES: The effective date of this rule is **[INSERT DATE 30 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER]**. Representations must be based on testing in accordance with the final rule starting **[INSERT DATE 180 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER]**. The incorporation by reference of certain publications listed in this rule was approved by the Director of the Federal Register on **[INSERT DATE 30 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER]**.

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

A link to the docket web page can be found at https://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/28. This web page will contain a link to the docket for this notice on the www.regulations.gov site. The www.regulations.gov web page will contain simple instructions on how to access all documents, including public comments, in the docket.

For further information on how to review the docket, contact Ms. Emily Marchetti at (202) 586-6636 or by email: medium_base_compact_fluorescent_lamps@ee.doe.gov.

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SUPPLEMENTARY INFORMATION: This final rule incorporates by reference into part 430 specific sections of the following industry standards:

1) American National Standards Institute and International Electrotechnical Commission (ANSI) C78.901-2014, American National Standard for Electric Lamps—Single-Based Fluorescent Lamps—Dimensional and Electrical Characteristics.

   Copies of ANSI C78.901-2014 can be obtained from ANSI Attn: Customer Service Department, 25 W 43rd Street, 4th Floor, New York, NY, 10036, or by going to http://webstore.ansi.org/.

2) CIE 13.3-1995 (“CIE 13.3”), Technical Report: Method of Measuring and Specifying Colour Rendering Properties of Light Sources, 1995, ISBN 3 900 734 57 7.

3) CIE 15:2004 (“CIE 15”), Technical Report: Colorimetry, 3rd edition, 2004, ISBN 978 3 901906 33 6.

Copies of CIE 13.3 and CIE 15 can be obtained from Commission Internationale de l'Eclairage, Central Bureau, Kegelgasse 27, A-1030, Vienna, Austria, 011 + 43 1 714 31 87 0, or by going to *http://www.cie.co.at.*

(4) IEC 62301 (“ IEC 62301-W”), Household electrical appliances—Measurement of standby power (Edition 2.0, 2011-01).

A copy of IEC 62301 can be obtained from the American National Standards Institute, 25 W. 43rd Street, 4th Floor, New York, NY 10036, (212) 642-4900, or by going to http://webstore.ansi.org.

5) Illuminating Engineering Society of North America (IES) LM-54-12, IES Guide to Lamp Seasoning.

6) IES LM-65-14, IES Approved Method for Life Testing of Single-Based Fluorescent Lamps.

7) IES LM-66-14, (“IES LM-66”), IES Approved Method for the Electrical and Photometric Measurements of Single-Based Fluorescent Lamps.

8) IESNA LM-78-07, IESNA Approved Method for Total Luminous Flux Measurement of Lamps Using an Integrating Sphere Photometer.

Copies of IES LM-54-12, IES LM-65-14, IES LM-66 and IES LM-78-07 can be obtained from IES, 120 Wall Street, Floor 17, New York, NY 10005-4001, or by going to www.ies.org/store.

For a further discussion of these standards, see section IV.M.

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I. Authority and Background

A. Authority

Title III of the Energy Policy and Conservation Act of 1975 (42 U.S.C. 6291, et seq.; "EPCA" or, "the Act") sets forth a variety of provisions designed to improve energy efficiency.[1] Part B of title III, which for editorial reasons was redesignated as Part A upon incorporation into the U.S. Code (42 U.S.C. 6291–6309, as codified), established the "Energy Conservation

[1] All references to EPCA refer to the statute as amended through the Energy Efficiency Improvement Act of 2015, Public Law 114-11 (April 30, 2015).

Program for Consumer Products Other Than Automobiles." CFLs are among the consumer products affected by these provisions.

Under EPCA, the energy conservation program consists essentially of four parts: (1) testing, (2) labeling, (3) Federal energy conservation standards, and (4) certification and enforcement procedures. 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 representations about the energy use or efficiency of the products (42 U.S.C. 6293(c)).

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

In addition, if DOE determines that a test procedure amendment is warranted, it must publish a proposed test procedure and offer the public an opportunity to present oral and written comments. (42 U.S.C. 6293(b)(2)) Finally, in any rulemaking to amend a test procedure, DOE must determine to what extent, if any, the proposed test procedure would alter the measured energy efficiency of the covered product as determined under the existing test procedure. (42 U.S.C. 6293(e)(1))

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

Finally, EPCA directs DOE to amend its test procedures for all covered products to integrate measures of standby mode and off mode energy consumption, if technically feasible. (42 U.S.C. 6295(gg)(2)(A)) DOE has determined that, while no CFLs are capable of operating under off mode, some CFLs are capable of operating under standby mode. Consequently, DOE adopts a test procedure for measuring standby mode power in appendix W, as detailed in section III.A.6 of this final rule.

B. Background

The Energy Policy Act of 2005 (Public Law 109-58) amended EPCA to require that MBCFL test procedures be based on the August 2001 version of the ENERGY STAR® Program Requirements for CFLs. (42 U.S.C. 6293(b)(12)) Consistent with this requirement, DOE published a final rule on December 8, 2006 (December 2006 final rule) that established DOE's current test procedures for MBCFLs under 10 CFR part 430, subpart B, appendix W. 71 FR 71340. The December 2006 final rule established test procedures for initial lamp efficacy, lumen maintenance at 1,000 hours, lumen maintenance at 40 percent of lifetime, rapid cycle stress test, and lifetime for MBCFLs. Id.

EPCA, however, also requires that at least once every 7 years, DOE must conduct an evaluation of all covered products and either amend the test procedures (if the Secretary determines that amended test procedures would more accurately or fully comply with the requirements of 42 U.S.C. 6293(b)(3)) or publish a determination in the Federal Register not to amend them. (42 U.S.C. 6293(b)(1)(A)) The ENERGY STAR Program Requirements for CFLs have been updated several times since 2001 to reflect current best practices and technological developments. This final rule amends the CFL test procedure to directly reference the latest industry standards in accordance with this EPCA requirement.

On July 31, 2015, DOE issued a NOPR (July 2015 NOPR) to amend and expand its test procedures for CFLs. 80 FR 45723. DOE then held a public meeting to discuss these proposed amendments on August 31, 2015, and allowed for written comments to be submitted through October 14, 2015. This rule addresses comments that were received on the proposal and finalizes many of the proposed changes to appendix W to subpart B of 10 CFR part 430 and to 10 CFR part 429.

II. Synopsis of the Final Rule

In this final rule, DOE replaces the existing references to ENERGY STAR program requirements with direct references to the latest versions of the appropriate industry test methods from the Illuminating Engineering Society of North America (IES) (see section III.A.1 for further details). Directly referencing the latest industry standards will allow DOE to adopt current best practices and technological developments in its test procedures.

DOE also adopts, in this rule, test procedures for additional CFL categories and metrics to support energy conservation standard rulemakings for GSLs and CFLKs. DOE's existing test procedures apply only to integrated CFLs with medium screw bases (i.e., MBCFLs). Integrated CFLs (also referred to as self-ballasted or integrally ballasted) contain all components necessary for the starting and stable operation of the lamp, do not include any replaceable or interchangeable parts, and are connected directly to a branch circuit through an American National Standards Institute (ANSI) base and corresponding ANSI standard lamp-holder (socket). Non-integrated CFLs (also referred to as pin-base) require an external ballast to function, and mainly have pin bases, (e.g., 2-pin or 4-pin). On March 17, 2016, DOE issued a NOPR (March 2016 NOPR) that proposes a new definition for general service lamp that includes both non-integrated CFLs and integrated CFLs. 81 FR 14527. The March 2016 NOPR also proposes minimum efficacy and power factor standards for certain types of general service lamps and additional metrics for MBCFLs. On January 6, 2016, DOE issued a final rule (January 2016 final rule) establishing amended energy conservation standards for CFLs, both integrated and non-integrated, packaged with a CFLK. 81 FR 579.

DOE is also adopting these new test procedures to support: (1) the Federal Trade Commission (FTC) labeling requirements for lighting products as specified in 16 CFR 305.15; and (2) the U.S. Environmental Protection Agency's ENERGY STAR program for lamps and luminaires. Under the FTC Lighting Facts labeling requirement, manufacturers are required to include basic and consistent information about certain types of light bulbs (lamps) including information about the lumen output, input power, life, and correlated color temperature (CCT) on

the lamp packaging. Regarding ENERGY STAR, DOE's adopted CFL test procedure provides test methods for certain metrics included in the ENERGY STAR specification for lamps[2] and luminaires.[3] The ENERGY STAR lamps specification includes, among others, metrics for initial lamp efficacy, lumen maintenance at 1,000 hours, lumen maintenance at 40 percent of lifetime, rapid cycle stress test, lifetime, CCT, color rendering index (CRI), power factor, and start time. The ENERGY STAR luminaires specification includes, among others, metrics for efficacy, lumen maintenance at 40 percent of lifetime, lifetime, CCT, CRI, power factor, and start time.

Table II.1 summarizes the metrics adopted in this final rule and which agency requires them.

[2] ENERGY STAR® Program Requirements Product Specification for Lamps (Light Bulbs), Eligibility Criteria, Version 2.0. December 31, 2015. Washington, DC. https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Lamps%20V2_0%20Program%20Requirements.pdf

[3] ENERGY STAR® Program Requirements Product Specification for Luminaires (Light Fixtures), Eligibility Criteria, Version 2.0. May 29, 2015. Washington, DC. https://www.energystar.gov/sites/default/files/asset/document/Luminaires%20V2%200%20Final.pdf

Table II.1 CFL Metrics in DOE Regulations, FTC Labeling Requirements, and the ENERGY STAR Program

Metric	DOE Proposed or Established Regulations			FTC Labeling Requirements	EPA ENERGY STAR Program for Lamps or Luminaires
	MBCFL	GSL	CFLK		
Integrated CFLs					
Efficacy	X	X	X	X	X
CCT		-	-	X	X
CRI		X	-	-	X
Lumen maintenance at 1,000 hours	X	X	X	-	X
Lumen maintenance at 40% of lifetime	X	X	X	-	X
Lifetime	X	X	X	X	X
Rapid Cycle Stress Test	X	X	X	-	X
Power Factor		X	-	-	X
Start Time		X	-	-	X
Standby Mode Energy Consumption		X	-	-	X
Non-Integrated CFLs					
Efficacy	-	*	X	-	X
CCT	-	-	-	-	X
CRI	-	-	-	-	X
Lumen maintenance at 40% of lifetime	-	-	-	-	X
Lifetime	-	-	-	-	X

*In the March 2016 NOPR, DOE notes that the backstop provision in 6296(i)(6)(A)(v) is automatically triggered. The backstop provision requires all lamps that meet the definition of a general service lamp (which includes many non-integrated compact fluorescent lamps) comply with a minimum efficacy standard of 45 lumens per watt. 81 FR 14528, 14540 (March 17, 2016).

Additionally, DOE establishes a test procedure for CFL standby mode power measurement, as directed by EPCA. However, this test procedure will only apply to integrated CFLs because non-integrated CFLs are not capable of standby mode operation (see section III.A.6).

Finally, DOE also revises the current sampling plan in 10 CFR 429.35. This revised sampling plan is consistent with ENERGY STAR Lamps Specification V2.0, as detailed in section III.H.

III. Discussion

A. Amendments to Appendix W to Subpart B of 10 CFR Part 430

1. Updates to Industry Test Methods

DOE's existing MBCFL test procedures contained in appendix W to subpart B of 10 CFR part 430 are based on the August 2001 version of the ENERGY STAR program requirements for CFLs,[4] which has since been updated several times. In the July 2015 NOPR, DOE proposed replacing the existing references to ENERGY STAR program requirements with direct references to the latest versions of the appropriate industry test methods from the IES. DOE explained that directly referencing the latest industry standards would allow DOE to adopt current best practices and technological developments in its test procedures. As a result, DOE proposed to directly incorporate by reference in appendix W the latest versions of the following industry test procedures: IES LM-66-14,[5] IES LM-65-14,[6] and IES LM-54-12.[7] DOE also proposed to no longer incorporate by reference the August 2001 version of the ENERGY STAR Program Requirements for CFLs, previously approved for appendix W.

DOE compared the currently referenced versions and the new updated versions of the relevant industry standards to determine, as directed by EPCA, whether adopting the latest industry standards would alter measured energy efficiency for MBCFLs as determined under the

[4] ENERGY STAR® Program Requirements for CFLs Partner Commitments, Version 2.0, Washington, DC (Aug. 9, 2001). www.energystar.gov/ia/partners/product_specs/program_reqs/archive/CFLs_Program_RequirementsV2.0.pdf
[5] IES Approved Method for the Electrical and Photometric Measurements of Single-Based Fluorescent Lamps (approved December 30, 2014).
[6] IES Approved Method for Life Testing of Single-Based Fluorescent Lamps (approved December 30, 2014).
[7] IES Guide to Lamp Seasoning (approved October 22, 2012).

current DOE test procedure. DOE determined that these changes would have a de minimis effect on measured values.

Both the National Electrical Manufacturers Association (NEMA) and OSRAM SYLVANIA, Inc. (OSI) supported the incorporation by reference of IES LM-66-14 and IES LM-65-14 stating that it would not significantly affect the testing or measured values. (NEMA, No. 9 at pp. 3,8; OSI, No. 5 at pp. 2–3)[8]

DOE received comments regarding the provisions on cycling lamps during seasoning in IES LM-54-12. Under the current test procedure, in accordance with IES LM-54-1991, all lamps are seasoned at a 3 hour on, 20 minute off cycle for 100 operating hours. The latest version of the standard, IES LM-54-12, also specifies that lamps that are to be lifetime tested shall be cycled during seasoning. However, IES LM-54-12 does not specify a specific operating cycle during seasoning for lifetime testing. IES LM-54-12 also states that lamps to be tested for other performance metrics can be continuously burned (not cycled) during seasoning to shorten the time required for seasoning. In the July 2015 NOPR, DOE tentatively determined that not providing a specific operating cycle during seasoning for lifetime testing and not requiring cycling during seasoning for other performance metrics would have a de minimis impact on measured values.

[8] DOE identifies comments received in response to the July 2015 CFL TP NOPR on Docket No. EERE-2015-BT-TP-0014 by the commenter, the document number as listed in the docket maintained at www.regulations.gov, and the page number of that document where the comment appears (for example: OSI, No. 5 at p. 7). If a comment was made verbally during the August 2015 NOPR public meeting, DOE

The California Investor Owned Utilities (CA IOUs)[9] and the Energy Efficiency Advocates (EEAs),[10] however, disagreed and recommended that DOE require lamps to be cycled (operated 3 hours and then turned off for 20 minutes) during seasoning as was specified in IES LM-54-1991. (CA IOUs, No. 7 at p. 3; EEAs, No. 8 at p. 4)

DOE continues to find that cycling during seasoning would have a de minimis impact on measured values. However, in this final rule, in order to establish a more consistent test procedure, DOE specifies cycling during seasoning for all metrics. As discussed in section III.H.5, in this final rule, DOE requires that the same set of lamps be used for measurement of initial lamp efficacy, lumen maintenance, lifetime, color measurements, start time, and power factor. Because of this requirement to use the same set of lamps and the specification in IES LM-54-12 that lamps should be cycled during seasoning for lifetime measurements, lamps used in DOE's test procedure must be cycled during seasoning for all other measurements as well. Rapid cycle stress testing is conducted on a unique set of lamps – a separate set of lamps than used for all other metrics. However, DOE requires in this final rule that lamps used for rapid cycle stress testing also be cycled while seasoned and thereby provides a consistent methodology for seasoning across all metrics.

To provide further consistency and specificity in test method, in this final rule, DOE specifies in this test procedure how to cycle lamps. Although section 6.2.2.1 of LM-54-12 states

[9] The CA IOUs are Pacific Gas and Electric Company (PG&E), Southern California Gas Company (SCG), San Diego Gas and Electric Company (SDG&E), and Southern California Edison (SCE).
[10] The EEAs are the Appliance Standards Awareness Project (ASAP), American Council for an Energy Efficient Economy (ACEEE), Alliance to Save Energy (ASE), Natural Resources Defense Council (NRDC), Northeast Energy Efficiency Partnerships (NEEP), and Northwest Energy Efficiency Alliance (NEEA).

that for lifetime testing, lamps should be cycled during seasoning, IES LM-54-12 does not define the cycling time. IES LM-54-1991 required that all lamps be seasoned at a 3 hour (180 minutes) on, 20 minute off cycle for 100 operating hours. Additionally, section 6.4 of IES LM-65-14 states that the standard life operating cycle shall be 180 minutes on, 20 minutes off. Therefore, in this final rule, DOE specifies in section 3.1.3 of appendix W that lamps must be cycled during seasoning, and the operating cycle must be 180 minutes on, 20 minutes off in accordance with section 6.4 of IES LM-65-14. In this final rule, DOE incorporates by reference IES LM-54-12, and supplements its seasoning requirements with the additional requirements noted in this section.

DOE also received several comments regarding how industry standards incorporated by reference should be cited within the DOE test procedure. Both NEMA and OSI commented that in the NOPR, DOE proposed text copied directly from the referenced industry standards for incorporation into the CFR. NEMA recommended that instead, DOE should incorporate these publications by reference, ensuring that interested parties understand the context. (NEMA, No. 9 at p. 2; OSI, No. 5 at p. 2) Philips Lighting (Philips) expressed concern that when the DOE test procedure deviates from a document incorporated by reference it adds another level of complexity and possibly leads to confusion. (Philips, Public Meeting Transcript, No. 4 at pp. 83–84) As a solution, Philips suggested that DOE provide specific instructions to the testing laboratory like ENERGY STAR and other programs. (Philips, Public Meeting Transcript, No. 4 at p. 68) Westinghouse stated that, although they preferred DOE incorporate by reference the entire document, it was acceptable if only portions can be referenced. Westinghouse stated that it can cause confusion when DOE makes modifications such that something not in the referenced standard is included in the DOE test procedure. In particular, when auditing a test lab,

Westinghouse noted that the lab may meet requirements based on the referenced standard but not based on DOE's test procedure. (Westinghouse, Public Meeting Transcript, No. 4 at p. 85)

DOE appreciates the feedback related to incorporation by reference of industry standards as well as ways to improve the clarity of DOE's test procedure. In the NOPR and in this final rule, DOE did not include text in the regulatory language copied directly from an industry standard and instead incorporated by reference relevant industry standards in 10 CFR 430.3 and referenced sections of the incorporated industry standards as relevant in DOE's test procedures. DOE lays out instructions regarding the test setup conditions, test methods, and measurements for each CFL metric in appendix W. In these instructions, DOE references relevant sections of industry standards, and provides further clarification as needed. To generate reliable and consistent results, DOE, in some instances, provides further clarification and/or exceptions to the industry standards referenced. For example, appendix W states that lamps should be seasoned according to sections 4, 5, 6.1, and 6.2.2.1 of IES LM-54-12. To reduce test burden, DOE provides further clarification in appendix W that time during seasoning can be counted toward time to failure and lumen maintenance at 40 percent of lifetime (see section III.A.2.e for further details). IES LM-54-12 states that, for lifetime testing, lamps shall be cycled during seasoning, and for all other performance metrics, lamps can be continuously burned during seasoning. To ensure consistent seasoning requirements across all metrics, DOE requires in this final rule that, for all metrics, including lifetime, lamps must be cycled during seasoning (as noted in this section). Therefore, DOE's test procedure in appendix W is streamlined to provide, at each step, only the relevant sections of industry standards, and any related additional instructions and/or clarifications specific to the DOE test procedure. In summary, DOE finds that the test

procedures for CFLs as prescribed in this final rule address the concerns of interested parties to provide clear, unambiguous instruction regarding the appropriate procedures for testing CFLs.

2. Clarifications to General Test Conditions and Setup

a. Instrumentation

In the July 2015 NOPR, DOE proposed that photometric measurements including lumen output, CCT, and CRI be carried out in an integrating sphere. DOE made this proposal because of potential differences in measured values when conducting testing with an integrating sphere versus a goniophotometer and certain issues with the use of goniophotometers. DOE received comments related to its proposal to only allow the use of integrating spheres for photometric measurements. P.R. China noted that although the integrating sphere method is simpler, the goniophotometer measures luminous flux using an absolute method and is therefore more accurate. Specifically, P.R. China argued that the goniophotometer method should be allowed because integrating spheres might lead to errors with large-sized lamps or lamps with special shapes. P.R. China added that additional testing cost and/or burden could be introduced by only allowing the use of integrating spheres. (P.R. China, No. 10 at p. 3) However, NEMA and OSI were supportive of using only an integrating sphere for testing. (NEMA, No. 9 at p. 3; OSI, No. 5 at p. 3)

Both the integrating sphere and goniophotometer methods are allowed in IES LM-66-14. DOE understands that both these methods are valid ways to take photometric measurements. However, DOE is concerned about the potential difference in measured values generated from the two different measurement approaches. Because DOE test procedures must yield repeatable and reproducible results and comparable measured values, DOE determined that it must specify

one method of measurement. DOE believes that the integrating sphere method is preferable to the goniophotometer method because of certain issues that make goniophotometer testing more variable and potentially less accurate. The goniophotometer is potentially problematic for lamps that emit light in all directions as the setup may result in a dead angle where some part of the light output is blocked by the equipment (e.g., the arm in which the lamp is held). The goniophotometer method also requires a precise scanning resolution that may differ by lamp and is not subject to a specific industry requirement that could provide consistency across measurements. Integrating spheres can come in a range of sizes and can accordingly be used to test a variety of sizes and shapes of lamps, including linear fluorescent lamps, which are much larger than CFLs. Therefore, DOE is not aware of any constraints or limitations regarding testing CFLs using integrating spheres.

DOE also proposed to incorporate by reference IESNA LM-78-07 in the July 2015 NOPR, which provides more specific guidance on measuring lumen output in an integrated sphere. DOE did not receive any comments related to IESNA LM-78-07.

For these reasons, DOE requires that all photometric measurements, including lumen output, CCT, and CRI, must be carried out using the integrating sphere method. Additionally, to provide a method for measuring lumen output in an integrating sphere, DOE incorporates by reference IESNA LM-78-07.

b. Ambient Temperature

In the July 2015 NOPR, DOE proposed that photometric and electrical testing of CFLs must be conducted at an ambient temperature of 25 ± 1 °C. 80 FR 45731. Section 4.3 of IES

LM-66-14 states that the ambient temperature during photometric and electrical testing must be maintained at 25 ± 1 °C unless the CFL is designed to perform optimally under non-standard conditions. Similar requirements and allowance were given in IES LM-66-1991. DOE's review of manufacturer-published product literature suggests that photometric and electrical testing of CFLs is typically conducted at the standard 25 ± 1 °C temperature conditions and possible inconsistencies could arise between represented values if testing occurred at other temperatures.

OSI commented that the ambient temperature requirement of 25 ± 1 °C is acceptable for most lamps, but not for non-integrated lamps specifically designed for high ambient temperature operation. (OSI, No. 5 at p. 3) General Electric (GE) was also supportive of the temperature range for testing for most products, but requested an exclusion for products that are specifically designed for high ambient temperatures. (GE, Public Meeting Transcript, No. 4 at pp. 32–33) NEMA commented that non-integrated lamps specifically designed for high ambient temperature operation should not be tested at 25 °C. (NEMA, No. 9 at p. 3)

DOE understands the concerns of interested parties, but believes that it is important to establish test procedures that provide a consistent set of measurements. That is, DOE believes that adopting a consistent rating condition across all CFL models will make the results more comparable among CFL models.

c. Input Voltage

In the July 2015 NOPR, DOE proposed that if rated input voltage is a range that includes 120 volts (V), the CFL must be operated at 120 V when conducting the DOE test procedures. If the CFL can be operated with multiple rated input voltages and is not rated for 120 V, the CFL

must be operated at the highest rated input voltage. DOE determined that requiring testing at a single input voltage would limit testing variation and ensure more accurate and consistent measurements of time to failure (see sections III.A.3.a and III.A.4.b). In addition, section 5.1.1 of IES LM-65-14 specifies that when the rated input voltage of a lamp or ballast is a range, a nominal value should be selected for lifetime testing and reported as a test condition. 80 FR 45732. NEMA supported DOE's proposal regarding testing input voltage. (NEMA, No. 9 at p. 3) DOE received no other comments regarding input voltage. In this final rule, DOE adopts a testing voltage requirement that if a rated input voltage is a range that includes 120 V, the CFL must be operated at 120 V. If the CFL with multiple rated input voltages is not rated for 120 V, the CFL must be operated at the highest rated input voltage.

d. Lamp Orientation

In the July 2015 NOPR, DOE proposed a clarification that lamp orientation must be maintained throughout all testing, including preparation (e.g., seasoning and preburning), storage, and handling between tests. The intent of DOE's proposal was to minimize changes in lamp operating characteristics between various stages of testing and allow for more accurate and repeatable measurements. 80 FR 45732. NEMA supported DOE's proposal of maintaining lamp orientation. (NEMA, No. 9 at p. 3) DOE received no other comments regarding lamp orientation. In this final rule, DOE adopts a requirement that lamp orientation must be maintained throughout all testing, including preparation (e.g., seasoning and preburning), storage, and handling between tests.

e. Lamp Seasoning

In the July 2015 NOPR, DOE proposed that the seasoning requirements in IES LM-54-12 must be followed prior to the testing of all CFLs. DOE also proposed two additional provisions related to lamp seasoning. First, DOE proposed that unit operating time during seasoning may be counted toward lumen maintenance at 1,000 hours, lumen maintenance at 40 percent of lifetime, and time to failure if the required operating cycle and test conditions are satisfied as stated in the test method for time to failure. This would reduce testing burden by minimizing the overall testing time required for measuring time to failure and lumen maintenance values. Second, DOE proposed to require that, if a lamp breaks, becomes defective, fails to stabilize, exhibits abnormal behavior such as swirling prior to the end of the seasoning period, or stops producing light, the lamp must be replaced with a new unit. 80 FR 45732.

NEMA was supportive of the proposed seasoning requirements. (NEMA, No. 9 at p. 3) DOE received several comments regarding its proposal that a lamp that fails during seasoning should not be included in the sample set to determine the represented value of metrics. DOE addresses these comments in section III.H.6.

In this final rule, DOE adopts the clarifications regarding seasoning as noted in this section. As previously stated in section III.A.1, to provide consistency in test methodology, DOE also requires in this final rule that lamps must be cycled during seasoning for all measurements and specifies an operating cycle of 180 minutes on and 20 minutes off in accordance with section 6.4 of IES LM-65-14.

f. Lamp Stabilization

In the July 2015 NOPR, DOE proposed to disallow the "peak" method provided in Annex B of IES LM-66-14, which can serve as a time saving alternative to the stabilization method specified in section 6.2.1 of IES LM-66-14. IES LM-66-14 states that the information in the Annex is not intended to be a recommended procedure, but is presented as reference information; it also notes that the stabilization method specified in section 6.2.1 is preferred because considerable testing and experience with a given lamp design may be required due to the number of lamp designs and process variations that exist when conducting the peak according to Annex B. Because of the variabilities that could arise from testing using the peak method, DOE concluded that the peak method could cause inconsistent and potentially inaccurate results. 80 FR 45732.

NEMA supported DOE's proposal. (NEMA, No. 9 at p. 3) DOE received no other comments regarding the "peak" method for stabilization. In this final rule, DOE disallows the "peak" method provided for reference in Annex B of IES LM-66-14.

g. Simulated Fixtures during Time to Failure Testing

In the July 2015 NOPR, DOE proposed not to allow the use of simulated fixtures during time to failure testing of CFLs. This proposal would remove potential variation in the testing of CFLs and ensure that all CFLs are tested in a consistent manner. 80 FR 45732.

NEMA supported this proposal. (NEMA, No. 9 at p. 3) DOE received no other comments regarding testing of lamps in fixtures. In this final rule, DOE disallows the use of simulated fixtures during time to failure testing of CFLs.

h. Ballasted Adapters

In the July 2015 NOPR, DOE proposed that CFLs packaged with or designed exclusively for use with ballasted adapters must be tested as non-integrated CFLs, without the inclusion of the ballasted adapter. DOE proposed to define a "ballasted adapter" as a ballast that is not permanently attached to a CFL, has no consumer-replaceable components, and serves as an adapter by incorporating both a lamp socket and a lamp base. 80 FR 45732.

NEMA agreed with the proposed term "ballasted adapter." (NEMA, No. 9 at p. 3) DOE received no other comments regarding the definition for "ballast adapter." In this final rule, DOE adopts the proposed definition for the term "ballasted adapter."

DOE also received comments related to the inclusion of screw-base ballasted adapters for non-integrated CFLs. NEMA, OSI, and Philips stated that screw-base ballasted adapters for non-integrated CFLs should not be part of the CFL test procedure, but rather addressed in the fluorescent lamp ballast (FLB) rulemaking.[11] (NEMA, No. 9 at p. 2; OSI, No. 5 at p. 2; Philips, No. 6 at p. 3) DOE notes that it is not proposing a test procedure for ballasted adapters in this rulemaking, only a test procedure for compact fluorescent lamps.

Philips disagreed with DOE's proposal that CFLs, packaged with or designed exclusively for use with ballasted adapters, must be tested as non-integrated CFLs, without the inclusion of the ballasted adapter. Instead, Philips recommended that a ballasted adapter sold with a lamp

[11] Information regarding the Fluorescent Lamps Ballast Rulemaking can be found at http://www.regulations.gov/docket?D=EERE-2015-BT-STD-0006.

should be tested as a system and the system should be subject to the same energy conservation standards as integrated lamps. (Philips, No. 6 at p. 3)

DOE requires that non-integrated CFLs be tested on reference ballasts as specified in IES LM-66-14. This ensures consistent test conditions for measuring the performance characteristics of non-integrated CFLs that are externally ballasted. As noted in this preamble, DOE defines ballasted adapter as a component that is not permanently attached to the CFL, and therefore is similar to the external ballasts used with non-integrated CFLs. DOE reviewed CFLs that are compatible with ballasted adapters and determined that there was no technical reason they could not be tested on a reference ballast. Further, although the CFL may be packaged with a certain ballasted adapter, a consumer could choose to replace it with a different ballasted adapter or a manufacturer could pair the same lamp with different ballasted adapters. Thus, use of a reference ballast allows for a consistent and comparable assessment of the lamp's performance. Therefore, DOE continues to require that CFLs packaged with or designed exclusively for use with ballasted adapters be tested as non-integrated CFLs.

i. Multi-Level CFLs and Dimmable CFLs

Footnote 2 to the energy conservation standards for MBCFLs codified at 10 CFR 430.32(u) includes the statement that for multi-level or dimmable systems, measurements shall be at the highest setting. In the July 2015 NOPR, DOE proposed to remove the footnote in order to consolidate testing requirements in the test procedure and add language to the test procedure addressing dimmable CFLs in the general instruction section of appendix W. The lumen output level and input power can be adjusted for some CFLs (i.e., dimmable), and thus not clarifying the input power for testing these lamps can introduce testing variation.

Therefore, to ensure consistent results, DOE proposed that a dimmer not be used in the circuit and that all CFLs be tested at the labeled wattage, which DOE defines as the highest wattage marked on the lamp and/or lamp packaging (see section III.A.3.f for further details on the labeled wattage). 80 FR 45732-45733.

NEMA and OSI agreed that testing should be conducted with no dimmer in the circuit, but the CA IOUs proposed testing dimmable CFLs at dimmed states in addition to full power. (NEMA, No. 9 at p. 4; OSI, No. 5 at p. 3; CA IOUs, No. 7 at p. 4) However, neither the current energy conservation standards nor those proposed in the March 2016 NOPR require measurements of performance of CFLs at dimmed levels. Therefore, DOE is not establishing test procedures for CFLs to be tested at such levels.

Both NEMA and OSI commented that CFL testing should be conducted at labeled voltage (which is an independent variable), rather than at labeled wattage (which is a dependent variable). (NEMA, No. 9 at pp. 3–4; OSI, No. 5 at p. 3) DOE agrees that wattage is dependent on voltage and understands that, during testing, the electrical characteristics of the incoming power to the lamp would be adjusted to achieve a given wattage. Because voltage and wattage are related quantities, DOE notes that specifying either the voltage or wattage will achieve the same result when testing a given lamp. DOE's specification that the lamp be tested at the labeled wattage is intended to indicate that CFLs specified for a range of wattages should be measured at the highest wattage marked on the lamp. This is consistent with the existing test specifications for CFL testing and DOE's proposed definition of "labeled wattage," as discussed in section III.A.3.f.

In this final rule, DOE removes the text regarding multi-level or dimmable systems from §430.32(u) and, instead, specifies in appendix W that dimmable CFLs must be tested at their highest labeled wattage. DOE believes specifying that a dimmer cannot be used in the circuit is an unnecessary addition as DOE also specifies that dimmable CFLs must be tested at their highest labeled wattage. DOE therefore removes this direction in the final rule.

3. Clarifications to Definitions

a. Average Rated Life

In the July 2015 NOPR, DOE proposed to remove the term "average rated life" and adopt the terms "lifetime of a compact fluorescent lamp" and "time to failure." The existing definition of "average rated life" makes only general reference to the sample size for time to failure testing. DOE believes the use of the word "average" in the term "average rated life" may be confusing, and although defined in appendix W, the term is not otherwise used in appendix W or in specifications of existing MBCFL energy conservation standards. Further, the term "rated life" is used as a descriptor in appendix W, but is not defined. Therefore, DOE proposed to remove the term "average rated life" from appendix W and to add the definition "lifetime of a compact fluorescent lamp" at 10 CFR 430.2. 80 FR 45733. See section III.B.3 for more detail.

In the July 2015 NOPR, DOE also proposed to define "time to failure" in appendix W to support the new definition of "lifetime of a compact fluorescent lamp" specified in 10 CFR 430.2. "Time to failure" in the context of CFLs is the time elapsed between first use and the

point at which the lamp fully extinguishes and no longer creates light. 80 FR 45733.This definition aligns with the definition of lamp failure in section 8.2 of ANSI/IES RP-16-14.[12]

The EEAs were supportive of DOE's proposed changes related to lifetime, but recommended that the definition of "time to failure" be the point at which the lumen output falls below 70 percent of initial lumen output. The EEAs stated that 70 percent is a common threshold within the lighting industry and addresses a situation where the CFL starts, but does not provide sufficient light. (EEAs, No. 8 at p. 1)

DOE is only aware of 70 percent initial lumen output to characterize lifetime of light-emitting diode (LED) lamps. This determination is based on the understanding that the LED lamp has reached the end of its useful life when it achieves a lumen maintenance of 70 percent. In the June 3, 2014 supplemental notice of proposed rulemaking (SNOPR), DOE concluded that there is no industry consensus for how to characterize lifetime of LED lamps in terms of performance metrics other than lumen maintenance. However, for other lighting technologies, such as CFLs, industry standards define lamp lifetime as the time at which 50 percent of tested samples stop producing light. 79 FR 32020, 32028. Therefore, in this final rule, DOE defines "time to failure" as the time elapsed between first use and the point at which the CFL ceases to produce measureable lumen output.

[12] Nomenclature and Definitions for Illuminating Engineering (approved 2010).

As noted in section III.A.1, DOE references IES LM-65-14 for lifetime testing of CFLs. Section 3.0 of IES LM-65-14 specifies the terms "lamp failure," "lamp life," and "rated lamp life." However, DOE is specifically defining the terms, "time to failure" and "lifetime of a compact fluorescent lamp" (see section III.B.3) to support its lifetime testing of CFLs and align with terminology used in other DOE lamp test procedures. Although the definitions in section 3.0 of IES LM-65-14 are often analogous to DOE's adopted definitions for time to failure and lifetime of a compact fluorescent lamp, to avoid confusion regarding terminology when executing the lifetime test procedure for CFLs, DOE proposed that section 3.0 of IES LM-65-14 should be disregarded and replaced with the DOE definitions used for lifetime testing of CFLs. DOE did not receive any comments regarding this proposal and adopts it in this final rule.

b. Initial Performance Values

DOE proposed in the July 2015 NOPR to (1) delete the term "initial performance values;" (2) add a definition for the term "initial lamp efficacy;" (3) add a definition for the term "measured initial input power;" (4) delete the term "rated luminous flux or rated lumen output;" and (5) add a definition for the term "measured initial lumen output." 80 FR 45733-45734. The new terms clarify the measurement of CFL initial performance values, and eliminate the need for the terms "initial performance values" and "rated luminous flux or rated lumen output." DOE did not receive any comments related to deletion or addition of these terms. Therefore, in this final rule, DOE removes the terms "initial performance values" and "rated luminous flux or rated lumen output," and adopts definitions for "initial lamp efficacy," "measured initial input power," and "measured initial lumen output."

c. Lumen Maintenance

In the July 2015NOPR, DOE proposed to amend the definition of "lumen maintenance" to clarify that calculated lumen maintenance values are based on measured lumen output as the existing definition of "lumen maintenance" does not clearly distinguish between rated and measured values. The DOE proposed to adopt the term "lumen maintenance" in appendix W as the lumen output measured at a given time in the life of the lamp and expressed as a percentage of the measured initial lumen output. 80 FR 45734.

NEMA agreed with this clarification. (NEMA, No. 9 at p. 5) DOE did not receive any other comments on the term "lumen maintenance." In this final rule, DOE adopts the term "lumen maintenance" and definition as proposed in the July 2015 NOPR.

d. Rated Voltage

In appendix W, the term "rated voltage" is defined as meaning the voltage marked on the lamp. As previously noted, in this final rule, DOE requires measurement at the highest rated input voltage for lamps rated at multiple input voltages not including 120 V (see section III.A.2.c). In order to support this test condition, in this final rule, DOE adds clarifying text to the definition of "rated voltage." Specifically, in this final rule, DOE replaces the term "rated voltage" with "rated input voltage," defined as the voltage(s) marked on the lamp as the intended operating voltage, or if not marked on the lamp, 120 V.

e. Rated Supply Frequency

In the July 2015 NOPR, DOE proposed to remove from appendix W the term "rated supply frequency" because appendix W does not use this term. 80 FR 45734.

NEMA agreed with removing this term. (NEMA, No. 9 at p. 4) DOE did not receive any other comments on removing "rated supply frequency." In this final rule, DOE removes the term "rated supply frequency" from appendix W.

f. Rated Wattage

In the July 2015 NOPR, DOE proposed to change the term "rated wattage" to "labeled wattage" and amend the definition to clarify its applicability to multi-level (i.e., multi-power) and dimmable CFLs. 80 FR 45734. Currently, in appendix W "rated wattage" is defined as the wattage marked on the lamp. The term is intended to denote the wattage marked on the lamp that should be used to determine the applicable minimum efficacy requirement for existing MBCFL energy conservation standards as specified in 10 CFR 430.32(u). However, in ANSI standards, the rated wattage is a targeted rather than actual value and can sometimes differ from the value displayed on the lamp packaging.

NEMA and OSI recommended DOE not remove the term "rated wattage," which they stated is widely used and understood by the lighting industry, and instead suggested adding the term "ANSI rated wattage" to differentiate the ANSI-based wattages. (NEMA, No. 9 at p. 5; OSI, No. 5 at p. 4)

Although DOE understands that "rated wattage" is a commonly used term in the lighting industry, DOE also notes that its meaning may differ depending on the context in which it is used (i.e., referring to wattages referenced in ANSI standards as opposed to the wattage listed on the CFL). Using the term "labeled wattage" will avoid any potential confusion when applying DOE's test procedures and align with the definition of the term, which specifies it as the wattage

marked on the lamp. Therefore, in this final rule, DOE removes "rated wattage" and defines "labeled wattage" as the highest wattage marked on the lamp and/or lamp packaging.

g. Self-Ballasted Compact Fluorescent Lamp

The term "self-ballasted compact fluorescent lamp," as defined in appendix W, means a CFL unit that incorporates, permanently enclosed, all elements that are necessary for the starting and stable operation of the lamp, and does not include any replaceable or interchangeable parts. The terms self-ballasted CFL, integrally ballasted CFL, and integrated CFL are used interchangeably in industry to identify a CFL that contains all components necessary for the starting and stable operation of the lamp, does not include any replaceable or interchangeable parts, and is connected directly to a branch circuit through an ANSI base and corresponding ANSI standard lamp-holder (socket). Because DOE proposed to include test procedures for additional categories of CFLs, including integrated and non-integrated CFLs, in the July 2015 NOPR, DOE also proposed to define the mutually exclusive terms "integrated CFL" and "non-integrated CFL" to clearly differentiate the applicability of the relevant CFL test procedures and energy conservation standards. Specifically, DOE proposed to remove the definition of "self-ballasted compact fluorescent lamp" and add a new definition for the term "integrated compact fluorescent lamp" as an integrally ballasted CFL that contains all components necessary for the starting and stable operation of the lamp, does not include any replaceable or interchangeable parts, and is connected directly to a branch circuit through an ANSI base and corresponding ANSI standard lamp-holder (socket). DOE also proposed to add a definition of "non-integrated compact fluorescent lamp" as "a compact fluorescent lamp that is not integrated." 80 FR 45734.

OSI and NEMA stated that the proposed definition for "non-integrated" was unnecessarily broad and encompassed all CFLs that are not integrated CFLs. OSI and NEMA instead suggested DOE incorporate the following ANSI C78.901-2014 definition for non-integrated CFLs: a CFL that has an ANSI pin base, does not incorporate a ballast, and appears in ANSI C78.901-2014. (OSI, No. 5 at p. 5; NEMA, No. 9 at p. 5) Additionally, during the public meeting held to discuss the July 2015 NOPR, OSI asked why the term "integrated" was chosen as opposed to "self-ballasted." OSI also inquired about the use of the term "pin based" in the context of "non-integrated." (OSI, Public Meeting Transcript, No. 4 at pp. 53–54) Philips responded that UL 1993[13] uses the term "self-ballasted lamp" and acknowledged that the IES struggled with the terms when developing IES LM-65-14 and IES LM-66-14, but ultimately both documents use the terms integrated and non-integrated when appropriate. (Philips, Public Meeting Transcript, No. 4 at pp. 53–55)

The term "integrated" can be used across lamp technologies to describe lamps that contain all the necessary components for operation, and thereby provides consistency across DOE test procedures for lamps. The term supports the March 2016 NOPR and the amended standards for CFLKs, both of which apply to lamps that use ballasts as well as drivers. Further, because this test procedure applies to all CFLs, it is DOE's intent to set forth terminology that includes all CFL types. Based on its review of products, DOE determined that a CFL is either "integrated" or "non-integrated" and intentionally defined the terms to be mutually exclusive (i.e., a CFL can be either integrated or non-integrated, but not both) and inclusive of all CFLs.

[13] UL. UL1993, "Self-Ballasted Lamps and Lamp Adapters," http://ulstandards.ul.com/standard/?id=1993_4

Therefore, DOE defines "non-integrated compact fluorescent lamp" to include any CFL that does not meet the definition "integrated compact fluorescent lamp" and does not limit this definition by base type or inclusion in industry standard. Hence, in this final rule, DOE removes the definition of "self-ballasted compact fluorescent lamp" and adds new definitions for "integrated compact fluorescent lamp" and "non-integrated compact fluorescent lamp."

4. Test Procedures for Existing and New Metrics

a. Test Procedures for Initial Lamp Efficacy, Lumen Maintenance, CCT, CRI, and Power Factor

In the July 2015 NOPR, DOE proposed to continue to include test procedures for measuring initial lamp efficacy and lumen maintenance and add test procedures for measuring CCT, CRI, and power factor in appendix W. DOE proposed that the test procedures for initial lamp efficacy, lumen maintenance at 1,000 hours, lumen maintenance at 40 percent of lifetime, CCT, and CRI would apply to both integrated and non-integrated lamps, although the test procedure for power factor would only apply to integrated lamps. 80 FR 45735. The following sections discuss these metrics and the related comments received.

Initial Lamp Efficacy and Lumen maintenance

Although appendix W currently specifies a test procedure for initial lamp efficacy and lumen maintenance, it does not explicitly state how to measure and calculate initial lamp efficacy and lumen maintenance values. In order to standardize the CFL test procedure and the calculation of these values, DOE proposed that initial lamp efficacy be determined as the measured initial lumen output divided by the measured initial input power. DOE further proposed to reference IES LM-66-14 for test conditions and setup to measure initial lamp

efficacy, lumen maintenance at 1,000 hours, and lumen maintenance at 40 percent of lifetime. 80 FR 45735. DOE did not receive any comments regarding its proposals for initial lamp efficacy and therefore, in this final rule, adopts them as described in the July 2015 NOPR.

Similarly, in the July 2015 NOPR, DOE proposed to calculate lumen maintenance at 1,000 hours as measured lumen output at 1,000 hours divided by the measured initial lumen output and to calculate lumen maintenance at 40 percent of lifetime as the measured lumen output at 40 percent of lifetime of a compact fluorescent lamp divided by the measured initial lumen output. 80 FR 45735.

DOE evaluated its existing energy conservation standards and ongoing standards rulemakings for CFLs as well as FTC Lighting Facts labeling and determined that a lumen maintenance at 1,000 hours metric is not required for non-integrated CFLs. Therefore, in this final rule, DOE is only adopting a test procedure for lumen maintenance at 1,000 hours for integrated CFLs.

GE and Philips commented during the public meeting for the July 2015 NOPR that logistical testing issues arise if the definition of lifetime is changed to a measured quantity. GE and Philips postulated that they could not measure lumen maintenance at 40 percent of measured lifetime because the point at which lifetime is determined would be later than the 40 percent of the lifetime measurement point. (GE, Public Meeting Transcript, No, 4 at pp. 44–47; Philips, Public Meeting Transcript, No. 4 at pp. 21–22) Both NEMA and OSI proposed measuring lumen maintenance at 40 percent of a rated lifetime rather than the lifetime measured as proposed by DOE. (NEMA, No 9 at pp. 4–5; OSI, No 5 at p. 4)

DOE acknowledges the logistical concerns about measuring lumen maintenance at 40 percent of the lifetime of a CFL. In this final rule, DOE is adopting that lumen maintenance at 40 percent of lifetime can be an estimated value for initial certification of new basic models or existing basic models when retesting is required until lifetime testing is complete. As described in section 10 CFR 429.35(b), certification reports must be submitted for CFLs and represented values of lifetime, lumen maintenance at 40 percent of lifetime, life, and rapid cycle stress test surviving units are estimated values until testing is complete. Upon completion of lifetime testing, the next annual certification report must include final values for these metrics based on the actual represented value for lifetime. In this way, the time required to test for lifetime, lumen maintenance at 40 percent of lifetime, life, and rapid cycle stress will not delay the distribution in commerce of a lamp. (See section III.G for further details on certification reports.)

Although DOE is adopting test methods for lumen maintenance at 40 percent of lifetime for both integrated and non-integrated CFLs, DOE notes that standards for lumen maintenance at 40 percent of lifetime are only applicable for integrated CFLs, specifically MBCFLs. Lumen maintenance at 40 percent of lifetime for non-integrated CFLs is only required to the extent that manufacturers wish to make representations regarding the lumen maintenance of their products or participate in the voluntary ENERGY STAR program.

Correlated Color Temperature (CCT)

In the July 2015 NOPR, DOE proposed to establish a test procedure for measuring CCT in appendix W. The term "correlated color temperature" is defined in 10 CFR 430.2 as the absolute temperature of a blackbody whose chromaticity most nearly resembles that of the light source. DOE proposed adding the abbreviation "CCT" to this definition as explained in section

III.B.2. DOE further proposed that CCT be measured and calculated in accordance with IES LM-66-14, which references Commission Internationale de l'Eclariage (CIE) 15:2004 (3rd edition), "Colorimetry." 80 FR 45735. CIE 15:2004 was previously incorporated by reference in a test procedure final rule published on July 6, 2009 for general service fluorescent lamps, incandescent reflector lamps (IRLs), and general service incandescent lamps (GSIL) for appendix R (hereafter "2009 GSFL, IRL, and GSIL Test Procedure"). 74 FR 31829, 31834.

Both the CA IOUs and the EEAs supported the proposed methodology to measure CCT. (CA IOUs, No. 7. at pp. 3–4; EEAs, No. 8 at p. 4) Likewise, NEMA had no issues with the proposed test procedure, but noted that the proposed methodology would add measurements to the existing requirements. (NEMA, No. 9 at p. 6) OSI added that the additional measurements would have no regulatory benefit. (OSI, No. 5 at p. 5) Although DOE agrees with commenters that DOE has not set standards or requirements regarding the CCT of CFLs, as noted previously, this test procedure supports the FTC Lighting Facts labeling requirements for lighting products, the ENERGY STAR Lamps Specification V2.0 and the ENERGY STAR Luminaires Specification V2.0, all of which require the CCT metric. Therefore, in this final rule, DOE adopts the test procedure for CCT and incorporates CIE 15:2004 by reference for appendix W as proposed in the July 2015 NOPR.

Color Rendering Index (CRI)

In the July 2015 NOPR, DOE proposed establishing a test procedure for measuring CRI in appendix W. DOE proposed that CRI must be measured and calculated in accordance with IES LM-66-14, which references CIE 13.3-1995, "Method of Measuring and Specifying Colour Rendering Properties of Light Sources." DOE also proposed to incorporate CIE 13.3-1995 by

reference for appendix W. 80 FR 45735. CIE 13.3-1995 was previously incorporated by reference for appendix R in the 2009 GSFL, IRL, and GSIL Test Procedure.

The CA IOUs and EEAs, supported the proposed test procedure for CRI. (CA IOUs, No. 7 at pp. 3–4; EEAs, No. 8 at p. 4) NEMA and OSI expressed the view that a CRI test method would have no regulatory benefit and should not be included in the test method but agreed the proposed methodology was appropriate for measuring CRI. (NEMA, No. 9 at p. 6; OSI, No. 5 at p. 5) Philips, commented that CRI should be excluded from the test procedure, as the metric would not yield substantial energy savings. (Philips, No. 6 at p. 3)

The EEAs proposed testing color under the new IES metric outlined in IES TM-30-2015, IES Method for Evaluating Light Source Color Rendition. (EEAs, No. 8 at p. 4) IES TM-30-2015 is a new methodology for evaluating different color properties than CRI.[14] CRI is determined by comparing a specific set of eight color samples and calculating the average term known as R_a. In contrast, IES TM-30-2015 provides calculations and directions for quantifying fidelity (R_f, which is the closeness to a reference) and gamut (R_g, which is the increase or decrease in chroma).

DOE must specify test procedures in order to determine whether the products comply with any relevant standards promulgated under EPCA. (42 U.S.C. 6295(s)) In the March 2016 NOPR, DOE proposed that MBCFLs have a CRI of at least 80. 81 FR 14554. Additionally,

[14] IES Method for Evaluating Light Source Color Rendition. https://www.ies.org/store/product/ies-method-for-evaluating-light-source-color-rendition-3368.cfm

ENERGY STAR Lamps Specification V2.0 and Luminaire Specification V2.0 include a CRI requirement. Therefore, in this final rule, DOE establishes a test procedure for CRI and incorporates CIE 13.3-1995 by reference for appendix W. As there are no existing standards for IES TM-30-2015 color metrics for CFLs, nor were any proposed in the March 2016 NOPR, DOE is not adopting test procedures to evaluate color metrics specified in IES TM-30-2015 in this final rule.

In this final rule, DOE is adopting test methods for determining CRI for both integrated and non-integrated CFLs. While DOE is only adopting certification requirements for integrated CFLs when complying with general service lamps standards, if adopted, DOE's test procedure for CRI is applicable to all CFLs and must be used when making representations. (As proposed in the March 2016 NOPR, 81 FR 14554) More specifically, if a manufacturer of a non-integrated CFL decides to make representations of CRI in its product literature, manufacturer catalogues, labeling, or for voluntary energy-efficiency programs, the manufacturer must use the DOE test procedure, including sampling plan.

Power Factor

In the July 2015 NOPR, DOE proposed a test procedure for measuring power factor for integrated CFLs based on electrical measurements conducted in accordance with section 5.0 of IES LM-66-14. DOE also proposed to define power factor in appendix W as the measured root square mean (RMS) input power (watts) divided by the product of the measured RMS input voltage (volts) and the measured RMS input current (amps). 80 FR 45735. DOE did not receive comments on the proposed definition. In this final rule, DOE has modified the definition slightly to align with the definition in ENERGY STAR. Therefore, DOE adopts the following definition

of power factor: power factor means the measured input power (watts) divided by the product of the measured RMS input voltage (volts) and the measured RMS input current (amps).

The CA IOUs and EEAs commented that they were supportive of the requirement of testing power factor as well as the proposed approach. (CA IOUs, No. 7 at pp. 4; EEAs, No. 8 at pp. 3–4) GE, Philips, NEMA, and OSI commented that power factor should be excluded from the test procedure, with Philips stating that the metric would not yield substantial energy savings, and NEMA and OSI stating that it would have no regulatory benefit. (GE, Public Meeting Transcript, No. 4 at pp. 140–142; OSI, No. 5 at p. 5; Philips, No. 6 at p. 3)

In the March 2016 NOPR, DOE proposed setting a minimum power factor standard for MBCFLs. 81 FR 14528, 14554-14555 (March 17, 2016). DOE notes that ENERGY STAR Lamps Specification V2.0 also includes a power factor requirement. As power factor is required to demonstrate compliance with the proposed GSL energy conservation standards and to support the ENERGY STAR requirements, in this final rule, DOE is establishing a test procedure for power factor.

GE, NEMA, OSI, and Philips commented that power factor is not relevant to non-integrated CFLs because it is a metric specific to the ballast. (GE, Public Meeting Transcript, No. 4 at pp. 140–142; NEMA, No. 9 at p. 6; OSI, No. 5 at p. 5; Philips, No. 6 at p. 3) In response, DOE clarifies that the power factor test procedure is only applicable to integrated CFLs.

DOE also received a comment from the CA IOUs recommending that DOE consider requiring the measurement and reporting of total harmonic distortion of current (abbreviated as THD in the comment). (CA IOUs, No. 5 at p. 4) In the March 2016 NOPR, DOE stated that THD is directly related to power factor and a power factor requirement will effectively establish a standard for THD. 81 FR 14555-14556. Therefore, DOE is not adopting a test procedure for total harmonic distortion of current in this final rule.

b. Test Procedures for Time to Failure

In the July 2015 NOPR, DOE proposed test procedures for measuring time to failure in appendix W for integrated and non-integrated CFLs. 80 FR 45735. DOE determined that test conditions, setup, and measurement of time to failure should be as specified in IES LM-65-14. DOE also proposed that use of simulated fixtures during time to failure testing of CFLs not be allowed. This proposed provision was to prevent potential variation in testing of CFLs and to ensure that all CFLs are tested in a consistent manner. 80 FR 45732. NEMA agreed with DOE's proposal to disallow the use of simulated fixtures during time to failure testing. (NEMA, No. 9 at p. 3)

OSI requested that DOE not include lifetime testing for pin base CFLs in the test procedure, noting that initial lamp efficacy is sufficient for reporting metrics of these lamp types. (OSI, No. 5 at p. 2) NEMA agreed with OSI that DOE should not include lifetime testing for pin base CFLs. NEMA also stated that lifetime testing would depend on the ballast operating the non-integrated CFL. (NEMA, No. 9 at pp. 2, 6)

DOE agrees with NEMA that the specific ballast used affects the lifetime of non-integrated CFLs; however, the characteristics of the lamp also affect this metric. Further, manufacturer catalogs specify the lifetime of non-integrated CFL products and lifetime is also required by ENERGY STAR Luminaires Specification V2.0. Therefore, DOE finds that lifetime is an important characteristic of the performance of the non-integrated CFL. Additionally, by using reference ballasts when testing non-integrated CFLs, DOE is able to assess the performance of the non-integrated CFL in a comparable and standardized way across all non-integrated lamps. In this final rule, DOE adopts the proposed test procedures for time to failure for integrated and non-integrated CFLs to be used to determine lifetime.

c. Test Procedure for Rapid Cycle Stress Test

In the July 2015 NOPR, DOE proposed test procedures for conducting rapid cycle stress testing for integrated and non-integrated CFLs. DOE proposed that test conditions, setup, and rapid cycle stress testing be as specified in IES LM-65-14 , but retained the existing operating cycle for rapid cycle stress testing (i.e., CFLs must be cycled continuously with each cycle consisting of one 5-minute on period followed by one 5-minute off period). 80 FR 45735. DOE did not propose any modifications to the rapid cycle stress test itself, but did propose modifications to rounding requirements (see section III.A.7), removal of test procedure language from the energy conservation standard requirements (see section III.F.4), and modifications to sample size (see section III.H.2) for this test.

DOE received comments that rapid cycle stress testing should not be applied to non-integrated CFLs. GE commented that rapid cycle stress testing should not apply to non-integrated CFLs because it is dependent on the ballast paired with the lamp. (GE, Public

Meeting Transcript, No. 4 at pp. 140–142) OSI added that rapid cycle stress testing was designed to stress the ballast and not applicable to non-integrated CFLs. (OSI, No. 5 at pp. 2, 5) NEMA supported the test procedure for rapid cycle stress testing with the clarification that the test procedure should not apply to non-integrated CFLs. (NEMA, No. 9 at p. 6) Philips also stated that non-integrated CFLs be excluded from rapid cycle stress test and questioned the energy savings aspects related to measuring rapid cycle stress test. (Philips, No. 6 at p. 3)

In light of the comments received from interested parties, DOE evaluated its existing energy conservation standards and ongoing standards rulemakings as well as FTC Lighting Facts labeling and ENERGY STAR specifications and determined that rapid cycle stress testing of non-integrated CFLs is not required by any of these regulatory and non-regulatory programs. Therefore, DOE is not adopting a test procedure for rapid cycle stress testing of non-integrated CFLs. DOE notes, however, that the existing standards for MBCFLs, the proposed standards in the March 2016 NOPR, and the ENERGY STAR Lamps Specification V2.0 all contain a requirement for rapid cycle stress testing for MBCFLs. Therefore, DOE retains the test procedure for rapid cycle stress testing for integrated CFLs.

d. Test Procedure for Start Time

In the July 2015 NOPR, DOE proposed a test procedure for measuring start time for integrated CFLs. In support of the proposed start time test method, DOE defined the terms "start time," "start plateau," and "percent variability." DOE also proposed that the lamp be seasoned, stored at a certain temperature, and tested according to a certain operating procedure following the seasoning. 80 FR 45735–45736.

DOE received comments regarding the applicability of the start time metric. NEMA, OSI, and Philips stated that start time is not related to energy efficiency and should not be part of the test procedure. (NEMA, No. 9 at pp. 6,8; OSI, No. 5 at p. 5; Philips, No. 6 at p. 3) NEMA and OSI stated that DOE should abandon the effort to create a test procedure for start time. (NEMA, No. 9 at p. 6; OSI, No. 5 at p. 5) GE, NEMA, Philips, and OSI stated that start time is not applicable to non-integrated CFLs. (GE, Public Meeting Transcript, No. 4 at pp. 140–142; NEMA, No. 9 at p. 8; OSI, No. 5 at pp. 2,7; Philips, No. 6 at p. 3)

In the March 2016 NOPR, DOE proposed a requirement for start time for MBCFLs that the lamp must remain continuously illuminated within one second of application of electrical power. 81 FR 14528, 14555 (March 17, 2016). ENERGY STAR Lamps Specification V2.0 includes a requirement for start time. DOE notes that because the ongoing GSL rulemaking considered a start time metric for only integrated CFLs, the July 2015 NOPR proposed measuring start time for only integrated CFLs. 80 FR 45736. In this final rule, DOE continues to specify that only integrated lamps must be tested for start time.

DOE received several comments regarding the proposed definitions and test procedures for start time. The CA IOUs agreed with the proposed methods for start time outlined in the July 2015 NOPR. (CA IOUs, No. 7 at pp. 3–4) The EEAs stated that they supported DOE's test procedures for start plateau, percent variability, and start time as long as they are fully consistent with the ENERGY STAR test procedure for start time. (EEAs, No. 8 at p. 4)

If DOE were to require measuring and reporting start time, OSI suggested using the ENERGY STAR procedure, which it stated is well understood. (OSI, No. 5 at p. 5) NEMA noted

that although the ENERGY STAR test procedure for start time is well understood, it should not be required for lamps that are not ENERGY STAR certified. (NEMA, No. 9 at p. 6) Both Philips and Westinghouse commented that DOE's proposed start time procedure seemed overly complicated, and requested that DOE harmonize with or simply adopt the ENERGY STAR test procedure. (Philips, Public Meeting Transcript, No. 4 at p. 65; Westinghouse, Public Meeting Transcript, No. 4 at pp. 66–67)

When developing the start time test procedure, DOE reviewed the August 2013 "ENERGY STAR Program Requirements Product Specification for Lamps Version 1.0: Start Time Test Method."[15] ENERGY STAR released "ENERGY STAR Program Requirements for Lamps and Luminaires Start Time Test Method"[16] in September 2015 (hereafter "ENERGY STAR Start Time Test Method"). For this final rule, DOE reviewed the latest version of the ENERGY STAR Start Time Test Methods and determined that the only differences between the two methods are the applicable products and referenced documents.[17]

DOE determined that its proposed start time test method continues to align with the ENERGY STAR Start Time Test Method, while providing greater specificity in order to ensure

[15] ENERGY STAR® Program Requirements Product Specification for Lamps Version 1.0: Start Time Test Method. August 2013. www.energystar.gov/sites/default/files/specs//ENERGY%20STAR%20Lamps%20V1%200%20Final%20Test%20Methods%20and%20Recommended%20Practices.pdf

[16] ENERGY STAR® Program Requirements for Lamps and Luminaires Start Time Test Method. September 2015. https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Start%20Time%20Test%20Method_1.pdf

[17] The August 2013 ENERGY STAR Start Time Test Method applied to integrated CFLs and solid-state lighting (SSL) lamps. In contrast, the September 2015 ENERGY STAR Start Time Test Method applies to all integrated and externally ballasted CFLs, and SSL lamps, light engines, and luminaires. Both versions referenced IES LM-66, "IES Approved Method for Electrical and Photometric Measurements of Single-Based Compact Fluorescent Lamps." However, the August 2013 ENERGY STAR Start Time Test Method referenced the 2011 version of IES LM-66 and the latest version references the 2014 version of IES LM-66.

consistency and reproducibility in measurements. (DOE also notes section 11.4 of ENERGY STAR Lamps Specification V2.0 references the DOE test procedure for compact fluorescent lamps (once final) for measuring start time of fluorescent lamps.) The following sections describe how the proposed definitions and test procedures for start time harmonize with the ENERGY STAR Start Time Test Methods as well as amendments to these proposals that provide further simplification and clarity.

Definitions

In the July 2015 NOPR, DOE proposed definitions for the terms "start plateau," "percent variability," and "start time." 80 FR 45754. DOE proposed to define the term "start plateau" as the first 100 millisecond period of operation during which the percent variability does not exceed 5 percent and the average measured lumen output is at least 10 percent of the measured initial lumen output. 80 FR 45736. This definition aligns with ENERGY STAR's definition of "initial plateau" as "the point at which the average increase in the light output over time levels out (reduces in slope). This can be determined mathematically or visually based on the lamp output trace."

Both definitions are intended to describe a time interval in which the light output is relatively steady. ENERGY STAR does not specify the method by which such a time interval should be quantitatively and objectively determined. In order to ensure consistent and reproducible measurements, DOE's proposed definition specifies the time period over which lumen output should be steady as 100 milliseconds and described the criteria for light output that must be met during this time period. DOE selected 100 milliseconds to evenly capture either 5 or 6 full cycles of the sampled waveform (for 50 or 60 Hz input voltage, respectively). 80 FR

45736. Section 5.4 of IES LM-28-12 states that by choosing the integrating time to be a multiple of the period of the line frequency (16.67 milliseconds for 60 Hz), for example, 100 milliseconds (6 line cycles for 60 Hz and 5 line cycles for 50 Hz), the effect of flicker for either line frequency can be removed. Id.

Regarding the criteria for determining stability of light output during the first 100 milliseconds, DOE proposed that the percent variability not exceed 5 percent and that the average measured lumen output over the time interval should be at least 10 percent of the measured initial lumen output. The first criterion is intended to quantify when the light output can be deemed "stable." DOE determined that the criterion that the percent variability cannot exceed 5 percent is sufficient to capture a 100 millisecond interval in which light output is steady and subsequently determine an appropriate start time. The second criterion is intended to capture the time at which light output is first detected for a continuous period and ensure that light is actually being created from the lamp (e.g., a stable output of zero if the lamp fails to turn on is not acceptable).

In re-evaluating the latter criterion, DOE found that requiring a specific threshold of light output is unnecessary for the start time metric. According to the test procedures established in this final rule, measured initial lumen output must be determined using the integrating sphere method. Therefore, for comparison purposes, the average lumen output in a 100 millisecond span that occurs during the initial operation of the lamp must also be determined using the integrating sphere method. However, DOE has determined that, due to the precision of the measurement, the integrating sphere may require reconfiguration and additional setup to measure the lumen output in the initial milliseconds of lamp operation. DOE has determined that

including the latter criterion does not merit requiring a potentially complex test setup. Removing this criterion would allow for start time testing to be conducted using either an integrating sphere or non-integrating sphere method such as a photodetector. Therefore, in this final rule, DOE defines "start plateau" to mean "the first 100 millisecond period of operation during which the percent variability does not exceed 5 percent."

To provide further clarity to the definition of "start plateau," DOE proposed to define the term "percent variability" as the range (calculated by subtracting the minimum from the maximum) expressed "as a percentage of the mean for the contiguous set of separate lumen output measurements spanning the specified time period, where each lumen output measurement is the average value of the sampled waveform over an interval corresponding to one full cycle of sinusoidal input voltage." 80 FR 45736.

Because DOE is no longer requiring lumen measurements to determine start plateau, percent variability also does not have to be based on lumen output. Therefore, DOE is replacing the specification of lumen output measurements with light output values. Additionally, DOE is providing a clearer description of calculating a time-average of measured light output values. In summary, in this final rule, DOE is specifying "percent variability" to be "the result of dividing the difference between the maximum and minimum values by the average value for a contiguous set of separate time-averaged light output values spanning the specified time period. For a waveform of measured light output values, the time-averaged light output is computed over one full cycle of sinusoidal input voltage, as a moving average where the measurement interval is incremented by one sample for each successive measurement value."

In the July 2015 NOPR, DOE proposed to define the term "start time" as the time, measured in milliseconds, between the application of power to the CFL and the point when the measured full-cycle lumen output (the average value of the sampled waveform over an interval corresponding to one full cycle of sinusoidal input voltage) reaches 98 percent of the average measured lumen output of the start plateau. 80 FR 45754. ENERGY STAR defines start time as "the time between the application of power to the device and the point where light output reaches 98% of the lamp's initial plateau."

GE commented that from the consumer's perspective the simplest definition for start time is the time between energizing the circuit and the first light output. GE added that the specification of 97 or 96 percent of the plateau was not distinguishable. (GE, Public Meeting Transcript, No. 4 at pp. 68–70)

ENERGY STAR Lamps Specification V2.0 describes start time as the time for a lamp to remain continuously illuminated after applying electrical power. DOE agrees that the start time metric is intended to capture the time of detection of first continuous light output. Hence, the 98 percent threshold is not necessary for representative measurements of start time. Therefore, in this final rule, DOE removes this element from the definition of start time. Additionally, DOE provides a clearer description of the point at which start time should be determined. In summary, DOE defines "start time" to mean "the time, measured in milliseconds, between the application of power to the CFL and the beginning of the start plateau."

Lamp Storage / Operating Cycle Post Seasoning

In the July 2015 NOPR, DOE proposed that, after seasoning, units must be stored at 25 ± 5 °C ambient temperature for a minimum of 16 hours prior to testing, after which the ambient temperature must be 25 ± 1 °C for a minimum of 2 hours prior to testing. DOE also determined that any units that have been off for more than 24 hours must be operated for 3 hours and then be turned off for 16 to 24 hours prior to testing. 80 FR 45736. ENERGY STAR Start Time Test Method prescribes similar specifications with the time period characterized as 20 ± 4 hours.

During the public meeting for the July 2015 NOPR, OSI stated that 16 hours after the lamp is seasoned before testing was atypical for its test laboratories and based on this schedule the time that testing could begin would be outside the normal work schedule. OSI added that the rationale for the 16 hours after seasoning was not well understood. (OSI, Public Meeting Transcript, No. 4 at pp. 73–74) During the public meeting, DOE noted that the proposed storage and operating cycle post seasoning requirements were consistent with ENERGY STAR. (DOE, Public Meeting Transcript, No. 4 at p. 75) OSI acknowledged the ENERGY STAR specification of the 16 hour period, but, stated that ENERGY STAR testing does not represent all of the testing that OSI conducts because not all of their products are submitted to ENERGY STAR. OSI elaborated they did not have a technical justification for or against the time period, but that it could be a potential cost burden. (OSI, Public Meeting Transcript, No. 4 at p. 74) Westinghouse Lighting (Westinghouse) added that the scheduling and subsequent cost issues described by OSI are even more pronounced for them because they use an independent testing laboratory where not all Westinghouse products may be tested at the same time. (Westinghouse, Public Meeting Transcript, No. 4 at pp. 74–76)

The proposed operating cycle ensures that the lamp has been seasoned and recently operated, but not so recently that elements in the recent operation of the lamp could directly affect start time. DOE does clarify in this final rule that the 3 hours that the unit must be operated after being off for more than 24 hours is a minimum of 3 hours. This specification is mainly for clarification purposes; DOE does not find that operating the lamp for a longer period would affect the start time testing. Any units that have been off for more than 24 hours must be operated for a minimum of 3.0 hours and then be turned off for 16 to 24 hours prior to testing. DOE notes that the range of 16 to 24 hours in the off state provides an 8 hour range during which start time testing may begin, which should allow it to be conducted during normal working hours. Therefore, DOE adopts the proposed operating cycle and ambient temperature requirements described in this final rule.

Testing Methodology

For test setup and conditions for measuring start time, DOE proposed in the July 2015 NOPR to reference IES LM-66-14 and IES LM-54-12. 80 FR 45735–45736. DOE proposed to adopt the measurement circuit requirements as specified in section 5.2 of IES LM-66-14 and that lumen output measurements be taken as specified in section 6.3.1 of IES LM-66-14. DOE also proposed to adopt seasoning specifications as provided in sections 4, 5, 6.1, 6.2.2.1of IES LM-54-12. 80 FR 45736. Further, DOE proposed that a multichannel oscilloscope with data storage capability be connected to record the input voltage to the CFL and its lumen output. DOE specified that the oscilloscope must be set to trigger at 10 V lamp input voltage, to have the vertical scale set at a vertical resolution that is 1 percent of measured initial lumen output or finer, and to be set to sample the lumen output waveform at a minimum rate of 2 kHz. Id.

The proposed test setup and conditions generally align with those specified by ENERGY STAR. Section 4(B) of the ENERGY STAR Start Time Test Method references IES LM-66-14 and IES LM-54-12. Section 5.A(2) of the ENERGY STAR Start Time Test Method requires a multichannel oscilloscope with data storage capability and section 7.1(F) also requires to set the trigger level at 10 V. DOE's proposal for a minimum 2 kHz sampling rate is also consistent with the ENERGY STAR requirement for flicker testing,[18] and DOE understands that this requirement would also provide sufficient horizontal resolution for start time testing. DOE did not receive any comments specific to the proposed test setup and conditions for start time. In this final rule, DOE adopts the test setup and conditions as proposed in the July 2015 NOPR.

In the July 2015 NOPR, DOE also proposed that upon the trigger for start time testing, the sampled lumen output waveform must be recorded until the measured lumen output has reached the start plateau. 80 FR 45736. In addition, DOE proposed in the NOPR that the trace of full-cycle lumen output must be calculated as a moving average, whereby values are determined at least once every millisecond and each value represents the full-cycle interval in which it is centered. Id. The August 2013 ENERGY STAR Start Time Test Method provides an example of a light output trace for compact fluorescent lamps. Aligning with ENERGY STAR, DOE's proposed steps provide specifics on recording such a light output trace and how time-averaged values from the light output trace should be calculated. Specifically, in this final rule, DOE states that, upon the trigger for start time testing, the sampled light output must be recorded

[18] ENERGY STAR® Program Requirements Product Specification for Lamps Version 1.0—Light Source Flicker Recommended Practice. August 2013. Washington, DC. www.energystar.gov/sites/default/files/specs//ENERGY%20STAR%20Lamps%20V1%200%20Final%20Test%20Methods%20and%20Recommended%20Practices.pdf

until the start plateau (as defined in this section) has been determined. Additionally, in this final rule, to determine the "percent variability" of light output in accordance with the start plateau definition, DOE requires calculation of a time-averaged light output value at least once every millisecond where each value represents the full-cycle interval in which it is centered. DOE further specifies that, for a waveform of measured light output values, the time-averaged light output is computed over one full cycle of sinusoidal input voltage, as a moving average where the measurement interval is incremented by one sample for each successive measurement value.

Lamp Orientation

In the July 2015 NOPR, DOE proposed that all units be tested in the base up position, but that if the position is restricted by the manufacturer, units would be tested in the manufacturer specified position. 80 FR 45755. Section 5(H) of the September 2015 ENERGY STAR Start Time Test Method states the samples be tested in the orientation(s) as specified by the ENERGY STAR specification or manufacturer specified position if different. It should be noted that ENERGY STAR Lamps Specification V2.0 does not state the testing orientation in section 11.4, Start Time. However, for purposes of consistency, DOE proposed that all units for start time be tested in the base up position, but that if the position is restricted by the manufacturer, units must be tested in the manufacturer specified position. DOE did not receive any comments specific to lamp orientation for start time; and in this final rule adopts the sample unit orientation specification.

Hybrid Lamps

In the July 2015 NOPR, DOE proposed measuring only integrated CFLs for start time, which would include hybrid lamps. 80 FR 45755. DOE also proposed that hybrid CFLs must be tested with all supplemental light sources turned off, if possible. 80 FR 45737.

The EEAs cautioned that having the supplemental light source off during testing could yield inaccurate test results for start time testing. (EEAs, No. 8 at p. 3) NEMA requested the start time test procedure not apply to hybrid CFLs or to not require that the supplementary light source not be operating. (NEMA, No. 9 at p .7) GE also requested that hybrid CFLs be exempt from start time testing because it could lead to inaccurate results because one of the primary functions of hybrid CFLs is to allow for quicker start time through the supplemental light source. (GE, Public Meeting Transcript, No. 4 at pp. 59–60)

DOE has determined that hybrid lamps should not be exempt from the start time test procedure. The March 2016 NOPR proposes a start time metric for medium base CFLs. If a hybrid CFL meets the definition of medium base CFL, then the applicable standard applies to the hybrid CFL. Similarly, ENERGY STAR Lamps Specification V2.0 does not specify different start time requirements for hybrid CFLs. DOE determined that requiring the supplemental light source be off, if possible, is the most consistent manner in which the various combinations of primary and supplementary light sources in hybrid CFLs can be tested. Therefore, in this final rule, DOE retains the requirement that hybrid CFLs be tested for start time with the supplemental light source turned off, if possible.

5. Test Procedures for New CFL Categories

a. Test Procedures for Integrated CFLs

In the July 2015 NOPR, DOE proposed test procedures for integrated CFLs without exclusion of any base type. NEMA, OSI, and Philips requested that DOE exclude E12[19] and GU24-based integrated lamps from the test procedure. All three entities stated that lamps with these bases represented a small portion of the market. (NEMA, No. 9 at pp. 2,8; OSI, No. 5 at p. 7; Philips, No. 6 at p. 3) NEMA and OSI further stated that if a particular lamp has the same technical specifications across lamps with medium, E12, and GU24 base types, then DOE should only require testing on MBCFLs. NEMA and OSI argued that base type does not have any effect on lamp performance. (NEMA, No. 9 at pp. 2, 6; OSI, No. 5 at pp. 2, 5)

Regarding the applicability of the test procedure to integrated lamps with certain base types, DOE notes that the March 2016 NOPR proposed standards for GU24 base integrated lamps. 81 FR 14551. Further, CFLK standards with required compliance in 2019 are applicable to CFLKs packaged with CFLs of all base types. As both of these standards will be supported by this test procedure, DOE is obligated to establish test procedures for CFLs of all base types for the applicable metrics addressed in those rules. Therefore, in this final rule, DOE does not exclude E12 and GU24-base lamps from the test procedures for integrated CFLs.

[19] DOE defines a candelabra base incandescent lamp in 10 CFR 430.2 as a lamp that uses a candelabra screw base as described in ANSI C81.61, Specifications for Electric Bases, common designations E11 and E12 . The base is not specific to the light source, therefore a candelabra base lamp can be either an E11 or E12 base.

Regarding lamps that have the same technical specifications, manufacturers must submit represented values of required metrics for each basic model before distribution in commerce. 10 CFR 429.12(a). Represented values of measures of energy efficiency or energy consumption must be the same for all individual models represented by a given basic model. 10 CFR 429.11(a). However, DOE provides manufacturers with the flexibility to group individual models into basic models for the purposes of certification to DOE, provided that all representations regarding the energy efficiency or energy consumption of CFLs within that basic model are identical and based on the most consumptive unit. See 76 FR 12422, 12423 (March 7, 2011). Therefore, it may be possible to group lamps that have the same technical specifications but different base types into the same basic model. However, all representations within a basic model must have essentially identical electrical, physical, and functional characteristics that affect energy efficiency (see definition of basic model per 10 CFR 430.2). Accordingly, CFLs that are in separate product classes and thereby subject to separate standards (e.g., integrated and non-integrated CFLs) cannot be grouped in the same basic model. Also, DOE does not believe it is appropriate to group models of lamps that have different testing methods as defined in Appendix W into the same basic model as they will not have essentially identical electrical characteristics.

b. Test Procedures for Non-Integrated CFLs

In the July 2015 NOPR, DOE proposed test procedures for non-integrated CFLs. Specifically, DOE proposed adopting section 5.2 of IES LM-66-14 for electrical and photometric testing of non-integrated CFLs, which specifies procedures for determining initial lamp efficacy, lumen maintenance at 40 percent of lifetime, CRI, and CCT. 80 FR 45737. To ensure repeatable and consistent measurements, DOE proposed that non-integrated CFLs must be tested

using the appropriate reference ballasts as provided in section 5.2 of IES LM-66-14, which specifies using reference ballasts specifications listed in ANSI C78.901-2014, "American National Standard for Electric Lamps—Single-Based Fluorescent Lamps—Dimensional and Electrical Characteristics," (hereafter "ANSI C78.901-2014"). Id.

NEMA and OSI agreed with referencing ANSI C78.901-2014 to identify reference ballasts for non-integrated CFLs, but also stated that industry only has experience using reference ballasts for photometry. (NEMA, No. 9 at pp. 6–7; OSI, No. 5 at pp. 5–6) Reference ballast characteristics provide the necessary functionality to operate a non-integrated CFL and a standardized and consistent method of testing non-integrated CFLs. DOE does not find any technical reason why reference ballasts cannot be used for non-photometric measurements. Therefore, in this final rule, DOE requires using reference ballast specifications in ANSI C78.901-2014 to test non-integrated CFLs for all measurements.

In the July 2015 NOPR, DOE noted that certain non-integrated CFL designs do not have reference ballast specifications listed in ANSI C78.901-2014. For these lamp designs, DOE proposed reference ballast specifications. In cases where there are no reference ballast specifications for a lower wattage CFL, DOE proposed the reference ballast specifications of the corresponding full wattage version, if they existed. For all other cases, DOE developed reference ballast specifications by matching the shape, diameter, and base of the CFL without reference ballast specifications to the most similar CFL with specifications that also had the closest wattage. 80 FR 45737. For any non-integrated CFLs that do not have a reference ballast listed in ANSI C78.901-2014 and for which DOE has not specified reference ballast characteristics in appendix W, DOE also specified two principles that must be employed to

determine the appropriate reference ballast specifications. For such a lamp, DOE specified that, manufacturers must use the specifications in ANSI C78.901 2014 for the higher wattage lamp for which it is a replacement; otherwise, use the specifications in ANSI C78.901 2014 for a lamp with the most similar shape, diameter, and base specifications, and next closest wattage. OSI agreed with DOE's proposal to address lamps for which reference ballast characteristics are not specified. (OSI, No. 5 at pp. 5–6) In this final rule, DOE is also specifying the appropriate frequency along with the reference ballast values of current, impedance, and voltage.

To specify a consistent set of testing procedures for non-integrated CFLs, in the July 2015 NOPR, DOE proposed several clarifications and specifications regarding the circuits on which the lamps must be tested. 80 FR 45737. DOE proposed to test non-integrated CFLs rated for operation on a choice of low frequency or high frequency circuits at low frequency only. Id.

GE, NEMA, and OSI stated they were unaware of any dual-frequency reference ballast specifications. (GE, Public Meeting Transcript, No. 4 at pp. 56–57; NEMA, No. 9 at pp. 6–7; OSI, No. 5 at p. 6) NEMA and OSI suggested that DOE require testing at the manufacturer-specified frequency. (NEMA, No. 9 at pp. 6–7; OSI, No. 5 at p. 6) GE stated that, because these products are operating at high frequency in application, testing them at low frequency reference conditions when high frequency reference conditions are available would misrepresent their efficacy. (GE, Public Meeting Transcript, No. 4 at pp. 56–57)

As noted previously, in order to establish a set of consistent specifications and conditions and to follow industry standards for testing non-integrated CFLs, in this final rule, DOE is requiring the use of ANSI C78.901-2014 for reference ballast values per IES LM-66-14. There

are certain lamps for which ANSI C78.901-2014 provides details for both low and high frequency operation. For example, a 36 W T5 single-based fluorescent lamp on datasheet 78901-ANSI-4019-1 provides reference ballast characteristics for low frequency operation and also information on high frequency ballast design. Manufacturers must use the values designated as "reference ballast characteristics" when testing lamps. If more than one set of values is designated as "reference ballast characteristics," then manufacturers must use the values designated for low frequency operation. DOE reviewed the reference ballast specifications for non-integrated CFLs and found that the majority are specified for low frequency operation. Therefore, in this final rule, in order to maintain consistency and comparability across testing, DOE continues to require operating on low frequency where reference ballast characteristics for both low and high frequency operation are provided.

DOE also proposed in the July 2015 NOPR that non-integrated CFLs rated for multiple circuits including rapid start (i.e., rapid start and either preheat start or instant start) be tested on rapid start circuits when rapid circuits are an option to ensure consistent measurements. 80 FR 45737.

NEMA and OSI disagreed with the requirement to use rapid start circuits. Both NEMA and OSI stated that rapid start circuits have not typically been used in testing of non-integrated CFLs and expressed concerns regarding how the testing would relate to certification, compliance, and enforcement. (NEMA, No. 9 at pp. 6–7; OSI, No. 5 at p. 6) GE indicated that a rapid start circuit would include cathode heat while use of a programmed start circuit would exclude cathode heat. GE explained that testing without cathode heat is the most representative of the current applications. GE further added that including cathode heat would decrease the

apparent lamp efficacy, and not be reflective of how the product is used. (GE, Public Meeting Transcript, No. 4 at pp. 56–58)

In reviewing the reference circuits specified for lamps, DOE has decided to modify its proposed specifications for reference circuits on which non-integrated CFLs must be tested in this final rule. In the July 2015 NOPR, DOE proposed to specify that a rapid start reference circuit be used when a non-integrated CFL is rated for multiple circuits in order to establish a consistent set of test specifications. In preparation for this final rule, DOE reviewed the reference ballast specifications for non-integrated CFLs and found that most lamps are rated for preheat circuits. DOE found that if a lamp was rated for multiple circuits, further specifications still may be needed to indicate the circuit to use for testing. If a lamp is rated for operation on both a preheat and high frequency circuit, the reference ballast characteristics provided describe low frequency operation and therefore the lamp must be tested on the low frequency preheat circuit. If a lamp is rated for operation on both a preheat and rapid start circuit, DOE is specifying in this final rule that the lamp be tested on the preheat circuit in order to maintain consistency and comparability across testing.

In this final rule, DOE is not adopting test procedures for lumen maintenance at 1,000 hours or rapid cycle stress test for non-integrated CFLs, as these metrics are not being evaluated for inclusion in, nor are they currently required by, any DOE energy conservation standards, FTC Lighting Facts labeling requirements, or ENERGY STAR program requirements. Therefore, in this final rule, DOE adopts test procedures for initial lamp efficacy, lumen maintenance at 40 percent of estimated lifetime, lifetime, CRI, and CCT for non-integrated CFLs.

c. Test Procedures for Hybrid CFLs

In the July 2015 NOPR, DOE proposed establishing a test procedure to measure the applicable metrics for hybrid CFLs in appendix W. That is, DOE proposed that the same test procedures for integrated CFLs would be applicable to hybrid CFLs, with a few minor clarifications regarding the configuration and operation of hybrid CFLs during testing. DOE considers hybrid CFLs to be CFLs with an additional light source of a different technology that is not the primary source of light. DOE proposed to define the term "hybrid compact fluorescent lamp" in appendix W as a CFL that incorporates one or more supplemental light sources of different technology. 80 FR 45737–45738. NEMA and OSI proposed the definition of "a compact fluorescent lamp that incorporates one or more supplemental light sources of different technology, such as halogen or LED, which are energized and operated independently and may or may not operate simultaneously." (NEMA, No. 9 at p. 7; OSI, No. 5 at p. 6) OSI stated that there are different types of hybrid lamps where either the main or the supplemental light source operates or both the main and supplemental light sources operate. OSI requested that both the definition and related test procedures address these different possible configurations of hybrid lamps. (OSI, Public Meeting Transcript, No. 4 at p. 59)

DOE reviewed the definition suggested by NEMA and OSI and notes that there is significant overlap between DOE's proposed definition and the alternate definition. Both definitions contain a reference to a CFL as well as supplemental technologies. DOE finds that the example "such as halogen or LED" is not necessary, as the DOE's proposed definition specifies that the supplemental light sources would be of "different technology." Further providing such examples may be misinterpreted by some users to limit the types of applicable supplementary sources. NEMA and OSI's other suggestion of "which are energized and

operated independently and may or may not operate simultaneously" identifies potential operating configurations of the supplementary light sources. By not specifying any configurations for the operation of the supplementary light source, DOE's proposed definition does not exclude the configurations mentioned by NEMA and OSI or any others. DOE's proposed definition is also consistent with industry definitions of other hybrid technologies such as a hybrid LED luminaire as defined in IES RP-16-10, which also does not identify the operating parameters of the different light sources. For these reasons, DOE retains the proposed definition from the July 2015 NOPR of the term "hybrid compact fluorescent lamp" as meaning a CFL that incorporates one or more supplemental light sources of different technology. DOE believes that this is consistent with the definition suggested by interested parties, but is more general and leaves less room for misinterpretation of specific examples or operating parameters.

In the July 2015 NOPR, DOE proposed a test procedure for hybrid CFLs where the supplemental light source is off (if possible) and the lamp stabilized. Id. In response to the proposal, the EEAs encouraged DOE to incorporate language defining a not-to-exceed time to stabilization prior to taking measurements to prevent extended periods of operation of secondary sources. (EEAs, No. 8 at p. 3)

DOE's test procedure for hybrid CFLs requires that the supplementary source be turned off before initiating testing. In the cases where supplementary source cannot be turned off, the lamp must adhere to stabilization criteria as specified in section 6.2.1 of IES LM-66-14. This stabilization criteria involves a series of time-related measurements to determine stable light output and electrical usage. Although the supplementary source may have some effect on the stabilization time, it is more important that the lamp achieve stabilization per an established

criterion in order to obtain accurate measurements. Further, the determination of a stable light output will likely be predominantly influenced by the CFL, which is the primary source of light. Therefore, in this final rule, DOE is not adding a not-to-exceed time for stabilization for taking measurements of hybrid CFLs.

NEMA was supportive of DOE's proposed test procedure for hybrid lamps. However, NEMA requested that start time not apply to hybrid CFLs. NEMA added that if start time testing was required for hybrid CFLs, the supplementary light source should be turned on. NEMA agreed with DOE's proposal to test hybrid CFLs as non-hybrid CFLs (that is with only the CFL source active) for any measurements besides start time. (NEMA, No. 9 at p .7) The EEAs disagreed with DOE's proposal that hybrid lamps be tested for efficacy with the supplemental light source turned off. The EEAs argued that having the supplemental light source off during testing could yield inaccurate test results for both start time testing and energy efficiency. (EEAs, No. 8 at p. 3) DOE addressed start time testing in section III.A.4.d. DOE disagrees with the EEAs that testing hybrid CFLs with the supplemental light source off (when possible) would yield inaccurate results for energy efficiency. Testing the hybrid CFL with only the CFL light source operating (when possible) would yield comparable efficacy measurements across basic models of CFLs. Further, based on a review of available hybrid CFLs, DOE has determined that many supplemental light sources turn off automatically or will likely be turned off during normal operation (such as when the supplemental light source is intended to be a night light). Thus, DOE's test procedure is representative of lamp operation under normal conditions.

In this final rule, DOE adopts a requirement that hybrid CFLs must be tested with all supplemental light sources turned off, if possible, and that the lamp be stabilized in the operating

mode that corresponds to its primary light source, according to test procedures for CFLs in appendix W.

6. Test Procedure for Standby Mode Energy Consumption

In the July 2015 NOPR, DOE proposed a test procedure to measure standby mode energy consumption for integrated CFLs, where applicable, in appendix W. 80 FR 45738. EPCA directs DOE to amend its test procedures for all covered products to incorporate a measure of standby and off mode energy consumption in accordance with IEC 62301 and IEC 62087, if technically feasible. (42 U.S.C. 6295(gg)(2))

DOE research indicated that some integrated CFLs include controls, and that these CFLs can operate in standby mode but not off mode. DOE did not find any non-integrated CFLs capable of operation in standby mode or off mode, and understands that any such circuitry would likely be found in the ballast rather than the lamp. Therefore, in the July 2015 NOPR, DOE proposed that standby mode power be measured only for integrated CFLs that are capable of standby mode operation. 80 FR 45738.

For integrated CFLs, DOE proposed that standby mode power be measured in accordance with IEC 62301. DOE also proposed to approve IEC 62301, which is already incorporated by reference in 10 CFR 430.3, for incorporation into appendix W. DOE proposed that, when measuring standby power for integrated CFLs, the test conditions and setup must be as prescribed in IEC 62301, except for ambient temperature and ambient airflow. Instead, DOE proposed to prescribe the ambient temperature and ambient airflow requirements in IES LM-66-14 to minimize differences between test procedures for active mode and standby mode.

DOE proposed to season lamps in the same manner as test procedures for the other applicable CFL metrics, as described in section III.A.2.e, and to measure standby mode power as prescribed in section 5 of IEC 62301. Finally, DOE proposed that standby mode be initiated when the integrated CFL is connected to the power supply and lumen output is set to zero via remote or other wireless/sensor control. 80 FR 45738.

NEMA and OSI commented that, according to the definition proposed in the July 2015 NOPR, CFLs operate in the off mode when switched off. They also stated that off mode consumes no power nor produces any function. (NEMA, No. 9 at p. 7; OSI, No. 5 at p. 6)

DOE determined that it is not possible for CFLs to meet the off mode criteria because there is no condition in which a CFL is connected to main power and is not already in a mode accounted for in either active or standby mode. That is, DOE is not aware of any CFLs that, when provided with power, are not operating in active mode (i.e., illuminated) or standby mode (i.e., facilitating the activation or deactivation of active mode via remote switch, internal sensor, or timer). In response to the specific example raised by NEMA and OSI, a CFL that is switched off is not connected to a main power source because the circuit is disrupted at the switch and thus power is not being provided to the CFL. Therefore, in this final rule, DOE retains the position that CFLs do not operate in off mode and has not considered test procedures for such modes of operation.

NEMA, Philips, and OSI also requested that DOE explicitly exclude CFLs that are not designed with standby operation from standby mode power measurements. (NEMA, No. 9 at p. 7; OSI, No. 5 at p. 6; Philips, No. 6 at p. 4) DOE agrees with NEMA, OSI, and Philips that only

integrated CFLs capable of operating in standby mode should be tested for standby mode energy consumption. In the July 2015 NOPR, DOE proposed regulatory language for measuring standby power in appendix W that stated standby mode energy consumption should be measured only for integrated CFLs that are capable of standby mode operation. 80 FR 45755. For further clarity, in the final rule DOE has moved this instruction to the beginning of the regulatory text for the standby mode test procedure in appendix W.

DOE received comments from CA IOUs to harmonize testing for standby mode operation with the LED lamps test procedure.[20] (CA IOUs, No. 7 at pp. 4–5) The CA IOUs wanted to ensure that lamps capable of operation in network mode were tested in network mode. (CA IOUs, No. 7 at pp. 4–5) Specifically, CA IOUs requested that DOE define network mode and suggested that if a product is designed to be connected to a wireless network in order to fully operate, then the test procedure should specify that the lamp is to be connected to the network before testing begins. Connected lamps may require the use of an external control system or hub to serve as a communication point between the lamp and end user, and the CA IOUs asked DOE to specify a maximum permissible distance the control system can be from the lamp during testing. (CA IOUs, No. 7 at pp. 4–5) The EEAs were supportive of the CA IOUs comments. (EEAs, No. 8 at pp. 5–6)

[20] Information regarding the Light-Emitting Diode Lamps Test Procedure Rulemaking can be found on regulations.gov, docket number EERE-2011-BT-TP-0071 at www.regulations.gov/#!docketDetail;D=EERE-2011-BT-TP-0071.

DOE agrees that the test procedure needs additional detail to specify that lamps capable of operation in standby mode must remain connected to the external wireless network through the entirety of the test for standby mode energy consumption. If the lamp becomes disconnected, the lamp may exit standby mode or otherwise have its power draw affected, which would yield inaccurate test results. Therefore, in this final rule DOE is adding detail to section 4 of appendix W to specify that integrated CFLs capable of connecting to a communication network must be connected to the network prior to testing and must remain connected throughout the duration of the test. DOE did not specify a maximum distance the integrated CFL can be from the control system or hub during testing because DOE believes the requirement for the integrated CFL to remain connected throughout the entire duration of the test ensures that, if an integrated CFL is moved to a distance such that it disconnects from the communication network, the test results would be invalid.

CA IOUs also commented that connected lamps may experience cycles or power fluctuations when lamps are communicating with the wireless network, and requested the test procedure provide instructions to account for this in an average power metric over a minimum 5-minute test duration. (CA IOUs, No. 7 at pp. 4–5) The EEAs were supportive of the CA IOUs comments. (EEAs, No. 8 at pp. 5–6)

DOE is requiring that standby mode measurements be taken as specified in section 5 of IEC 62301. DOE notes that section 5 of IEC 62301 gives manufacturers the flexibility to choose the measurement method that best applies to the nature of their products' power supply. Further, each of the methods available for use in IEC 62301 specifies that the product must have test durations of at least 10 minutes, which is an adequate test duration to ensure wattage fluctuations

have been recorded. IEC 62301 also states that data collection at equal intervals of 0.25 seconds or faster is recommended for loads that are unsteady or where there are any regular or irregular power fluctuations. DOE finds that the measurement instructions provided in section 5.0 of the IEC 62301 appropriately account for any potential power fluctuations, and is not specifying additional instructions regarding measurement of standby mode power.

In addition, DOE is clarifying in this final rule that standby mode testing must be conducted prior to testing for time to failure. DOE is also clarifying that ambient conditions, power supply, electrical settings, and instrumentation must be the same as used for active mode testing. These clarifications are intended to ensure that test conditions will be as consistent as possible.

7. Rounding Values

In the July 2015 NOPR, DOE proposed amending certain rounding requirements for existing metrics, as DOE found the existing rounding requirements for individual units in a given test sample to be inconsistent with the required standard level for some metrics. For example, although final values for lumen maintenance at 1,000 hours and lumen maintenance at 40 percent of lifetime must be rounded to whole numbers, existing standards for lumen maintenance at 1,000 hours (90.0 percent) and lumen maintenance at 40 percent of lifetime (80.0 percent) are specified to the tenth of a percent in 10 CFR 430.32(u). In the July 2015 NOPR, DOE also proposed to move the rounding requirements from appendix W to 10 CFR 429.35. 80 FR 45738.

DOE noted in the July 2015 NOPR that the rounding requirements for lumen maintenance measurements are to the nearest tenth for integrated CFLs, and proposed the same

requirement for non-integrated CFLs. Id. Both NEMA and OSI recommended that lumen maintenance be rounded to the nearest whole number. (NEMA, No. 9 at p. 8; OSI, No. 5 at p. 7) NEMA further stated that rounding lumen maintenance to the nearest tenth of a percent is not practical or meaningful. (NEMA, No. 9 at p. 8) DOE notes that the lumen maintenance value of the standard is to the tenth of a percent and was established in the 2006 rule that adopted standards for MBCFLs. 71 FR 71340, 71369 (Dec. 8, 2006). DOE understands that at least 3 significant figures are required in both the numerator (maintained lumens) and denominator (initial lumens) to yield 3 significant figures for lumen maintenance values. DOE reviewed product catalogs currently published by OSI and several other CFL manufacturers and determined that lumen output values are often reported to 3 or 4 significant figures. Therefore, DOE has concluded that it is possible to determine lumen maintenance to the nearest tenth of a percent. To align with existing standards, in this final rule, DOE provides in 10 CFR 429.35 that lumen maintenance at 1,000 hours and lumen maintenance at 40 percent of lifetime must be rounded to the nearest tenth of a percent.

In the July 2015 NOPR, DOE proposed that lifetime of a CFL be rounded to the nearest hour and that these requirements be located in 10 CFR 429.35. 80 FR 45738. Both NEMA and OSI argued that lifetime should be rounded to two significant digits. (NEMA, No. 9 at p. 8; OSI, No. 5 at p. 7) NEMA further stated that expressing lifetime to the nearest hour is meaningless, as the uncertainty in an individual time-to-failure measurement is much larger than 1 hour. (NEMA, No. 9) However, rounding to the nearest whole hour is consistent with the unit of time

used for lifetime metrics for other lamp technologies, such as LED,[21] and is a level of accuracy a laboratory is capable of measuring with a standard time-keeping device. In this final rule, DOE adopts a rounding requirement to the nearest whole hour for lifetime. DOE notes that manufacturers can make representations of lifetime to the nearest two significant digits provided that the value is lower than the actual measured lifetime when rounded to the nearest hour (i.e., manufacturers are reporting a conservative value for lifetime).

DOE did not receive any comments on the proposal to round initial lamp efficacy values to the nearest tenth of a lumen per watt, input power to the nearest tenth of a watt, lumen output to three significant digits, or rapid cycle stress values to whole numbers. Therefore, in this final rule, DOE adopts these requirements.

Additionally, in the July 2015 NOPR, DOE proposed rounding requirements for new proposed metrics of CRI, CCT, start time, standby mode power, and power factor based on industry standard reporting precision, as determined based on a review of manufacturer catalogs. DOE also proposed locating those rounding requirements in 10 CFR 429.35. 80 FR 45738. DOE did not receive any comments related to this proposal. Therefore, in this final rule, DOE adopts the rounding requirements for these metrics as proposed in the July 2015 NOPR, specifically: CRI be rounded to the nearest whole number; start time be rounded to the nearest whole number in milliseconds; CCT be rounded to the nearest 100 K; standby mode power

[21] See LED final rule test procedure. 81 FR 43404 (July 1, 2016).

rounded to the nearest tenth of a watt; and power factor be rounded to the nearest hundredths place.

B. Amendments to Definitions at 10 CFR 430.2

1. Compact Fluorescent Lamp

In the July 2015 NOPR, DOE proposed to add a definition of "compact fluorescent lamp" in 10 CFR 430.2. 80 FR 45738-45739. DOE reviewed its definitions for other lighting products and considered the existing definition of the term "fluorescent lamp" at 10 CFR 430.2 as a basis for its definition of "compact fluorescent lamp." DOE also consulted the current IES definition of "compact fluorescent lamp" contained in IES RP-16-10 and the description of compact fluorescent lamps in IES LM-66-14, which includes elements of the lamp characteristics and discusses elements of light output generation. During the public meeting for the July 2015 NOPR, OSI inquired why DOE did not adopt the IES RP-16-10 definition rather than developing a novel definition for compact fluorescent lamp. (OSI, Public Meeting Transcript, No. 4 at pp. 16 -20) Lucidity Lights stated that IES labors over the exact wording in definitions and also encouraged DOE to use the exact wording in IES RP-16-10. (Lucidity Lights, Public Meeting Transcript. No. 4 at p. 22) Both NEMA and OSI also recommended that DOE use definitions from or reference IES RP-16-10. (NEMA, No. 9 at p. 5; OSI, No. 5 at pp. 2–3) NEMA stated that the proposed definition for CFL was technically correct, but raised concern that it expanded the scope of the definition. (NEMA, No. 9 at p. 8)

DOE appreciates the work that members of the IES did in developing the definitions in IES RP-16-10. DOE reviewed IES RP-16-10 and IES LM-66-14 in developing this final rule. DOE considered: (1) use of the term fluorescent lamp; (2) tube diameter; (3) general features

(i.e., amalgam, cold chamber); (4) lamp geometry; and (5) base specification and lamp configuration in the definition. The following paragraphs provide additional details on each of these elements.

The definition of CFL in section 6.5.6.1.4 of IES RP-16-10 includes the phrase "a fluorescent lamp with…" DOE cannot use this element in 10 CFR 430.2 to define a CFL because 10 CFR 430.2 already defines the term fluorescent lamp, which establishes a fluorescent lamp as a low pressure mercury electric-discharge source in which a fluorescent coating transforms some of the ultraviolet energy generated by the mercury discharge into light, and is limited to six specific lamps, all of which are longer than 22 inches and are double ended. If DOE adopted a definition of CFL that contained the term "fluorescent lamp," it would include these large lamp lengths and base configurations that are not CFLs.

The definition of CFL in IES RP-16-10 also specifies that the diameter of the lamp's tube must be less than or equal to that of a T5. However, DOE's review of ANSI standards and manufacturer's lamp marketing materials indicated that there are CFLs with tube diameters greater than T5. Specifically, ANSI C78.901-2014 includes within their list of data sheets a handful of "square" shaped CFLs that are listed with a corresponding T6 tube diameter. DOE also found manufacturer data sheets of lamps greater than T5 in diameter that were single-ended and folded or bent fluorescent lamps and characterized as CFLs. Therefore, DOE determined that diameter could be a limiting specification that may exclude lamps that should be categorized as CFLs. Therefore, in this final rule, DOE does not include specification of the tube diameter in the definition of "compact fluorescent lamp."

The IES RP-16-10 definition also states that the lamp designs generally include amalgam and a cold chamber, or a cold spot, to control the mercury vapor pressure and light output. These features are general and not distinctive for all CFLs. Therefore, in this final rule, DOE does not include this description in the definition of "compact fluorescent lamp."

The IES RP-16-10 definition of "compact fluorescent lamp" specifies that tube construction must be glass and describes the configuration of the glass tube as folded, bent, or bridged to create a long discharge path. The IES LM-66-14 description of fluorescent lamps notes that a fluorescent lamp can be made compact in two ways. Fluorescent lamps with electrodes (typically long, tubular lamps) can be made compact by folding the tube one or more times or spiraling it in a helix in such a way that both electrodes are configured to have one connection, leading to single base construction. IES LM-66 also notes that induction-driven electrodeless fluorescent lamps are compact because the discharge current is required to form a closed loop inside the structure. Because fluorescent lamps with a compact size do not necessarily include a glass tube with a specific geometry, DOE does not add such a description to the definition of "compact fluorescent lamp."

Both of the introductory sections of IES LM-65-14 and LM-66-14 discuss that there are two types of CFLs: integrated and non-integrated. Further, the titles of both IES LM-65-14 and LM-66-14 contain the phrase "single-based." DOE agrees with these IES documents in the importance of clarifying that CFLs are integrated or non-integrated and single-based. Therefore, DOE retains those terms in the definition of "compact fluorescent lamp" adopted in this final rule. IES LM-66-14 also specifically excludes U-shaped and circline fluorescent lamps from its CFL definition. DOE agrees with IES LM-66-14 that U-shaped and circline lamps are not CFLs.

Therefore, to ensure such lamps are not inadvertently misclassified, DOE also retains these exclusions in the definition of "compact fluorescent lamp" adopted in this final rule.

In summary, DOE has incorporated language from IES RP-16-10 and IES LM-66-14 that helps clearly define CFLs without erroneously excluding or including lamps. In this final rule, DOE defines a compact fluorescent lamp (CFL) as an integrated or non-integrated single-base, low-pressure mercury, electric-discharge source in which a fluorescing coating transforms some of the ultraviolet energy generated by the mercury discharge into light; the term does not include circline or U-shaped lamps.

2. Correlated Color Temperature

In the July 2015 NOPR, DOE proposed modifying the definition of "correlated color temperature" in 10 CFR 430.2 by adding the abbreviation "CCT." DOE explained that a similar abbreviation exists in 10 CFR 430.2 for the definition of color rendering index or CRI. The abbreviation "CCT" is widely used in industry as well as by ENERGY STAR and in 10 CFR part 430, subpart B, appendix R. 80 FR 45739.

Both NEMA and OSI submitted written comments in support of the proposed change. (NEMA, No. 9 at p. 8; OSI, No. 5 at p. 7) OSI also suggested that DOE harmonize the definition with IES RP-16-10. (OSI, Public Meeting Transcript, No. 4 at pp. 16–19) Section 4.6.4.2 of IES RP-16-10 defines "correlated color temperature of a light source" as the absolute temperature whose chromaticity most nearly resembles that of the light source. Other than the added abbreviation of "or CCT" and the phrase "of a light source," DOE's definition (defined by EPCA) is the same as IES RP-16-10. Therefore, in this final rule, DOE adopts the abbreviation

"CCT" into the term "correlated color temperature" and makes no other changes to the definition.

3. Lifetime of a Compact Fluorescent Lamp

DOE proposed to define "lifetime of a compact fluorescent lamp" in 10 CFR 430.2 as the time to failure of 50 percent of the sample size (as defined and calculated in 10 CFR 429.35(a)(1)) in accordance with the test procedures described in section 3.3 of appendix W. 80 FR 45733.

NEMA and Philips raised concerns that replacing "average rated life" with "lifetime of a compact fluorescent lamp" might result in unintended consequences; specifically, lumen maintenance of a lamp could not be determined until the lamp's lifetime is known. (NEMA, No. 9 at pp. 4–5; Philips, No. 6 at p. 4) DOE addresses lumen maintenance measurements in section III.A.4.a.

NEMA proposed replacing "average rated life" with "rated life," noting that the latter term appears in the CFR and is similar to the term "rated lamp life" defined in "Nomenclature and Definitions for Illuminating Engineering" from the IES (IES RP-16). NEMA stated the determination of lifetime should be independent of a specific sample size and allow for the use of more stable statistical estimators of the population median value than failure of 50 percent of the sample. Therefore, NEMA recommended that DOE define "rated life" as median time to failure of the population of CFLs. For further support, NEMA stated that EPCA defines "life" and "lifetime" as the length of operating time of a statistically large group of lamps between first use and failure of 50 percent of the group. NEMA also cited the IES Lighting Handbook which

states in section 13.3 that for incandescent, fluorescent, and HID lamps, rated lamp life is the total operating time at which, under normal operating conditions, 50% of any large group of initially installed lamps is expected to have failed. This is a statistically determined estimate of the median operational life. NEMA stated that by adopting the definition in the IES Lighting Handbook, DOE would indicate that the lifetime is the median value of a large group of lamps and is statistically determined. NEMA also noted that DOE should not restrict the sample size to a multiple of two if statistical estimation of the population median value is accepted. (NEMA, No. 9 at pp. 4-5, 10)

OSI also proposed the term "rated life" citing 10 CFR part 430 and IES RP-16-10. OSI agreed with NEMA that lifetime should be determined independent of a specific sample size. OSI recommended a definition similar to the one in the IES Lighting Handbook, defining rated life as the total operating time at which, under normal operating conditions, 50 percent of any large group of initially installed lamps is expected to have failed, referencing the historic ENERGY STAR and IES definition. (OSI, No. 5 at pp. 4–5)

In general, NEMA and OSI stated lifetime is poorly estimated by the arithmetic mean of the time to failure of the two middle sample units when sorted in order. (NEMA, No. 9, p. 10; OSI, No. 5 at p. 9) During the public meeting for the July 2015 NOPR, both GE and Westinghouse stated the middle value of a sample was a poor indicator of the median and instead recommended using an entire population. (GE, Public Meeting Transcript, No. 4 at pp. 14–15, 25–26; Westinghouse, Public Meeting Transcript, No. 4 at pp. 15–16) GE added that the intent of the statutory language was to indicate a median value for lifetime, that DOE has the opportunity to clearly specify this and, further, that this value should represent 50 percent failure

of the population to align with the industry standard for rated lifetime of lamps. (GE, Public Meeting Transcript, No. 4 at pp. 25–26)

DOE understands that the IES Lighting Handbook and EPCA describe "rated lamp life" and "lifetime"/"life" to be based on a large group of lamps rather than a specific number of lamps. Further, the IES Lighting Handbook states that "rated lamp life" is when 50 percent of any large group of lamps is expected to have failed and that it is a statistically determined estimate of the median operational life. However, DOE notes that it must prescribe test procedures that provide consistent and reproducible results, and allow for comparison of represented values across basic models. Therefore, rather than allow any number of lamps to be used to determine the represented value of lifetime, DOE must specify a minimum sample size.

Commenters did not suggest a specific minimum sample size, and as proposed in the July 2015 NOPR, DOE is adopting a minimum sample size of 10 for testing the initial lamp efficacy, lumen maintenance at 1,000 hours, lumen maintenance at 40 percent of lifetime, lifetime, CCT, CRI, power factor, and standby mode power. DOE is requiring that the same sample of 10 units be used for testing these metrics, and that a minimum of three units from the same sample of units be tested for start time. (Due to the nature of the test, a unique sample set is required for rapid cycle stress testing.) Each of these metrics contribute to the overall performance of a CFL, and because they are fundamentally related, directly and/or indirectly impact each other. Therefore, the same set of sample units and sample size should result in more accurate measurements of all metrics, including lifetime. Manufacturers may, at their discretion, use a larger sample size to determine a representative value of lifetime if they believe it is warranted. However, the same sample set and size must also be used for testing initial lamp efficacy, lumen

maintenance at 1,000 hours, lumen maintenance at 40 percent of lifetime, lifetime, CCT, CRI, power factor, and standby mode power; the total number of units in the sample set must be a multiple of two; and a minimum of three units from the sample set must be used for start time. If the same sample of units is not available for the testing of additional metrics for an existing model, the basic model must be retested using the same sample set for all metrics.

DOE notes that the statutory definition of lifetime does not include any mention of a statistical method that can be used and DOE is hesitant to allow for any statistical method to determine lifetime. Commenters did not provide explicit suggestions regarding any applicable statistical methods in their comments. In addition, neither the IES Lighting Handbook nor any other industry standard provides a specific statistical method that should be used to determine the lifetime of compact fluorescent lamps. Further, DOE notes that the median of a sample is a robust statistical descriptor of the central tendency of the sample (and thereby the population) that deals well with outlier values, which may be the case in lifetime testing of CFLs. Although other statistical tools can be used to describe the variance about the median or estimate adjusted median values if other attributes about the population are known (e.g., the distribution is a Pareto distribution or a weighted median if the precision of each data point is known and is significantly variable), these more advanced statistical tools are unnecessary, as they would not provide a better description of the expected lifetime of the lamp, as defined by EPCA, than the median value.

Therefore, DOE finalizes its proposal in the July 2015 NOPR, that lifetime of a CFL be calculated as the operating time between first use and failure of 50 percent of the sample units; the sample size must be at least 10 units; and the represented value of lifetime must be the

median time to failure of the sample (calculated as the arithmetic mean of the time to failure of the two middle sample units when the numbers are sorted in value order). DOE believes that this definition provides the appropriate specificity to produce consistent and repeatable results while aligning with EPCA's definition of "lifetime" and "life" as the "length of operating time of a statistically large group of lamps between first use and failure of 50 percent of the group." In order to provide a clear and consistent test procedure, DOE specifies "group" as a minimum sample size of 10 units for CFLs, but reiterates that manufacturers are not prevented from testing significantly more than 10 CFLs provided the total number tested is a multiple of two.

C. Amendments to Materials Incorporated by Reference at 10 CFR 430.3

In the July 2015 NOPR, DOE proposed to incorporate by reference ANSI C78.901 – 2014, IES LM-54-12, IES LM-65-14, and IES LM-78-07 industry standards and to extend the incorporation by reference of CIE 13.3-1995, CIE 15:2004, IES LM-66-14, and IEC 62301 into DOE's test procedure for CFLs in appendix W.

As noted in section III.A.1, DOE proposed in the July 2015 NOPR to incorporate by reference IES LM-54-12, IES LM-65-14, and IES LM-66-14 for appendix W for seasoning, time to failure measurements, and electrical and photometric measurements respectively. 80 FR 45727. In response to this proposal, both NEMA and OSI agreed with the incorporation of IES LM-54-12, IES LM-65-14, and IES LM-66-14. (NEMA, No. 9 at pp. 3, 8; OSI, No. 5 at pp. 2–3) The CA IOUs noted that the IES LM-54-12 removes the requirement of cycling during seasoning for metrics other than lifetime and did not agree with DOE's proposal to, accordingly, also remove the cycling requirements in its test procedure. (CA IOUs, No. 7 at p. 3) DOE is requiring cycling for all metrics, see section III.A.1 for further details. In this final rule, DOE

incorporates by reference these test methods into 10 CFR 430.3 for appendix W or extends the incorporation by reference of these test procedures to appendix W.

As noted in section III.A.2.a, DOE also proposed in the July 2015 NOPR to incorporate by reference IESNA LM-78-07 for appendix W for measurements using an integrating sphere photometer. 80 FR 45731. DOE did not receive any comments related to incorporating IESNA LM-78-07. Therefore, in this final rule, DOE incorporates by reference this test method into 10 CFR 430.3 for appendix W.

As noted in section III.A.4.a, in the July 2015 NOPR DOE proposed incorporating CIE 13.3-1995 and CIE 15:2004 (3rd edition) for appendix W for measuring and calculating CRI and CCT respectively. 80 FR 45739. The CA IOUs were supportive of incorporating by reference both CIE 13.3-1995 and CIE 15:2004 (3rd edition). (CA IOUs, No. 7 at pp. 3–4) Therefore in this final rule, DOE extends the incorporation by reference of these test procedures to appendix W.

As noted in section III.A.5.b, in the July 2015 NOPR DOE proposed incorporating by reference ANSI C78.901-2014 for appendix W to include reference ballast specifications for non-integrated CFLs. 80 FR 45739. NEMA supported incorporating by reference ANSI C78.901-2014. (NEMA, No. 9 at pp. 6–7) Therefore in this final rule, DOE incorporates by reference this industry standard into 10 CFR 430.3 for appendix W.

As noted in section III.A.6, in the July 2015 NOPR, DOE proposed incorporating by reference IEC 62301 for appendix W for measuring standby mode energy consumption. 80 FR

45739. DOE did not receive any comments related to this proposal. DOE notes that 10 CFR 430.3 presently has two different versions of IEC 62301 incorporated. DOE is extending the incorporation by reference of the edition 2.0, 2011-01 version of IEC 62301 to appendix W.

D. Amendments to 10 CFR 430.23(y)

In the July 2015 NOPR, DOE proposed to revise and add text at 10 CFR 430.23(y) to reflect other proposed changes to the scope and applicability of DOE's CFL test procedures. 80 FR 45739. Specifically, the existing text at 10 CFR 430.23(y) indicates that, for MBCFLs, the initial lamp efficacy, lumen maintenance at 1,000 hours, lumen maintenance at 40-percent of rated life, and lamp life must be measured, and the rapid cycle stress test conducted, in accordance with section 4 of appendix W of this subpart. DOE proposed to delete the text "medium base" to reflect the inclusion of additional CFL categories. Id. In addition, in the July 2015 NOPR, DOE also proposed to specify in 10 CFR 430.23(y) the relevant sections of appendix W to be used to measure the following metrics: initial lamp efficacy, lumen maintenance at 1,000 hours, lumen maintenance at 40 percent of lifetime, CRI, CCT, power factor, time to failure, rapid cycle stress test, start time, and standby mode energy consumption. 80 FR 45739-45740.

Both NEMA and OSI submitted comments requesting that DOE retain the term "medium base" in the title of the term because they did not think non-integrated CFLs should be part of the test procedures. (NEMA, No. 9 at p.7; OSI, No. 5 at p. 6) DOE did not receive any other comments related to this proposed modification. As DOE has stated previously, the test procedures that are the subject of this final rule address integrated and non-integrated CFLs in support of existing and potential standards, as well as requirements of FTC's Lighting Facts

Label and ENERGY STAR Program Requirements for Lamps and Luminaires (see section II for further details). Therefore, in this final rule, DOE is removing the reference to "medium base" and specifying all applicable metrics for CFLs.

E. Amendments to Laboratory Accreditation Requirements at 10 CFR 430.25

In the July 2015 NOPR, DOE proposed to amend 10 CFR 430.25 to extend the laboratory accreditation requirements for MBCFL testing to additional CFL categories and metrics covered under the proposed new and amended test procedures. 80 FR 45740. Specifically, DOE proposed to replace the text "medium base compact fluorescent lamps" with the text "compact fluorescent lamps" and specify that if a manufacturer's or importer's laboratory is accredited, it may conduct the applicable testing. Id.

NEMA and OSI raised concerns that expanding testing in an accredited lab from MBCFLs to all CFLs would increase the testing burden, adding that non-integrated CFLs typically are not tested in accredited laboratories. Additionally, NEMA and OSI asked that this potential requirement be addressed in both the manufacturing impact analysis, as well as testing burden analyzed in the regulatory flexibility analysis. (NEMA, No. 9 at p. 9; OSI, No. 5 at p. 7)

Testing in accredited laboratories helps ensure that measurements are consistent and reproducible. Therefore, in this final rule, DOE removes the phrase "medium base" and specifies that if a manufacturer's or importer's laboratory is accredited, it may conduct the applicable testing in 10 CFR 430.25. See section IV.B for a discussion of test burden.

F. Clarifications to Energy Conservation Standard Text at 10 CFR 430.32(u)

MBCFL energy conservation standards are codified in a table at 10 CFR 430.32(u). Certain language in the MBCFL energy conservation standards table provides clarification relevant to test procedures (e.g., sampling, test methods, and test calculations). Although this clarifying language is not in conflict with the specifications in the test procedures for MBCFLs contained in appendix W and in 10 CFR 429.35, for simplicity DOE proposed to modify the text in the MBCFL energy conservation standards table to remove specific test procedure language and instead reference the relevant parts of the MBCFL test procedures. In addition, in the introductory paragraph of 10 CFR 430.32(u), DOE proposed to replace the text "bare lamp and covered lamp" with the text "bare or covered." DOE considered these revisions to be clarifications that do not modify the energy conservation standards. 80 FR 45740-45741.

NEMA and OSI in general agreed with separating the test procedure specifications from section (u) with certain exceptions discussed in the next sections. (NEMA, No. 9 at p. 9; OSI, No. 5 at p. 8) In this final rule, DOE retains the change to the first sentence in 10 CFR 430.32(u) to read as "A bare or covered (no reflector) medium base compact fluorescent lamp manufactured on or after January 1, 2006…" Revisions to specific metrics in the table at 10 CFR 430.32(u) and related comments received are described in the subsequent sections.

1. Initial Lamp Efficacy

In the July 2015 NOPR, DOE proposed amending the first column of the table in 10 CFR 430.32(u) by replacing the seven instances of the text "lamp power" with the text "labeled wattage." 80 FR 45740. DOE proposed to use labeled wattage as that is the term DOE is using to define the wattage marked on the lamp that should be used to determine the applicable

minimum efficacy requirement (see section III.A.3.f). DOE also proposed deleting the current text in footnote 1. Id.

NEMA and OSI recommended using the term "rated wattage" rather than "labeled wattage." (NEMA, No. 9 at p. 9; OSI, No. 5 at pp. 8–9) As discussed in section III.A.3.f, DOE disagrees with NEMA and OSI about using the term "rated wattage" because DOE believes it may cause confusion or be easily misinterpreted. Instead, DOE retains in this final rule the term "labeled wattage."

In the July CFL TP NOPR, DOE also proposed to remove the text from footnote 2 indicating that for multi-level or dimmable systems, measurements shall be at the highest setting, and acceptable measurement error is ±3 percent. NEMA and OSI suggested keeping the 3 percent measurement error for efficacy and extend it to all other parameters. (NEMA, No. 9 at p. 9; OSI, No. 5 at pp. 8–9) DOE has determined that a 3 percent tolerance is not necessary. DOE addresses measurement error in sample size, confidence limit, and de-rating values as provided in 10 CFR 429.35. Because this allowance for determining compliance with existing standards already exists in 10 CFR 430.32(u), the 3 percent tolerance for efficacy has been maintained but moved to 10 CFR 429.35.

2. Lumen Maintenance at 1,000 Hours

In the July 2015 NOPR, DOE proposed amending the text for 1,000-hour lumen maintenance in the second column of the table in 10 CFR 430.32(u), which indicates that the average of at least 5 lamps must have a minimum 90.0 percent of initial (100-hour) lumen output at 1,000 hours of rated life. DOE proposed to delete this text and only state the standard as ≥90.0

percent. DOE also provided specific other changes to the table to correspond with terminology in the amended test procedure. 80 FR 45740. DOE did not receive any comments regarding these specific changes. Therefore, in this final rule, DOE modifies 10 CFR 430.32(u) to remove test procedure text and to align the terminology with the amended test procedure.

3. Lumen Maintenance at 40 Percent of Lifetime

In the July 2015 NOPR, DOE proposed amending the text for lumen maintenance in the second column of the table in 10 CFR 430.32(u), which indicates 80.0 percent of initial (100-hour) rating at 40 percent of rated life (per ANSI C78.5 Clause 4.10). 80 FR 45740-45741. DOE proposed to delete this text and state only the standard as ≥80.0 percent and other modifications to the table to read lumen maintenance at 40 percent of lifetime. Id. DOE did not receive any comments regarding these specific changes. Therefore, in this final rule, DOE modifies 10 CFR 430.32(u) to remove test procedure text and to align the terminology with the amended test procedure. In addition, for clarity DOE includes a footnote on the term "lifetime" that states "Lifetime refers to lifetime of a compact fluorescent lamp as defined in 10 CFR 430.2."

4. Rapid Cycle Stress Test

In the July 2015 NOPR, DOE proposed amending the text in the second column of the table for rapid cycle stress test in 10 CFR 430.32(u). 80 FR 45741. DOE proposed to delete the first two sentences of this text and to state that each lamp must be cycled once for every 2 hours of lifetime and at least 5 lamps must meet or exceed the minimum number of cycles. Id.

NEMA and OSI responded that the row in the table that codifies MBCFL energy conservation standards at 10 CFR 430.32(u) specifically retains the term "rated lifetime." (NEMA, No. 9 at p. 9; OSI, No. 5 at p. 8) In this final rule, DOE defines the term "lifetime of a compact fluorescent lamp" to be used in the new and amended test procedures (see section III.A.3.a for further details). Therefore, to align with the test procedures, DOE amends table 10 CFR 430.32(u) in this final rule to state that each lamp must be cycled once for every 2 hours of lifetime and at least 5 lamps must meet or exceed the minimum number of cycles. In addition, for clarity DOE includes a footnote on the term "lifetime" that states "Lifetime refers to lifetime of a compact fluorescent lamp as defined in 10 CFR 430.2."

5. Lifetime

In the July 2015 NOPR, DOE proposed amending 10 CFR 430.32(u) by deleting the term "average rated lamp life" and replacing it with the term "lifetime." 80 FR 45741. DOE also proposed to amend the text in the second column pertaining to lifetime to only state the standard as ≥6,000 hours and that DOE will no longer allow the use of statistical methods at 80 percent of rated life to determine the represented value of lifetime. Id. NEMA and OSI stated that the row should retain the text "≥6,000 hours as declared by the manufacturer on packaging." (NEMA, No. 9 at p. 9; OSI, No. 5 at p. 8) In this final rule, DOE defines the term "lifetime of a compact fluorescent lamp" and provides test procedures for the measurement and reporting of this value. To avoid potential confusion regarding how lifetime should be measured, DOE removes the language "as declared by the manufacturer on packaging" in this final rule. In addition, for clarity DOE includes a footnote on the term "lifetime" that states "Lifetime refers to lifetime of a compact fluorescent lamp as defined in 10 CFR 430.2."

G. Amendments to Certification Report Requirements

In the July 2015 NOPR, DOE recognized that testing of CFL lifetime and lumen maintenance at 40 percent of lifetime require considerably more time than testing of other required CFL metrics. DOE proposed to allow new basic models of CFLs to be distributed prior to completion of the full testing for lifetime and lumen maintenance at 40 percent of lifetime, as well as prior to completion for the rapid cycle stress test because it is also dependent on lifetime. DOE's proposal was similar to other lighting technologies in that prior to distribution of the new basic model of CFL, manufacturers may submit an initial certification report based on estimated values of lifetime, 40 percent lumen maintenance, and rapid cycle stress test if the testing for lifetime is not complete. In such a case, the certification report would be required to specifically describe a prediction method that would be generally representative of the methods specified in appendix W. Manufacturers would be required to maintain relevant records, in accordance with 10 CFR 429.71, of the development of all estimated values and any associated initial test data. DOE also proposed amendments to the certification report to address the new and additional metrics that are being adopted in this final rule and are required for compliance with DOE's energy conservation standards. 80 FR 45741.

Philips commented that there currently are no restrictions with respect to the prediction models that may be used, so selection of the prediction model should be at the discretion of the manufacturer, and should only be disclosed to defend it to the DOE if challenged. (Philips, No. 6 at p. 4) NEMA and OSI similarly objected to the proposed requirements that manufacturers must disclose the prediction method and that it must represent one of the methods in appendix W. (NEMA, No. 9 at p. 9; OSI, No. 5 at p. 8; Philips p. 4)

The EEAs opposed DOE's proposal to allow manufacturers to estimate values for lifetime and rapid cycle stress prior to the completion of testing for time to failure, and particularly opposed the proposal that manufacturers be permitted to develop their own prediction methods for these estimates. (EEAs, No. 8 at p. 5) The EEAs stated that, by the time DOE received a full certification report showing that a given model did not meet the standard, manufacturers may be retiring the model and it will have been in commerce for a significant portion of its intended market life. The EEAs also suggested it may be theoretically possible to extrapolate lumen depreciation provided a common approach based on industry standard methods is used. (EEAs, No. 8 at p. 5)

Based on a review of the market, DOE found that most CFLs have a lifetime of 10,000 hours or longer and therefore, it may take more than a year to complete the necessary lifetime measurements. Therefore, to accommodate such long testing time, DOE believes that the use of estimated values for lifetime, lumen maintenance at 40 percent of lifetime, and rapid cycle stress testing are required. In response to the concerns of CA IOUs and the EEAs regarding the accuracy of such methods, DOE notes that DOE is not aware of any industry-wide accepted method for extrapolation of lumen depreciation for CFLs. Therefore, DOE is not requiring a specific prediction method for estimated values. However, DOE is requiring manufacturers to specify the method of prediction and that this method must be generally representative of DOE's test procedures for CFLs in appendix W. In addition, DOE is adding a requirement to the certification report that manufacturers must state whether values of lifetime, lumen maintenance at 40 percent of lifetime, and rapid cycle stress testing are based on estimated or measured values. DOE believes that, as noted by CA IOUs and EEAs, such information regarding the prediction methods used by manufacturers is necessary in order to verify that such predictions

are valid and based on sound engineering judgement and calculations. Therefore, DOE believes that these requirements regarding the prediction method are adequate and necessary to ensure estimated values are reliable, representative, and consistent with test conditions, setup, and methods specified in DOE's test procedures for CFLs.

In addition, DOE notes that there is precedent for allowing products to be distributed in commerce based on estimated values. DOE allows initial certification reports for GSFLs and incandescent reflector lamps and also requires that manufacturers include a description of any testing or analysis the manufacturer performed. 10 CFR 429.12(e)(2) Under EPCA, MBCFLs may be marketed before completion of testing for lifetime and lumen maintenance at 40 percent of lifetime with supporting engineering predictions and analysis. 42 U.S.C. 6293(b)(12)(C).

Therefore, by allowing new basic models of CFLs to be distributed in commerce based on estimated values determined by prediction methods representative of DOE's test procedures for CFLs, DOE is ensuring products are available to consumers in a reasonable time while still requiring a rigorous process to ensure that all representative values are as accurate and precise as possible. In this final rule, DOE also clarifies that for existing basic models that require retesting, manufacturers may submit an initial certification report based on estimated values of lifetime, 40 percent lumen maintenance, and rapid cycle stress if the testing for lifetime is not complete.

The EEAs also recommended that DOE take action to enhance industry adherence with the CFL test procedure. They noted that under two CFL verification testing programs, ENERGY STAR and the Program for the Evaluation and Assessment of Residential Lighting (PEARL), a significant number of ENERGY STAR-qualified CFLs were found to be noncompliant with

ENERGY STAR program requirements. The EEAs noted that these results varied between brands, but the overall consumer dissatisfaction and perception of poor CFL quality applied throughout the industry, regardless of a particular brand's performance. The EEAs suggested DOE collect and analyze performance data for CFLs sold in the retail distribution chain and adopt an enhanced enforcement strategy focused on brands, rather than only basic models. The EEAs recommended that DOE require manufacturers to submit data that support the enhanced enforcement strategy and to tighten data submission requirements to prevent manufacturers from submitting incomplete or incorrect test data that may misrepresent the quality of products being verified. (EEAs, No. 8 at pp. 6–7)

DOE currently has enforcement procedures in place for, among many other products, CFLs that are subject to energy conservation standards. For more information please refer to DOE's "Implementation, Certification, and Enforcement" website at http://energy.gov/eere/buildings/implementation-certification-and-enforcement.

Additionally in the July 2015 NOPR, DOE proposed that if, prior to completion of testing, a manufacturer ceases to distribute in commerce a basic model, the manufacturer must submit a full certification report and provide all of the information listed in 10 CFR 429.12(b), including the product-specific information required by 10 CFR 429.35(b)(2), as part of its notification to DOE that the model has been discontinued. 80 FR 45741. DOE did not receive any comments regarding this proposal and adopts it in this final rule. This provision will help alleviate potential issues envisioned by the EEAs that models will be retired without any accountability for compliance with the standards.

Further, for this final rule, DOE separated the certification report requirements for medium base CFLs that are showing compliance with the current energy conservation standards, integrated CFLs that would need to show compliance with potential GSL energy conservation standards, and non-integrated CFLs which may need to show compliance with potential GSL energy conservations standards. DOE separated these requirements in order to clarify that different values must be reported when certifying compliance to existing standards in 430.32(u) (as it appears in 10 CFR parts 200-499 edition revised as of January 1, 2016) for medium base CFLs; general service lamp energy conservation standards (if adopted) for integrated CFLs; and general service lamp energy conservations standards (if adopted) for non-integrated CFLs.

H. Amendments to 10 CFR 429.35

The text of the 10 CFR 429.35 title currently addresses bare or covered (no reflector) MBCFLs. DOE proposed in the July 2015 NOPR to remove this text and identical text found in §429.35(a)(1) and (a)(2), and replace it with the text "compact fluorescent lamps" to reflect the inclusion of additional CFL categories. 80 FR 45741. DOE did not receive any comments on this proposal and therefore adopts this change in the final rule.

In addition, DOE also proposed to clarify and amend the sampling requirements for existing and new metrics, provide clarification on reuse of samples, and address failures of sample units. 80 FR 45741. DOE concluded that these clarifications and amendments would not have a significant effect on measured values or test burden. Id. In general, the EEAs were supportive of DOE's proposed changes to sampling requirements. (EEAs, No. 8 at pp. 2–4) DOE received comments related to the specific proposals to 10 CFR 429.35 and discusses these in detail in the following sections.

1. Initial Lamp Efficacy and Lumen Maintenance

Currently, in 10 CFR 429.35, sampling requirements are specified for efficacy, 1,000-hour lumen maintenance, and lumen maintenance at 40 percent of rated life. In the July 2015 NOPR, DOE proposed to replace the terms efficacy, 1,000-hour lumen maintenance, and lumen maintenance, respectively, with the terms initial lamp efficacy, lumen maintenance at 1,000 hours, and lumen maintenance at 40 percent of lifetime. 80 FR 45741–45742.

DOE also proposed to create a separate sampling requirement section for initial lamp efficacy in order to include an allowance of 3 percent tolerance on the represented value of this metric (see section III.F.1). Specifically, DOE proposed that, to account for measurement error, the represented value for initial lamp efficacy of MBCFLs may include 3 percent added to the lower of (a) the mean of the sample and (b) the lower 97.5 percent LCL of the true mean divided by 0.95. For example, if the lower value is the mean of the sample at 60.0 lumens per watt, then the 1.03 multiplier could be applied to yield a represented value for initial lamp efficacy of up to 61.8 lumens per watt. DOE concluded that this clarification does not result in a significant impact to measured values. DOE received comments on this proposal and addresses them in section III.F.1. In this final rule, DOE adopts the proposal regarding the 3 percent tolerance for initial lamp efficacy as described in this preamble.

Additionally, DOE proposed to expand the sample size from a minimum of 5 units to a minimum of 10 units for initial lamp efficacy, 1,000 hour lumen maintenance, and lumen maintenance at 40 percent of lifetime. 80 FR 45742. Further DOE proposed that if more than 10 units are tested as part of the sample for these three metrics, the total number of units must be a multiple of two so that an equal number of units can be tested base up and base down. DOE also

notes that, because the sample set must be the same for all metrics, if the sample size is greater than 10, the same larger sample set must be used for the other metrics required to utilize the sample set (see III.H.5).

In the July 2015 CFL TP NOR, DOE also proposed that half of the units be tested base up and half of the units be tested base down, rather than testing all units base up as currently required. Testing in both the base up and base down positions provides an accurate representation of performance under both orientations since the end-use orientation is unknown. 80 FR 45742.

OSI raised concerns that adding another orientation besides base up will effectively double testing costs by increasing the number of units under test as well as increasing the infrastructure required. OSI also stated that in many cases, manufacturers have evaluated products only in the base up position. (OSI, No. 5 at p. 8) NEMA stated that modifying the orientation specification would change measured values and add test burden. (NEMA, No. 9 at pp. 3, 8)

Test burden is discussed in section IV.B. DOE notes that ENERGY STAR has required both a sample size of 10 and that half be tested in the base up position and the other half in the base down position orientations since version 3.0 of the "ENERGY STAR® Program Requirements for CFLs", which was finalized in 2003.[22] CA IOUs commented (and DOE

[22] Version 3.0 of the CFL lamps specification was superseded by other versions of the CFL lamp specification and then ultimately the CFL specification was replaced by the overall lamp specification. However, the original

verified) that according to ENERGY STAR 64 percent of integrated CFLs shipped in 2014 were ENERGY STAR certified. (CA IOUs, No. 7 at p. 4) Therefore, a majority of integrated CFLs have already been evaluated in both orientations.

NEMA and OSI stated that if testing of non-integrated CFLs is necessary, that these lamps should only be tested in the base up position as base down testing is not representative of actual usage. Further, both NEMA and OSI raised concerns about the burden related to testing non-integrated CFLs in both base up and base down orientations. (NEMA, No. 9 at p. 10; OSI, No. 5 at p. 8)

Test burden is discussed in section IV.B. Contrary to the assertion of NEMA and OSI that base down orientation would not be representative of actual use for non-integrated CFLs, DOE has identified fixtures for non-integrated CFLs classified as "chandelier," "decorative pendant," and "sconce/marker light" all with base down lamp orientations.[23] DOE retains in this final rule that, for both integrated and non-integrated CFLs, half the sample size be tested in the base up and the other half in base down orientation.

In the July 2015 NOPR, DOE also proposed to specify in 10 CFR 429.35 that any represented value of lumen maintenance at 40 percent of lifetime must be based on a lifetime

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specification can be found at http://www.energystar.gov/products/spec by searching lighting, light bulbs (CFLs) and historic in status.

[23] DOE conducted a search using eLumit, an independently owned, industry-neutral company that is a lighting search and specification tool for design professionals. www.eLumit.com.

value that is equal to or greater than the represented value of lifetime. DOE did not receive any comments regarding this proposal; therefore, DOE adopts it in this final rule.

2. Rapid Cycle Stress Testing

In the July 2015 NOPR, DOE proposed to restrict the sample size for rapid cycle stress testing to an exact number of units. 80 FR 45742. Currently, the sampling size for rapid cycle stress testing is specified at 10 CFR 429.35(a)(2)(ii) as no less than 6 unique units. DOE proposed specifying that exactly 6 unique units must be tested per basic model for rapid cycle stress testing with the rationale that this new specification will minimize confusion and improve consistency in the number of samples used for testing. 80 FR 45742. This new sampling requirement is consistent with the sample size requirement for rapid cycle stress testing in the ENERGY STAR Lamps Specification V2.0. DOE did not receive any comments related to the sample size for rapid-cycle stress testing and therefore adopts the requirement in this final rule that the sample size for rapid-cycle stress testing be 6 unique units.

NEMA and OSI stated that lamp orientation has little effect on the rapid cycle stress testing and suggested that testing half of the lamps base up and half base down would be an additional burden that would not affect the results of the rapid-cycle stress test. (NEMA, No. 9 at p. 10; OSI, No. 5 at p. 8)

Rapid cycle stress testing is intended to stress the lamp's electrical components to evaluate the performance of a lamp undergoing repeated cycling. Lamp orientation affects the thermal conditions of the lamp. Because temperature has some impact on the performance of a lamp's electrical components, testing in both base up and base down orientations will provide a

more comprehensive set of results for assessing rapid cycle stress. Therefore, in this final rule, DOE specifies in appendix W that for rapid cycle stress testing half of the units must be tested in the base up position, and half of the units must be tested in the base down position, but that if the position is restricted by the manufacturer, units must be tested in the manufacturer-specified position.

In the July 2015 CFL NOPR, DOE also proposed a new paragraph in 10 CFR 429.35 that any represented value of rapid cycle stress test surviving units must be based on a lifetime value that is equal to or greater than the represented value of lifetime. 80 FR 45742. DOE did not receive any comments on this proposal and therefore, adopts it in this final rule.

3. Lifetime of a Compact Fluorescent Lamp

In the July 2015 NOPR, DOE proposed clarifying the sampling requirements for the lifetime of a CFL, including the position in which lamps are tested. Specifically DOE proposed to align the sampling requirements for lifetime with the sampling requirements for initial lamp efficacy and lumen maintenance. DOE clarified that if more than 10 units are tested as part of the sample, the total number of units must be a multiple of two and the time to failure value as determined per section 3.3 of appendix W must be used to determine the represented value of lifetime. 80 FR 45742. DOE did not receive any comments regarding this proposal and therefore, in this final rule, adopts it as proposed.

4. New Metrics

As discussed in section III.A.4 in this document, DOE establishes test procedures for measuring new metrics including CRI, power factor, CCT, start time, and standby mode energy

consumption. For CRI, power factor, CCT, and standby mode power, in the July 2015 NOPR, DOE proposed requiring a sample size of at least 10 (half base up and half base down). Testing in both the base up and base down positions provides an accurate representation of performance under both orientations since the end-use orientation is unknown. DOE also proposed specifying within the sampling requirements for CRI, power factor, CCT, and standby mode power, that, if more than 10 units are tested as part of the sample, the total number of units must be a multiple of two.

DOE proposed to specify the same sampling requirements for CRI and power factor as those specified for initial lamp efficacy, lumen maintenance at 1,000 hours, and lumen maintenance at 40 percent of lifetime in 10 CFR 429.35. Thus, for CRI and power factor, DOE determined that representations of these metrics be equal to the lesser of the mean of the sample and the 97.5 percent LCL divided by 0.95. Since higher values are desirable for CRI and power factor, use of the lesser of the mean and LCL ensures that a representative value is reported.

Because there are no targeted upper or lower bound values for CCT, DOE proposed to specify in 10 CFR 429.35 that representations of CCT be the mean of the sample.

For the start time, DOE proposed a sample size of three units in 10 CFR 429.35. DOE believes this is an appropriate sample size to determine an accurate value for the lamp start time. Further, DOE proposed that for start time, representations be equal to the greater of the mean of the sample and the 97.5 percent upper confidence limit (UCL) divided by 1.05, since lower values are desirable.

For standby mode power, DOE proposed to specify in 10 CFR 429.35 a sample size of at least 10 units, consistent with that used for the active mode power metric and initial lamp efficacy. DOE determined that representations should be equal to the greater of the mean of the sample and the 97.5 percent UCL divided by 1.05, as lower values are desirable.

DOE notes that the current sampling requirements already require 10 units for determining lifetime, and that several of these metrics (e.g., CRI, CCT, and power factor values) can be determined in the course of lifetime testing. Additionally, this sampling plan is consistent with the sampling requirements for these metrics in the ENERGY STAR Lamps Specification v2.0.

OSI stated that power factor, CRI, and start time requirements are not necessary and thus the proposed sampling requirements should not be included. (OSI, No. 5 at p. 9) As noted previously, DOE is establishing test procedures that include sampling requirements for power factor, CRI, and start time, in support of the ongoing GSL standards rulemaking (see section II for further details). Therefore, DOE retains the sampling plan for these metrics in this final rule. However, DOE notes that power factor and start time measurements are not applicable to or required for non-integrated CFLs.

NEMA and OSI also commented on DOE's use of the lower confidence level (LCL), UCL, and statistical divisor in determining represented values. They argued that DOE's current methodology is biased and statistically incorrect and recommended DOE use only the sample mean as it is the best estimator of the population parameters. (NEMA, No. 9 at p. 10; OSI, No. 5 at p. 9)

Confidence limits are a valid statistical method used to understand the accuracy of the sample mean. By using confidence limits, DOE is able to implement a conservative approach, ensuring that products on the market perform at least as well as represented by manufacturers, by requiring the lower confidence limit value if it is less than the sample mean when higher values are desirable and requiring the upper confidence limit if it is greater than the sample mean when lower values are desirable. DOE finds this methodology more appropriate in determining represented values than relying only on the sample mean. Therefore, in this final rule, DOE retains the confidence limit methodology for existing metrics and implements it for new metrics, where applicable.

DOE also clarifies that on or after 180 days after publication of this final rule, manufacturers of MBCFLs must use the test procedures established in this final rule to certify compliance with existing standards and for any representations regarding energy use or efficiency, and manufacturers of other CFLs without existing standards must use the test procedures for any representations regarding energy use or efficiency. As of the compliance date of any standards adopted in the GSL ECS rulemaking, manufacturers must use the test procedures established in this final rule to certify compliance with GSL standards, if adopted. (See section III.J for further details regarding effective dates.) Further, in this final rule, DOE specifies sampling requirements specific to metrics of integrated CFLs and non-integrated CFLs.

5. Reuse of Samples

In the July 2015 NOPR, DOE proposed to specify in 10 CFR 429.35 that the same sample of units must be used to determine initial lamp efficacy, lumen maintenance at 1,000

hours, lumen maintenance at 40 percent of lifetime, lifetime, CRI, CCT, power factor, start time, and standby mode power. 80 FR 45743.

NEMA and OSI commented that reuse of samples should not be mandatory except in the case of lumen maintenance values where a ratio is required involving the initial measurements. NEMA and OSI stated that the manufacturer should be permitted to use representative samples and make measurements in parallel to reduce the time burden of measurement. OSI also stated that this requirement would preclude large sample size life tests in which the lamps would run uninterrupted until failure. NEMA added that it is restrictive to require the same samples for all tests completed for one basic model. (NEMA, No. 9 at p. 10–11; OSI, No. 5 at p. 9) Philips commented that manufacturers should be allowed to test larger populations for lifetime than for photometric-related measurements. (Philips, Public Meeting Transcript, No. 4 at p. 90) GE recommended that, rather than requiring the reuse of a sample across all tests, DOE should require that all test units must be drawn from the same population. (GE, Public Meeting Transcript, No. 4 at pp. 91–95)

By requiring the same sample set to be used across all metrics, DOE ensures sample units are not selected to obtain favorable measurements for one metric over others and that all representative values are internally consistent and representative of the population (to the extent the selected test sample is representative of the population). The lifetime measurement is just an extension of the other photometric measurements taken at different points in time of the same lamp. DOE believes taking these photometric measurements such as efficacy, lumen maintenance, and lifetime on the same set of lamps will result in a better characterization of the photometric performance of the population by minimizing the variation that may be introduced

into the measurement by using different test units for different metrics. Hence, the requirement of the same sample set allows for a more accurate assessment of a basic model's compliance with standards for all metrics. Therefore, DOE retains in this final notice that the same sample of units must be used as the basis for representations for standby power, power factor, CCT, CRI, initial lumen output, input power, initial lamp efficacy, lumen maintenance at 1,000 hours, lumen maintenance at 40 percent of lifetime, and lifetime; no less than three units from the same sample of units must be used when testing for the start time; and exactly six unique units must be used for rapid cycle stress testing. Additionally, in this final rule, DOE specifies that sample units must be comprised of production units. For those basic models that currently make representations of the energy efficiency metrics described in this test procedure, including medium base CFLs, manufacturers must ensure that representations, including certifications, are made in accordance with the DOE test procedure, including sampling plan. While DOE believes manufacturers have been following these testing procedures, including sampling plans, for making current representations, DOE clarifies that a manufacturer may need to retest in the event that the current representations are not supported by the test when measured in accordance with the method being adopted in this final rule, including the sampling plan.

6. Lamp Failures

In the July 2015 NOPR, DOE also clarified that, if a lamp breaks, becomes defective, fails to stabilize, exhibits abnormal behavior such as swirling or stops producing light, prior to the end of the seasoning period, the lamp must be replaced with a new unit. 80 FR 45732. If a lamp fails after the seasoning period, the lamp's measurements must be included when calculating represented values. Id.

The CA IOUs stated that lamps that fail during lamp seasoning ("early failure lamps") should also be maintained in the sample and new units should be added until the required units pass the seasoning period. The CA IOUs stated that not including units that fail during the seasoning period in the sample set will result in inaccurate measurements of metrics. The CA IOUs gave the example where a manufacturer might test 100 units, 90 of which would fail during seasoning, and report the lifetime of the lamp based on the 10 units that passed. The CA IOUs asserted that these early failures cause consumer dissatisfaction related to CFL lifetime. Citing an ENERGY STAR report[24] the CA IOUs stated that the majority of verification testing failures for CFLs in ENERGY STAR are related to tests for product lifetime (e.g., interim life test, lumen maintenance, and rapid cycle stress tests). Additionally, the CA IOUs and the EEAs cited a study conducted by PEARL that found that 2 to 12 percent of the CFLs tested failed to reach 40 percent of rated life. (CA IOUs, No. 7 at pp. 1 -3; CA IOUs, Public Meeting Transcript, No. 4 at pp. 38–41, 89)

The CA IOUs further stated that the number of "early failures" should be recorded along with the time and manner of failure. The CA IOUs also suggested that DOE require the entire sample set to be discarded if one unit fails during seasoning in order to incentivize manufacturers to produce higher quality products. Additionally, the CA IOUs recommended DOE evaluate data on early CFL failures to verify that the majority of early failures occur in the first 100 hours of operation and increase this time interval for recording early failures, if necessary. (CA IOUs, No. 7 at p. 3)

[24] Overview of CFL Verification Testing Results Jan 2010-Apr 2014. EPA. 2014. www.energystar.gov/sites/default/files/specs/Presentation%20Verification%20Testing%207-31-14.pdf

The EEAs supported CA IOUs written comments related to early failures, noting that ignoring early failures would make it difficult to develop metrics to address these failures. The EEAs added that lamps that fail during seasoning would fall in the category of manufacturing defect, a category of lamp failure identified in IES LM-65-14. (EEAs, No. 8 at p. 3) GE (with Philips concurring) agreed that failures of lamps "right out of the box" represented a manufacturing defect and stated it is appropriate to remove these from the sample during seasoning. (GE, Public Meeting Transcript, No. 4 at p. 38, Philips, Public Meeting Transcript, No. 4 at p. 38) Westinghouse stated that its products were not experiencing industry failures within the warranty period, and definitely not within the first 100 hours. Westinghouse added that lamps that did fail early would not pass DOE's verification testing and therefore, would not be available on the market. (Westinghouse, Public Meeting Transcript, No. 4, at pp. 40–41)

DOE evaluated the reports cited by CA IOUs and EEAs in their comments, specifically, ENERGY STAR verification test report of 2014 and the study conducted by PEARL. While both of these reports indicate that there are lamps that fail to meet metrics related to product lifetime, neither support that these failures are due to lamps failing in the first 100 hours of the lamp lifetime. Both documents only report failures before 40 percent of rated life as one aggregated value with no data on actual time of failure. Further, DOE evaluated results of a study conducted by the California Public Utility Commission that provided data on the number of hours before failure for 72 models of MBCFLs with a sample set of 3601 lamps that were tested on 10 different cycling times. Of the 360 lamps tested on the 180 minute cycling time, the

same as the cycling time for lifetime testing, none of the lamps failed during the first 100 hours of testing.[25]

Based on available data, DOE finds that it is not common for CFLs to fail before the seasoning period; therefore, the requirement that a sample unit be replaced if it fails during seasoning will not result in appreciably less accurate measurements. DOE notes that its proposed method for addressing lamp failures aligns with ANSI C78.5-2003,[26] which provides specifications on integrated CFLs and is referenced by IES LM-65-14 (incorporated by reference). Section 6.1.2 of ANSI C78.5-2003 notes that "… if a unit fails to stabilize or exhibits abnormal behavior, the lamp shall be discarded. Testing shall resume with a suitable replacement specimen procured and prepared in the same manner as the original specimen. The use of replacement specimens shall be documented in the test report." Further, section 3.1 of IES LM-65-14 states that lamp failures due to manufacturing defects are reported but not included in the calculation of lamp lifetime. Therefore, in this final rule, DOE retains the requirement that, if a lamp breaks, becomes defective, fails to stabilize, exhibits abnormal behavior such as swirling or stops producing light prior to the end of the seasoning period, the lamp must be replaced with a new unit. DOE also notes that ANSI C78.5-2003 and IES LM-65-14 recommend respectively, recording replacement of sample units and failures. Because such data can be informative, in this final rule, DOE adds the requirement that manufacturers must provide in the certification report, the number of sample units replaced within each unique

[25] CFL Laboratory Testing Report: Results from a CFL Switching Cycle and Photometric Laboratory Study. December 9, 2015. California Public Utilities Commission.
[26] American National Standard For Electric Lamps: Specifications for Performance of Self-Ballasted Compact Fluorescent lamps (approved 2003).

sample set used in determining represented values and believes that such information could be helpful to consumers or interested parties in determining more reliable CFL models, as requested by the CA IOUs and EEAs.

I. Federal Trade Commission (FTC) Labeling Requirements

As discussed throughout this document, the CFL test procedure adopted in this final rule is intended, among other things, to support FTC's Lighting Facts Labeling program. Accordingly, in the July 2015 NOPR, DOE proposed adding provisions to 10 CFR 429 for initial lumen output, input power, CCT, estimated annual energy cost, and life (in years) for MBCFLs to enable FTC to allow manufacturers to submit data through DOE's Compliance Certification Management System (CCMS) for the FTC labeling requirements. 80 FR 45743. Except for CCT, these metrics are already being determined as part of the existing test procedures in appendix W. For example, initial lumen output and input power (a standalone metric and also part of the calculation for estimated annual energy cost) are the two quantities required to calculate the existing metric of initial lamp efficacy. Furthermore, the life (expressed in years) is determined by dividing the existing metric of lifetime by an average operating hour value specified by FTC.

NEMA stated that the test procedures should not be developed for lamps not regulated by FTC. NEMA highlighted the fact that FTC's label does not cover non-integrated CFLs and reiterated that non-integrated CFLs should not be included in the test procedure. (NEMA, No. 9 at p. 2)

As noted previously, the test procedures that are the subject of this rulemaking are intended to support existing and potential standards for CFLs and ENERGY STAR lamp and luminaire specifications, as well as support the FTC Lighting Facts labeling requirements. DOE did not receive any other comments related to the proposed provisions for DOE to collect FTC Lighting Facts labeling data through DOE's CCMS. Therefore, in this final rule, DOE adopts the provisions as described in this preamble.

J. Effective Date

In the July 2015 NOPR, DOE specified that the effective date for the amended test procedures would be 30 days after publication of the final rule in the Federal Register. 80 FR 45743. Representations based on the amended and new test procedures would be required as of 180 days after publication of the final rule. (42 U.S.C. 6293(c)(2)) DOE received several comments regarding these dates and certifications of compliance for products according to the new and amended test procedures.

NEMA and OSI asked DOE to provide clarification on the need to retest lamps that are already certified in the CCMS database, or if industry is allowed to use existing test reports for current products. (NEMA, No. 9 at p. 2; OSI, No. 5 at p. 2) OSI also sought clarification from DOE regarding the disposition of existing inventory if retesting is required for current products. (OSI, No.5 at p. 2)

Representations related to the metrics addressed in the amended Appendix W must reflect testing in accordance with Appendix W not later than [**INSERT DATE 180 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER].** Representations are not

required by DOE for CFLs not currently subject to standards (although they may be required by the FTC). In contrast, certifications of compliance are required for medium base CFLs, which are currently subject to standards; those certifications must reflect testing in accordance with the amended Appendix W as of the next annual certification date or [**INSERT DATE 180 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER**], whichever is later. DOE also reiterates, as noted throughout this document, that the new and amended test procedures are not anticipated to result in changes in measured energy consumption or other performance metrics for any products that are currently subject to energy conservation standards and thus required to certify compliance to DOE. Therefore, existing medium base CFLs may not require re-testing if their representative values continue to be valid.

Certifications of compliance for basic models of CFLs with any new and/or amended energy conservation standards must reflect testing in accordance with Appendix W as amended in this final rule, prior to distribution in commerce, and annually thereafter by the filing date specified in 10 CFR 429.12(d); however, no basic model is required to be certified until it is required to comply with energy conservation standards. Therefore, for CFLs not currently subject to standards, the initial certification report must be filed by the compliance date of any new energy conservation standards.

NEMA and OSI stated that due to the additional testing required by the new and amended test procedures established in this final rule, it was not practical to certify all lamps to the new and amended test procedures by the next annual filing date for certification. In particular, OSI cited changes to the sample size and orientation; and NEMA added testing for rapid cycle stress. NEMA and OSI noted that publication of the final rule for the ongoing GSL standards

rulemaking is expected before the end of 2017. They requested that until March 1, 2018, only new CFLs certified after the publication of this test procedure final rule be required to be tested under the new and amended CFL test procedures established by it; and after March 1, 2018, all CFLs must be tested under the new and amended CFL test procedures. NEMA and OSI reasoned this would minimize testing burden on industry for current products that are expected to be rendered obsolete by the ongoing GSL standards rulemaking. (NEMA, No. 9 at p. 11; OSI, No. 5 at p. 9)

The change in sample size and orientation requirements adopted in this final rule align with ENERGY STAR Lamps Specification V2.0 (effective January 1, 2017) and its previous version, with the only exception being that DOE is requiring 3 units tested base up, and 3 units tested base down for the rapid cycle stress test. DOE notes that two thirds of compact fluorescent lamps already comply with ENERGY STAR, which already requires 10 units to be tested, and does not believe the change in orientation requirements for the rapid cycle stress test would require an extensive change to the existing test setup. While DOE is adopting test procedures for additional metrics, several of these metrics (e.g., CCT, CRI, power factor) can be determined simultaneously with existing metrics such as efficacy, and therefore testing new metrics would not require a significant amount of additional time to conduct.

Further for new basic models or existing basic models that require retesting because their certified values are no longer valid, if a metric requires a longer period of time to test (lifetime, lumen maintenance at 40 percent of lifetime), DOE allows for the reporting of estimated values until the testing is complete. Therefore, DOE finds that manufacturers should be able to certify and make representations of all applicable CFL products within 180 days of the publication of

this final rule. Hence, the effective date for the new and amended test procedures discussed in this final rule will be 30 days after publication of this document in the Federal Register. Representations must reflect testing in accordance with the new and amended test procedure not later than 180 days after publication of the final rule. (42 U.S.C. 6293(c)(2))

After the effective date and prior to 180 days following publication of this CFL test procedure final rule, manufacturers may voluntarily begin to make representations with respect to the energy use or efficiency of CFLs (including but not limited to MBCFLs) using the results of testing pursuant to this final rule. On or after 180 days after publication of this final rule, any representations including certifications of compliance (if required), made with respect to the energy use or efficiency of CFLs (including but not limited to MBCFLs) must be made in accordance with the results of testing pursuant to the new and amended test procedures.

IV. Procedural Issues and Regulatory Review

A. Review Under Executive Order 12866

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

B. Review under the Regulatory Flexibility Act

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

DOE reviewed this final rule, which amends and establishes new test procedures for CFLs, under the provisions of the Regulatory Flexibility Act and the procedures and policies published on February 19, 2003. DOE certifies that the rule will not have a significant economic impact on a substantial number of small entities. The factual basis for this certification is as follows.

The Small Business Administration (SBA) considers a business entity to be a small business, if, together with its affiliates, it employs less than a threshold number of workers specified in 13 CFR part 121. These size standards and codes are established by the North American Industry Classification System (NAICS). Manufacturing of CFLs is classified under NAICS 335110, "Electric Lamp Bulb and Part Manufacturing." The SBA sets a threshold of 1,250 employees or less for an entity to be considered as a small business for this category.

DOE conducted a focused market survey reviewing information from trade associations such as NEMA; ENERGY STAR programs; market reports (e.g. Hoover's reports); and individual company websites to identify companies that sell products covered by this rulemaking. DOE then determined the number of small businesses based on SBA definition. In its estimation of a company's number of employees, DOE also includes any parent companies and/or subsidiaries. In the July 2015 NOPR, DOE identified 26 manufacturers that would be considered small businesses. 80 FR 45744. Westinghouse indicated the number of small businesses identified by DOE was less than expected, noting that there are only a handful of large-size businesses in the market. (Westinghouse, Public Meeting Transcript, No. 4 at pp. 134–136)

For this final rule, DOE reviewed its estimated number of small businesses. DOE updated its list of small businesses by reviewing information from trade associations such as NEMA; ENERGY STAR programs; market reports (e.g. Hoover's reports); and individual company websites to identify companies that sell CFLs in the United States. DOE screened out companies that do not offer products covered by this rulemaking, do not meet the definition of a "small business," or are completely foreign owned and operated. DOE determined that there are no small businesses that maintain domestic production facilities for CFLs.

Based on the criteria outlined earlier and the reasons discussed above, DOE certifies that the test procedures adopted in this final rule would not have a significant economic impact on a substantial number of small entities, and the preparation of a final regulatory flexibility analysis is not warranted. DOE has submitted a certification and supporting statement of factual basis to the Chief Counsel for Advocacy of the SBA for review under 5 U.S.C. 605(b).

C. Review Under the Paperwork Reduction Act of 1995

Manufacturers of CFLs 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 CFLs. See generally 10 CFR part 429, subpart B. 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 30 hours per response including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

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

D. Review Under the National Environmental Policy Act of 1969

In this final rule, DOE is approving test procedure amendments that it expects will be used to develop and implement future energy conservation standards for CFLs. 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, this rule amends an existing rule without affecting the amount, quality or distribution of energy usage, and, therefore, will not result in any environmental impacts. Thus, this rulemaking is covered by Categorical Exclusion A5 under 10 CFR part 1021, subpart D, which applies to any rulemaking that interprets or amends an existing rule without changing the environmental effect of that rule. 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 http://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 (Public Law 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). DOE has reviewed this final rule under the OMB and DOE guidelines and has concluded that it is consistent with applicable policies in those guidelines.

K. Review Under Executive Order 13211

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

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

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

Under section 301 of the Department of Energy Organization Act (Public Law 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.

This final rule incorporates by reference the testing methods and modifications to the test procedures that are contained in the following commercial standards:

1) ANSI C78.901-2014, "American National Standard for Electric Lamps—Single-Based Fluorescent Lamps—Dimensional and Electrical Characteristics," 2014;
2) CIE 13.3-1995, "Technical Report: Method of Measuring and Specifying Colour Rendering Properties of Light Sources," 1995;

3) CIE 15:2004, "Technical Report: Colorimetry, 3rd edition," 2004;
4) IES LM-54-12, "IES Guide to Lamp Seasoning," 2012;
5) IES LM-65-14, "IES Approved Method for Life Testing of Single-Based Fluorescent Lamps," 2014;
6) IES LM-66-14, "IES Approved Method for the Electrical and Photometric Measurements of Single-Based Fluorescent Lamps," 2014;
7) IESNA LM-78-07, :IESNA Approved Method for Total Luminous Flux Measurement of Lamp Using an Integrated Sphere Photometer," 2007; and
8) IEC Standard 62301 (Edition 2.0, 2011-01), "Household electrical appliances – Measurement of standby power," 2011.

Although these test procedures are not exclusively based on these industry testing standards, some components of the DOE test procedure adopt definitions, test parameters, and measurement techniques from them without amendment. The Department has evaluated these industry testing standards and is unable to conclude whether they fully comply with the requirements of section 32(b) of the FEAA (i.e., that they were 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. Description of Materials Incorporated by Reference

DOE incorporates by reference the test standard published by ANSI, titled "American National Standard for Electric Lamps – Single-Based Fluorescent Lamps – Dimensional and Electrical Characteristics," ANSI C78.901-2014. ANSI C78.901-2014 is an industry accepted

test standard that specifies physical and electrical characteristics of non-integrated CFLs and is applicable to products sold in North America. It is used to identify the appropriate reference ballast specifications for CFL as described in this final rule. ANSI C78.901-2014 is readily available on ANSI's website at http://webstore.ansi.org/.

DOE incorporates by reference the test standard published by IES, titled "IES Guide to Lamp Seasoning," IES LM-54-12. IES LM-54-12 is an industry accepted test standard that specifies a method for seasoning CFLs prior to testing and is applicable to products sold in North America. The test procedures adopted in this final rule reference various sections of IES LM-54-12 that address seasoning of CFLs prior to testing. IES LM-54-12 is readily available on IES's website at www.ies.org/store.

DOE also incorporates by reference the test standard published by IES, titled "IES Approved Method for Life Testing of Single-Based Fluorescent Lamps," IES LM-65-14. IES LM-65-14 is an industry accepted test standard that specifies a method for measuring the time to failure of CFLs and is applicable to products sold in North America. The test procedures adopted in this final rule reference various sections of IES LM-65-14 that address test conditions and procedures for measuring time to failure and rapid cycle stress testing of CFLs. IES LM-65-14 is readily available on IES's website at www.ies.org/store.

DOE also incorporates by reference specific sections of the test standard published by IES, titled "IES Approved Method: Electrical and Photometric Measurements of Single-Based Fluorescent Lamps," IES LM-66-14. IES LM-66-14 is an industry accepted test standard that specifies a method for measuring electrical and photometric characteristics of CFLs and is

applicable to products sold in North America. The test procedures adopted in this final rule reference various sections of IES LM-66-14 that address test conditions and procedures for taking electrical and photometric measurements of CFLs. IES LM-66-14 is readily available on IES's website at www.ies.org/store.

DOE also incorporates by reference the test standard published by IES, titled "IESNA Approved Method for Total Luminous Flux Measurement of Lamps Using an Integrating Sphere Photometer," IESNA LM-78-07. IESNA LM-78-07 is an industry accepted test standard that specifies a method for measuring lumen output in an integrated sphere and is applicable to products sold in North America. The test procedures adopted in this final rule reference sections of IESNA LM-78-07 that address measurements of lumen output. IESNA LM-78-07 is readily available on IES's website at www.ies.org/store.

DOE also incorporates by reference certain sections of the test standard published by IEC, titled "Household electrical appliances – Measurement of standby power," IEC Standard 62301 (Edition 2.0). IEC Standard 62301 (Edition 2.0) is an industry accepted test standard that describes measurements of electrical power consumption in standby mode, off mode, and network mode. The test procedures adopted in this final rule reference sections of IEC Standard 62301 (Edition 2.0) for testing standby mode power consumption of CFLs. IEC Standard 62301 (Edition 2.0) is readily available on ANSI's website at https://webstore.iec.ch/home.

DOE also incorporates by reference the test standard published by CIE, titled "Technical Report: Method of Measuring and Specifying Colour Rendering Properties of Light Sources," CIE 13.3-1995. CIE 13.3-1995 is an industry accepted test standard that specifies method of

measuring and specifying color rendering properties of light sources based on resultant color shifts of test objects. The test procedures adopted in this final rule reference sections of CIE 13.3-1995 for testing CRI of CFLs. CIE 13.3-1995 is readily available on CIE's website at http://www.techstreet.com/cie/.

DOE incorporates by reference the test standard published by CIE, titled "Technical Report: Colorimetry," CIE 15:2004. CIE 15:2004 is an industry accepted test standard that summarizes colorimetric data. The test procedures adopted in this final rule reference sections of CIE 15:2004 for testing CCT of CFLs. CIE 15:2004 is readily available on CIE's website at http://www.techstreet.com/cie/.

DOE removes previously incorporated reference to "ENERGY STAR Program Requirements for [Compact Fluorescent Lamps] CFLs, approved August 9, 2001." These provided specifications including test procedures for ENERGY STAR qualified CFLs. The test procedures adopted in this final rule no longer reference "ENERGY STAR Program Requirements for [Compact Fluorescent Lamps] CFLs, approved August 9, 2001."

N. 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).

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, Reporting and recordkeeping requirements.

10 CFR Part 430

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

Issued in Washington, DC, on August 11, 2016

_____

Kathleen B. Hogan

Deputy Assistant Secretary for Energy Efficiency

Energy Efficiency and Renewable 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.

2. Section 429.12 is amended by revising paragraph (f) to read as follows:

§429.12 General requirements applicable to certification reports.

* * * * *

(f) Discontinued model filing. When production of a basic model has ceased and it is no longer being sold or offered for sale by the manufacturer or private labeler, the manufacturer must report this discontinued status to DOE as part of the next annual certification report following such cessation. For each basic model, the report must include the information specified in paragraphs (b)(1) through (7) of this section, except that for integrated light-emitting diode lamps and for compact fluorescent lamps, the manufacturer must submit a full certification report, including all of the information required by paragraph (b) of this section and the product-specific information required by §429.56(b)(2) or §429.35(b)(2), respectively.

* * * * *

3. Section 429.35 is revised to read as follows:

§429.35 Compact fluorescent lamps.

(a) Determination of Represented Value. Manufacturers must determine represented values, which include the certified ratings, for each basic model of compact fluorescent lamp by testing, in conjunction with the following sampling provisions:

(1) Units to be tested. (i) The requirements of § 429.11(a) are applicable except that the sample must be comprised of production units; and

(ii)(A) For each basic model of integrated compact fluorescent lamp, the minimum number of units tested shall be no less than 10 units when testing for the initial lumen output, input power, initial lamp efficacy, lumen maintenance at 1,000 hours, lumen maintenance at 40 percent of lifetime, lifetime, CCT, CRI, power factor, and standby mode power. If more than 10 units are tested as part of the sample, the total number of units must be a multiple of 2. The same sample of units must be used as the basis for representations for initial lumen output, input power, initial lamp efficacy, lumen maintenance at 1,000 hours, lumen maintenance at 40 percent of lifetime, lifetime, CCT, CRI, power factor, and standby mode power. No less than three units from the same sample of units must be used when testing for the start time. Exactly six unique units (i.e., units that have not previously been tested under this paragraph (a)(1)(ii) but are representative of the same basic model tested under this paragraph (a)(1)(ii)) must be used for rapid cycle stress testing.

(B) For each basic model of non-integrated compact fluorescent lamp, the minimum number of units tested shall be no less than 10 units when testing for the initial lumen output, input power, initial lamp efficacy, lumen maintenance at 40 percent of lifetime,

lifetime, CCT, and CRI. If more than 10 units are tested as part of the sample, the total number of units must be a multiple of 2. The same sample of units must be used as the basis for representations for initial lumen output, input power, initial lamp efficacy, lumen maintenance at 40 percent of lifetime, lifetime, CCT, and CRI.

(iii) For each basic model, a sample of sufficient size shall be randomly selected and tested to ensure that:

(A) Represented values of initial lumen output, initial lamp efficacy, lumen maintenance at 1,000 hours, lumen maintenance at 40 percent of lifetime, CRI, power factor, or other measure of energy consumption of a basic model for which consumers would favor higher values must be less than or equal to the lower of:

(*1*) The mean of the sample, where:

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

$\bar{x}$ is the sample mean,

n is the number of units in the sample, and

x_i is the i^{th} unit;

Or,

(*2*) The lower 97.5-percent confidence limit (LCL) of the true mean divided by 0.95, where:

$$LCL = \bar{x} - t_{0.975}\left(\frac{s}{\sqrt{n}}\right)$$

$\bar{x}$ is the sample mean of the characteristic value;

s is the sample standard deviation;

n is the number of units in the sample, and

$t_{0.975}$ is the t statistic for a 97.5% one-tailed confidence interval with n-1 degrees of freedom (from appendix A of this subpart).

(B) Represented values of input power, standby mode power, start time or other measure of energy consumption of a basic model for which consumers would favor lower values must be greater than or equal to the higher of:

(*1*) The mean of the sample, where:

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

$\bar{x}$ is the sample mean,

n is the number of units in the sample, and

x_i is the i^{th} unit;

Or,

(*2*) The upper 97.5-percent confidence limit (UCL) of the true mean divided by 1.05, where:

$$UCL = \bar{x} + t_{0.975}\left(\frac{s}{\sqrt{n}}\right)$$

$\bar{x}$ is the sample mean of the characteristic value;

s is the sample standard deviation;

n is the number of units in the sample, and

$t_{0.975}$ is the t statistic for a 97.5% one-tailed confidence interval with n-1 degrees of freedom (from appendix A of this subpart).

(C) The represented value of CCT must be equal to the mean of the sample, where:

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

$\bar{x}$ is the sample mean,

n is the number of units in the sample, and

x_i is the i^{th} unit.

(D) The represented value of lifetime must be equal to or less than the median time to failure of the sample (calculated as the arithmetic mean of the time to failure of the two middle sample units when the numbers are sorted in value order).

(E) The represented value of the results of rapid cycle stress testing must be

(*1*) Expressed in the number of surviving units and

(*2*) Based on a lifetime value that is equal to or greater than the represented value of lifetime.

(2) The represented value of life (in years) of a compact fluorescent lamp must be calculated by dividing the represented lifetime of a compact fluorescent lamp as determined in (a)(1) of this section by the estimated annual operating hours as specified in 16 CFR 305.15(b)(3)(iii).

(3) The represented value of the estimated annual energy cost for a compact fluorescent lamp, expressed in dollars per year, must be the product of the input power in kilowatts, an electricity cost rate as specified in 16 CFR 305.15(b)(1)(ii), and an estimated average annual use as specified in 16 CFR 305.15(b)(1)(ii).

(4) For compliance with standards specified in §430.32(u) as it appeared in 10 CFR parts 200-499 edition revised as of January 1, 2016, initial lamp efficacy may include a 3 percent tolerance added to the value determined in accordance with paragraph (a)(1)(iii)(A) of this section.

(5) The represented value of lumen maintenance at 40 percent of lifetime must be based on a lifetime value that is equal to or greater than the represented value of lifetime.

(6) Estimated values may be used for representations when initially testing a new basic model or when new/additional testing is required.

(b) Certification reports. (1) The requirements of §429.12 are applicable to compact fluorescent lamps; and

(2) Values reported in certification reports are represented values. Pursuant to §429.12(b)(13), a certification report shall include the following public product-specific information:

(i) For each basic model of mediumbase CFL when certifying compliance to the standards in §430.32(u) as it appeared in 10 CFR parts 200-499 edition revised as of January 1, 2016, the testing laboratory's ILAC accreditation body's identification number or other approved identification assigned by the ILAC accreditation body, the date of first manufacture, the seasoning time in hours (h), the initial lumen output in lumens (lm), the input power in watts (W), the initial lamp efficacy in lumens per watt (lm/W), the number of sample units replaced during the seasoning period within each unique sample set used in determining the represented value, the lumen maintenance at 40 percent of lifetime in percent (%) (and whether value is estimated), the lifetime in hours (h) (and whether value is estimated), life in years (and whether value is estimated), the lumen maintenance at 1,000 hours in percent (%), and the results of rapid cycle stress testing in number of units passed. or the initial certification of new basic models or any subsequent certification based on new testing, estimates of lifetime, life, lumen maintenance at 40 percent of lifetime, and rapid cycle stress test surviving units may be reported (if indicated in the certification report) until testing is complete. When reporting estimated values, the

certification report must specifically describe the prediction method, which must be generally representative of the methods specified in appendix W. Manufacturers are required to maintain records in accordance with §429.71 of the development of all estimated values and any associated initial test data.

(ii) For each basic model of integrated CFL when certifying compliance with general service lamp energy conservation standards, the testing laboratory's ILAC accreditation body's identification number or other identification assigned by the ILAC accreditation body, the date of first manufacture, a statement that the compact fluorescent lamp is integrated, the seasoning time in hours (h), the initial lumen output in lumens (lm), the input power in watts (W), the initial lamp efficacy in lumens per watt (lm/W), the CCT in kelvin (K), CRI, the lumen maintenance at 1,000 hours in percent (%), the lumen maintenance at 40 percent of lifetime in percent (%) (and whether value is estimated), start time in milliseconds, power factor, standby mode energy consumption in watts (W), the results of rapid cycle stress testing in number of units passed, the lifetime in hours (h) (and whether value is estimated), life in years (and whether value is estimated), and the number of sample units replaced during the seasoning period within the sample set used in determining the represented value. Estimates of lifetime, life, lumen maintenance at 40 percent of lifetime, and rapid cycle stress test surviving units may be reported (if indicated in the certification report) until testing is complete. When reporting estimated values, the certification report must specifically describe the prediction method, which must be generally representative of the methods specified in appendix W. Manufacturers are required to maintain records in accordance with §429.71 of the development of all estimated values and any associated initial test data.

(iii) For each basic model of non-integrated CFL when certifying compliance with general service lamp energy conservation standards, the testing laboratory's ILAC accreditation body's identification number or other identification assigned by the ILAC accreditation body, the date of first manufacture, a statement that the compact fluorescent lamp is non-integrated, the initial lumen output in lumens (lm), the input power in watts (W), the initial lamp efficacy in lumens per watt (lm/W), the CCT in kelvin (K), CRI, the lumen maintenance at 40 percent of lifetime in percent (%) (and whether value is estimated), the lifetime in hours (h) (and whether value is estimated), and the number of sample units replaced during the seasoning period within each unique sample set used in determining the represented value. Estimates of lifetime and lumen maintenance at 40 percent of lifetime may be reported (if indicated in the certification report) until testing is complete. When reporting estimated values, the certification report must specifically describe the prediction method, which must be generally representative of the methods specified in appendix W. Manufacturers are required to maintain records in accordance with §429.71 of the development of all estimated values and any associated initial test data.

(c) Rounding requirements. For represented values,

(1) Round input power to the nearest tenth of a watt.

(2) Round lumen output to three significant digits.

(3) Round initial lamp efficacy to the nearest tenth of a lumen per watt.

(4) Round lumen maintenance at 1,000 hours to the nearest tenth of a percent.

(5) Round lumen maintenance at 40 percent of lifetime to the nearest tenth of a percent.

(6) Round CRI to the nearest whole number.

(7) Round power factor to the nearest hundredths place.

(8) Round lifetime to the nearest whole hour.

(9) Round CCT to the nearest 100 kelvin (K).

(10) Round standby mode power to the nearest tenth of a watt; and

(11) Round start time to the nearest whole millisecond.

PART 430--ENERGY CONSERVATION PROGRAM FOR CONSUMER PRODUCTS

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

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

5. Section 430.2 is amended by:

a. Adding in alphabetical order a definition for “compact fluorescent lamp”;

b. Revising the definition of “correlated color temperature”; and

c. Adding in alphabetical order adefinition for “lifetime of a compact fluorescent lamp”.

The additions and revision read as follows:

§430.2 Definitions.

* * * * *

Compact fluorescent lamp (CFL) means an integrated or non-integrated single-base, low-pressure mercury, electric-discharge source in which a fluorescing coating transforms some of the ultraviolet energy generated by the mercury discharge into light; the term does not include circline or U-shaped lamps.

* * * * *

Correlated color temperature (CCT) means the absolute temperature of a blackbody whose chromaticity most nearly resembles that of the light source.

* * * * *

Lifetime of a compact fluorescent lamp means the length of operating time between first use and failure of 50 percent of the sample units (as specified in §429.35(a)(1) of this chapter), determined in accordance with the test procedures described in section 3.3 of appendix W to subpart B of this part.

* * * * *

6. Section 430.3 is amended by:

a. Redesignating paragraphs (e)(8) through (19) as paragraphs (e)(9) through (20), respectively, and adding new paragraph (e)(8);

b. Removing ‘‘appendix R’’ in paragraphs (l)(1) and (2) and adding in its place ‘‘appendices R and W’’;

c. Redesignating paragraph (o)(9) as (o)(13), paragraph (o)(10) as (o)(14), paragraph (o)(11) as (o)(15), and paragraph (o)(12) as (o)(16), paragraph (o)(8) as (o)(10), and paragraph (o)(7) as (o)(8),;

d. Adding new paragraphs (o)(7), (9), (11), and (12);

e. Adding paragraph (p)(7); and

f. Removing paragraph (v).

The additions read as follows:

§430.3 Materials incorporated by reference.

* * * * *

(e) * * *

(8) ANSI C78.901-2014, American National Standard for Electric Lamps—Single-Based Fluorescent Lamps—Dimensional and Electrical Characteristics, ANSI approved July 2, 2014; IBR approved for appendix W to subpart B.

* * * * *

(o) * * *

(7) IES LM-54-12, IES Guide to Lamp Seasoning, approved October 22, 2012; IBR approved for appendix W to subpart B, as follows:

(i) Section 4 – Physical/Environmental Test Conditions;

(ii) Section 5 – Electrical Test Conditions;

(iii) Section 6 – Test Procedure Requirements: Section 6.1 – Test Preparation; and

(iv) Section 6 – Test Procedure Requirements, Section 6.2 – Seasoning Test Procedures: Section 6.2.2.1 – Discharge Lamps: Discharge Lamps except T5 fluorescent.

* * * * *

(9) IES LM-65-14, IES Approved Method for Life Testing of Single-Based Fluorescent Lamps, approved December 30, 2014; IBR approved for appendix W to subpart B, as follows:

(i) Section 4.0 – Ambient and Physical Conditions;

(ii) Section 5.0 – Electrical Conditions; and

(iii) Section 6.0 – Lamp Test Procedures

* * * * *

(11) IES LM-66-14, ("IES LM-66"), IES Approved Method for the Electrical and Photometric Measurements of Single-Based Fluorescent Lamps, approved December 30, 2014; IBR approved for appendix W to subpart B, as follows:

(i) Section 4.0 – Ambient and Physical Conditions;

(ii) Section 5.0 – Power Source Characteristics; and

(iii) Section 6.0 – Testing Procedures Requirements.

(12) IESNA LM-78-07, IESNA Approved Method for Total Luminous Flux Measurement of Lamps Using an Integrating Sphere Photometer, approved January 28, 2007; IBR approved for appendix W to subpart B.

* * * * *

(p) * * *

(7) IEC 62301, ("IEC 62301-W"), Household electrical appliances—Measurement of standby power, (Edition 2.0, 2011-01), Section 5 – Measurements, IBR approved for appendix W to subpart B.

* * * * *

7. Section 430.23 is amended by revising paragraph (y) to read as follows:

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

* * * * *

(y) Compact fluorescent lamps. (1) Measure initial lumen output, input power, initial lamp efficacy, lumen maintenance at 1,000 hours, lumen maintenance at 40 percent of lifetime of a compact fluorescent lamp (as defined in 10 CFR 430.2), color rendering index (CRI), correlated color temperature (CCT), power factor, start time, standby mode energy consumption, and time to failure in accordance with appendix W of this subpart. Express time to failure in hours.

(2) Conduct the rapid cycle stress test in accordance with section 3.3 of appendix W of this subpart.

* * * * *

8. Section 430.25 is revised to read as follows:

§430.25 Laboratory Accreditation Program.

The testing for general service fluorescent lamps, general service incandescent lamps (with the exception of lifetime testing), incandescent reflector lamps, compact fluorescent lamps, fluorescent lamp ballasts, and integrated light-emitting diode lamps must be conducted by test laboratories accredited by an Accreditation Body that is a signatory member to the International Laboratory Accreditation Cooperation (ILAC) Mutual Recognition Arrangement (MRA). A manufacturer's or importer's own laboratory, if accredited, may conduct the applicable testing.

9. Appendix W to subpart B of part 430 is revised to read as follows:

Appendix W to Subpart B of Part 430 – Uniform Test Method for Measuring the Energy Consumption of Compact Fluorescent Lamps

Note: Before [**INSERT DATE 180 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER**], any representations, including certifications of compliance, made with respect to the energy use or efficiency of medium base compact fluorescent lamps must be made in accordance with the results of testing pursuant either to this appendix, or to the applicable test requirements set forth in 10 CFR parts 429 and 430 as they appeared in the 10 CFR parts 200 to 499 annual edition revised as of January 1, 2016.

On or after [**INSERT DATE 180 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER**], any representations, including certifications of compliance (if required), made with respect to the energy use or efficiency of CFLs must be made in accordance with the results of testing pursuant to this appendix.

1. Scope:

1.1. Integrated compact fluorescent lamps.

1.1.1. This appendix specifies the test methods required to measure the initial lamp efficacy, lumen maintenance at 1,000 hours, lumen maintenance at 40 percent of lifetime, time to failure, power factor, correlated color temperature (CCT), color rendering index (CRI), and start time of an integrated compact fluorescent lamp.

1.1.2. This appendix describes how to conduct rapid cycle stress testing for integrated compact fluorescent lamps.

1.1.3. This appendix specifies test methods required to measure standby mode energy consumption applicable to integrated CFLs capable of operation in standby mode (as defined in §430.2), such as those that can be controlled wirelessly.

1.2. Non-integrated compact fluorescent lamps.

1.2.1. This appendix specifies the test methods required to measure the initial lamp efficacy, lumen maintenance at 40 percent of lifetime, time to failure, CCT, and CRI for non-integrated compact fluorescent lamps.

2. Definitions:

2.1. Ballasted adapter means a ballast that is not permanently attached to a compact fluorescent lamp, has no consumer-replaceable components, and serves as an adapter by incorporating both a lamp socket and a lamp base.

2.2. Hybrid compact fluorescent lamp means a compact fluorescent lamp that incorporates one or more supplemental light sources of different technology.

2.3. Initial lamp efficacy means the lamp efficacy (as defined in §430.2) at the end of the seasoning period, as calculated pursuant to section 3.2.2.9 of this appendix.

2.4. Integrated compact fluorescent lamp means an integrally ballasted compact fluorescent lamp that contains all components necessary for the starting and stable operation of the lamp, contains an ANSI standard base, does not include any replaceable or interchangeable parts, and is capable of being connected directly to a branch circuit through a corresponding ANSI standard lamp-holder (socket).

2.5. Labeled wattage means the highest wattage marked on the lamp and/or lamp packaging.

2.6. Lumen maintenance means the lumen output measured at a given time in the life of the lamp and expressed as a percentage of the measured initial lumen output.

2.7. Measured initial input power means the input power to the lamp, measured at the end of the lamp seasoning period, and expressed in watts (W).

2.8. Measured initial lumen output means the lumen output of the lamp measured at the end of the lamp seasoning period, expressed in lumens (lm).

2.9. Non-integrated compact fluorescent lamp means a compact fluorescent lamp that is not an integrated compact fluorescent lamp.

2.10. Percent variability means the result of dividing the difference between the maximum and minimum values by the average value for a contiguous set of separate time-averaged light output values spanning the specified time period. For a waveform of measured light output values, the time-averaged light output is computed over one full cycle of sinusoidal input voltage, as a moving average where the measurement interval is incremented by one sample for each successive measurement value.

2.11. Power factor means the measured input power (watts) divided by the product of the measured RMS input voltage (volts) and the measured RMS input current (amps).

2.12. Rated input voltage means the voltage(s) marked on the lamp as the intended operating voltage or, if not marked on the lamp, 120 V.

2.13. Start plateau means the first 100 millisecond period of operation during which the percent variability does not exceed 5 percent.

2.14. Start time means the time, measured in milliseconds, between the application of power to the compact fluorescent lamp and the beginning of the start plateau.

2.15. Time to failure means the time elapsed between first use and the point at which the compact fluorescent lamp (for a hybrid CFL, the primary light source) ceases to produce measureable lumen output.

3. Active Mode Test Procedures

3.1. General Instructions.

3.1.1. In cases where there is a conflict, the language of the test procedure in this appendix takes precedence over any materials incorporated by reference.

3.1.2. Maintain lamp operating orientation throughout seasoning and testing, including storage and handling between tests.

3.1.3. Season CFLs prior to photometric and electrical testing in accordance with sections 4, 5, 6.1, and 6.2.2.1 of IES LM-54-12 (incorporated by reference, see §430.3). Season the CFL for a minimum of 100 hours in accordance with section 6.2.2.1 of IES LM-54-12. During the 100 hour seasoning period, cycle the CFL

(operate the lamps for 180 minutes, 20 minutes off) as specified in section 6.4 of IES LM-65-14 (incorporated by reference; see §430.3).

3.1.3.1. Unit operating time during seasoning may be counted toward time to failure, lumen maintenance at 40 percent of lifetime of a compact fluorescent lamp (as defined in §430.2), and lumen maintenance at 1,000 hours if the required operating cycle and test conditions for time to failure testing per section 3.3.1 of this appendix are satisfied.

3.1.3.2. If a lamp breaks, becomes defective, fails to stabilize, exhibits abnormal behavior (such as swirling), or stops producing light prior to the end of the seasoning period, the lamp must be replaced with a new unit. If a lamp exhibits one of the conditions listed in the previous sentence after the seasoning period, the lamp's measurements must be included in the sample. Record number of lamps replaced, if any.

3.1.4. Conduct all testing with the lamp operating at labeled wattage. This requirement applies to all CFLs, including those that are dimmable or multi-level.

3.1.5. Operate the CFL at the rated input voltage throughout testing. For a CFL with multiple rated input voltages including 120 volts, operate the CFL at 120 volts. If a CFL with multiple rated input voltages is not rated for 120 volts, operate the CFL at the highest rated input voltage.

3.1.6. Test CFLs packaged with ballasted adapters or designed exclusively for use with ballasted adapters as non-integrated CFLs, with no ballasted adapter in the circuit.

3.1.7. Conduct all testing of hybrid CFLs with all supplemental light sources in the lamp turned off, if possible. Before taking measurements, verify that the lamp has stabilized in the operating mode that corresponds to its primary light source.

3.2. Test Procedures for Determining Initial Lamp Efficacy, Lumen Maintenance, CCT, CRI, and Power Factor.

Determine initial lamp efficacy, lumen maintenance at 40 percent of lifetime of a compact fluorescent lamp (as defined in in §430.2), CCT, and CRI for integrated and non-integrated CFLs. Determine lumen maintenance at 1,000 hours and power factor for integrated CFLs only.

3.2.1. Test Conditions and Setup

3.2.1.1. Test half of the units in the sample in the base up position, and half of the units in the base down position; if the position is restricted by the manufacturer, test the units in the manufacturer-specified position.

3.2.1.2. Establish ambient conditions, power supply, auxiliary equipment, circuit setup, lamp connections, and instrumentation in accordance with the

specifications in sections (and corresponding subsections) 4.0, 5.0 and 6.0 of IES LM-66-14 (incorporated by reference; see §430.3), except maintain ambient temperature at 25 ± 1 °C (77 ± 1.8 °F).

3.2.1.3. Non-integrated CFLs must adhere to the reference ballast requirements in section 5.2 of IES LM-66 (incorporated by reference; see §430.3).

3.2.1.3.1. Test non-integrated lamps rated for operation on and having reference ballast characteristics for either low frequency or high frequency circuits (e.g., many preheat start lamps) at low frequency.

3.2.1.3.2. For low frequency operation, test non-integrated lamps rated for operation on either preheat start (starter) or rapid start (no starter) circuits on preheat.

3.2.1.3.3. Operate non-integrated CFLs not listed in ANSI C78.901-2014 (incorporated by reference; see §430.3) using the following reference ballast settings:

3.2.1.3.3.1. Operate 25-28 W, T5 twin 2G11-based lamps that are lower wattage replacements of 40 W, T5 twin 2G11-based

lamps using the following reference ballast settings: 60 Hz, 400 volts, 0.270 amps, and 1240 ohms.

3.2.1.3.3.2. Operate 14-15 W, T4 quad G24q-2-based lamps that are lower wattage replacements of 18 W, T4 quad G24q-2-based lamps using the following reference ballast settings: 60 Hz, 220 volts, 0.220 amps, and 815 ohms.

3.2.1.3.3.3. Operate 21 W, T4 quad G24q-3-based lamps that are lower wattage replacements of 26 W, T4 quad G24q-3-based lamps using the following reference ballast settings: 60 Hz, 220 volts, 0.315 amps, and 546 ohms.

3.2.1.3.3.4. Operate 21 W, T4 quad G24d-3-based lamps that are lower wattage replacements of 26 W, T4 quad G24d-3-based lamps using the following reference ballast settings: 60 Hz, 220 volts, 0.315 amps, and 546 ohms.

3.2.1.3.3.5. Operate 21 W, T4 multi (6) GX24q-3-based lamps that are lower wattage replacements of 26 W, T4 multi (6) GX24q-3-based lamps using the following reference ballast settings: 60 Hz, 220 volts, 0.315 amps, and 546 ohms.

3.2.1.3.3.6. Operate 27-28 W, T4 multi (6) GX24q-3-based lamps that are lower wattage replacements of 32 W, T4 multi (6) GX24q-3-based lamps using the following reference ballast settings: 20-26 kHz, 200 volts, 0.320 amps, and 315 ohms.

3.2.1.3.3.7. Operate 33-38 W, T4 multi (6) GX24q-4-based lamps that are lower wattage replacements of 42 W, T4 multi (6) GX24q-4-based lamps using the following reference ballast settings: 20-26 kHz, 270 volts, 0.320 amps, and 420 ohms.

3.2.1.3.3.8. Operate 10 W, T4 square GR10q-4-based lamps using the following reference ballast settings: 60 Hz, 236 volts, 0.165 amps, and 1,200 ohms.

3.2.1.3.3.9. Operate 16 W, T4 square GR10q-4-based lamps using the following reference ballast settings: 60 Hz, 220 volts, 0.195 amps, and 878 ohms.

3.2.1.3.3.10. Operate 21 W, T4 square GR10q-4-based lamps using the following reference ballast settings: 60 Hz, 220 volts, 0.260 amps, and 684 ohms.

3.2.1.3.3.11. Operate 28 W, T6 square GR10q-4-based lamps using the following reference ballast settings: 60 Hz, 236 volts, 0.320 amps, and 578 ohms.

3.2.1.3.3.12. Operate 38 W, T6 square GR10q-4-based lamps using the following reference ballast settings: 60 Hz, 236 volts, 0.430 amps, and 439 ohms.

3.2.1.3.3.13. Operate 55 W, T6 square GRY10q-3-based lamps using the following reference ballast settings: 60 Hz, 236 volts, 0.430 amps, and 439 ohms.

3.2.1.3.3.14. For all other lamp designs not listed in ANSI C78.901-2014 (incorporated by reference; see §430.3) or section 3.2.1.3.3 of this appendix:

3.2.1.3.3.14.1. If the lamp is a lower wattage replacement of a lamp with specifications in ANSI C78.901-2014, use the reference ballast characteristics of the corresponding higher wattage lamp replacement in ANSI C78.901-2014.

3.2.1.3.3.14.2. For all other lamps, use the reference ballast characteristics in ANSI C78.901-2014 for a lamp with the

most similar shape, diameter, and base specifications, and next closest wattage.

3.2.2. Test Methods, Measurements, and Calculations

3.2.2.1. Season CFLs. (See section 3.1.3 of this appendix.)

3.2.2.2. Stabilize CFLs as specified in section 6.2.1 of IES LM-66 (incorporated by reference; see §430.3).

3.2.2.3. Measure the input power (in watts), the input voltage (in volts), and the input current (in amps) as specified in section 5.0 of IES LM-66 (incorporated by reference; see §430.3).

3.2.2.4. Measure initial lumen output as specified in section 6.3.1 of IES LM-66 (incorporated by reference; see §430.3) and in accordance with IESNA LM-78-07 (incorporated by reference; see §430.3).

3.2.2.5. Measure lumen output at 1,000 hours as specified in section 6.3.1 of IES LM-66 (incorporated by reference; see §430.3) and in accordance with IESNA LM-78-07 (incorporated by reference; see §430.3).

3.2.2.6. Measure lumen output at 40 percent of lifetime of a compact fluorescent lamp (as defined in 10 CFR 430.2) as specified in section 6.3.1

of IES LM-66 (incorporated by reference; see §430.3) and in accordance with IESNA LM-78-07 (incorporated by reference; see §430.3).

3.2.2.7. Determine CCT as specified in section 6.4 of IES LM-66 (incorporated by reference; see §430.3) and in accordance with CIE 15 (incorporated by reference; see §430.3).

3.2.2.8. Determine CRI as specified in section 6.4 of IES LM-66 (incorporated by reference; see §430.3) and in accordance with CIE 13.3 (incorporated by reference; see §430.3).

3.2.2.9. Determine initial lamp efficacy by dividing measured initial lumen output by the measured initial input power.

3.2.2.10. Determine lumen maintenance at 1,000 hours by dividing measured lumen output at 1,000 hours by the measured initial lumen output.

3.2.2.11. Determine lumen maintenance at 40 percent of lifetime of a compact fluorescent lamp (as defined in §430.2) by dividing measured lumen output at 40 percent of lifetime of a compact fluorescent lamp (as defined in §430.2) by the measured initial lumen output.

3.2.2.12. Determine power factor by dividing the measured input power (watts) by the product of measured RMS input voltage (volts) and measured RMS input current (amps).

3.3. Test Method for Time to Failure and Rapid Cycle Stress Test.

Determine time to failure for integrated and non-integrated CFLs. Conduct rapid cycle stress testing for integrated CFLs only. Disregard section 3.0 of IES LM-65-14.

3.3.1. Test Conditions and Setup

3.3.1.1. Test half of the units in the base up position and half of the units in the base down position; if the position is restricted by the manufacturer, test in the manufacturer-specified position.

3.3.1.2. Establish the ambient and physical conditions and electrical conditions in accordance with the specifications in sections 4.0 and 5.0 of IES LM-65-14 (incorporated by reference; see §430.3). Do not, however, test lamps in fixtures or luminaires.

3.3.1.3. Non-integrated CFLs must adhere to ballast requirements as specified in section 3.2.1.3 of this appendix.

3.3.2. Test Methods and Measurements

3.3.2.1. Season CFLs. (See section 3.1.3 of this appendix.)

3.3.2.2. Measure time to failure of CFLs as specified in section 6.0 of IES LM-65-14 (incorporated by reference; see §430.3).

3.3.2.3. Conduct rapid cycle stress testing of integrated CFLs as specified in section 6.0 of IES LM-65-14 (incorporated by reference; see §430.3), except cycle the lamp continuously with each cycle consisting of one 5-minute ON period followed by one 5-minute OFF period.

3.4. Test Method for Start Time.

Determine start time for integrated CFLs only.

3.4.1. Test Conditions and Setup

3.4.1.1. Test all units in the base up position; if the position is restricted by the manufacturer, test units in the manufacturer-specified position.

3.4.1.2. Establish the ambient conditions, power supply, auxiliary equipment, circuit setup, lamp connections, and instrumentation in accordance with the specifications in sections 4.0 and 5.0 of IES LM-66

(incorporated by reference; see §430.3), except maintain ambient temperature at 25 ± 1 °C (77 ± 1.8 °F).

3.4.2. Test Methods and Measurement

3.4.2.1. Season CFLs. (See section 3.1.3 of this appendix.)

3.4.2.2. After seasoning, store units at 25 ± 5 °C ambient temperature for a minimum of 16 hours prior to the test, after which the ambient temperature must be 25 ± 1 °C for a minimum of 2 hours immediately prior to the test. Any units that have been off for more than 24 hours must be operated for a minimum of 3.0 hours and then be turned off for 16 to 24 hours prior to testing.

3.4.2.3. Connect multichannel oscilloscope with data storage capability to record input voltage to CFL and light output. Set oscilloscope to trigger at 10 V lamp input voltage. Set oscilloscope vertical scale such that vertical resolution is 1 percent of measured initial light output or finer. Set oscilloscope to sample the light output waveform at a minimum rate of 2 kHz.

3.4.2.4. Operate the CFL at the rated voltage and frequency.

3.4.2.5. Upon the commencement of start time testing, record sampled light output until start plateau has been determined.

3.4.2.6. Calculate the time-averaged light output value at least once every millisecond where the time-averaged light output is computed over one full cycle of sinusoidal input voltage, as a moving average where the measurement interval is incremented by one sample for each successive measurement value.

3.4.2.7. Determine start time.

4. Standby Mode Test Procedure

Measure standby mode energy consumption for only integrated CFLs that are capable of operating in standby mode. The standby mode test method in this section may be completed before or after the active test method for determining lumen output, input power, CCT, CRI, and power factor in section 3 of this appendix. The standby mode test method in this section must be completed before the active mode test method for determining time to failure in section 3.3 of this appendix. The standby mode test method must be completed in accordance with applicable provisions in section 3.1.

4.1. Test Conditions and Setup

4.1.1. Position half of the units in the sample in the base up position and half of the units in the base down position; if the position is restricted by the manufacturer, test units in the manufacturer-specified position.

4.1.2. Establish the ambient conditions (including air flow), power supply, electrical settings, and instrumentation in accordance with the specifications in sections 4.0, 5.0 and 6.0 of IES LM-66 (incorporated by reference; see §430.3), except maintain ambient temperature at 25 ± 1 °C (77 ± 1.8 °F).

4.2. Test Methods, Measurements, and Calculations

4.2.1. Season CFLs. (See section 3.1.3 of this appendix.)

4.2.2. Connect the integrated CFL to the manufacturer-specified wireless control network (if applicable) and configure the integrated CFL in standby mode by sending a signal to the integrated CFL instructing it to have zero light output. The integrated CFL must remain connected to the network throughout the entire duration of the test.

4.2.3. Stabilize the integrated CFL prior to measurement as specified in section 5 of IEC 62301-W (incorporated by reference; see §430.3).

4.2.4. Measure the standby mode energy consumption in watts as specified in section 5 of IEC 62301-W (incorporated by reference; see §430.3).

10. Section 430.32 is amended by revising paragraph (u) to read as follows:

§430.32 Energy and water conservation standards and their compliance dates.

* * * * *

(u) Compact fluorescent lamps. (1) Medium Base Compact Fluorescent Lamps. A bare or covered (no reflector) medium base compact fluorescent lamp manufactured on or after January 1, 2006, must meet the following requirements:

Factor	**Requirements**
Labeled Wattage (Watts) & Configuration *	Measured initial lamp efficacy (lumens per watt) must be at least:
Bare Lamp:	
Labeled Wattage < 15	45.0
Labeled Wattage ≥ 15	60.0
Covered Lamp (no reflector):	
Labeled Wattage < 15	40.0
15 ≤ Labeled Wattage < 19	48.0
19 ≤ Labeled Wattage < 25	50.0
Labeled Wattage ≥ 25	55.0
Lumen Maintenance at 1,000 Hours	≥90.0%
Lumen Maintenance at 40 Percent of Lifetime**	≥80.0%
Rapid Cycle Stress Test	Each lamp must be cycled once for every 2 hours of lifetime.** At least 5 lamps must meet or exceed the minimum number of cycles.
Lifetime**	≥6,000 hours

* Use labeled wattage to determine the appropriate efficacy requirements in this table; do not use measured wattage for this purpose.

** Lifetime refers to lifetime of a compact fluorescent lamp as defined in 10 CFR 430.2.

(2) [Reserved].

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