[6450-01-P]

DEPARTMENT OF ENERGY

10 CFR Parts 429 and 430

[Docket No. EERE-2011-BT-TP-0071]

RIN: 1904-AC67

Energy Conservation Program: Test Procedures for Light-Emitting Diode Lamps

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

ACTION: Notice of proposed rulemaking.

SUMMARY: The U.S. Department of Energy (DOE) proposes to establish test procedures for light-emitting diode (LED) lamps to support implementation of labeling provisions by the Federal Trade Commission (FTC) established under the Energy Policy and Conservation Act (EPCA). The proposed test procedures define methods for measuring the lumen output, input power, and relative spectral distribution (to determine correlated color temperature, or CCT) of LED lamps. Further, the proposed test procedures define methods for measuring the lumen maintenance of the LED source (the component of the LED lamp that produces light) to project the rated lifetime of LED lamps. The rated lifetime of the LED lamp is the time required for the LED source component of the lamp to reach lumen maintenance of 70 percent (that is, 70 percent of initial light output). After reviewing available industry standards for determining the lumen output, input power, CCT, and rated lifetime, as well as current best practices and technological developments, DOE tentatively identified that the test methods described in the relevant Illuminating Engineering Society of North America (IES) standards are appropriate for

developing test procedures for LED lamps. The proposed test procedures are based in large part on IES standards LM-79-2008, "Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products" for determining lumen output, input power, and CCT, and LM-80-2008, "Approved Method: Measuring Lumen Maintenance of LED Sources" and TM-21-2011, "Projecting Long Term Lumen Maintenance of LED Light Sources," for determining rated lifetime, with some modifications as required.

DATES: DOE will hold a public meeting on Thursday, May 3, 2012, from 9 a.m. to 4 p.m., in Washington, DC. The meeting will also be broadcast as a webinar. See section V, "Public Participation," for webinar registration information, participant instructions, and information about the capabilities available to webinar participants.

DOE will accept comments, data, and information regarding this notice of proposed rulemaking (NOPR) before and after the public meeting, but no later than [**INSERT DATE 75 DAYS AFTER FEDERAL REGISTER PUBLICATION**]. See section V, "Public Participation," for details.

ADDRESSES: The public meeting will be held at the U.S. Department of Energy, Forrestal Building, Room 8E-089, 1000 Independence Avenue, SW., Washington, DC 20585. To attend, please notify Ms. Brenda Edwards at (202) 586–2945. Please note that foreign nationals visiting DOE Headquarters are subject to advance security screening procedures. Any foreign national wishing to participate in the meeting should advise DOE as soon as possible by contacting Ms. Edwards to initiate the necessary procedures. Please also note that those wishing to bring laptops into the Forrestal Building will be required to obtain a property pass. Visitors should avoid

bringing laptops, or allow an extra 45 minutes. Persons can attend the public meeting via webinar. For more information, refer to the Public Participation section near the end of this notice.

Any comments submitted must identify the NOPR for Test Procedures for LED lamps, and provide docket number EERE-2011–BT–TP–0071 and/or regulatory information number (RIN) number 1904-AC67. Comments may be submitted using any of the following methods:

1. Federal eRulemaking Portal: http://www.regulations.gov Follow the instructions for submitting comments.
2. E-mail: LEDLamps-2011-TP-0071@ee.doe.gov. Include the docket number and/or RIN in the subject line of the message.
3. Mail: Ms. Brenda Edwards, U.S. Department of Energy, Building Technologies Program, Mailstop EE-2J, 1000 Independence Avenue, SW., Washington, DC, 20585-0121. If possible, please submit all items on a CD. It is not necessary to include printed copies.
4. Hand Delivery/Courier: Ms. Brenda Edwards, U.S. Department of Energy, Building Technologies Program, 950 L'Enfant Plaza, SW., Suite 600, Washington, DC, 20024. Telephone: (202) 586-2945. If possible, please submit all items on a CD. It is not necessary to include printed copies.

For detailed instructions on submitting comments and additional information on the rulemaking process, see section V of this document (Public Participation).

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

The www.regulations.gov web page contains simple instructions on how to access all documents, including public comments, in the docket. See section V for information on how to submit comments through www.regulations.gov.

For further information on how to submit a comment, review other public comments and the docket, or participate in the public meeting, contact Ms. Brenda Edwards at (202) 586-2945 or by email: Brenda.Edwards@ee.doe.gov.

FOR FURTHER INFORMATION CONTACT:

Ms. Lucy deButts, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Program, EE-2J, 1000 Independence Avenue, SW., Washington, DC, 20585-0121. Telephone: (202) 287-1604. E-mail: Lucy.deButts@ee.doe.gov.

Mr. Ari Altman, U.S. Department of Energy, Office of the General Counsel, GC-71, 1000 Independence Avenue, SW., Washington, DC, 20585-0121. Telephone: (202) 287-6307. E-mail: Ari.Altman@hq.doe.gov

SUPPLEMENTARY INFORMATION:

Table of Contents

VI. Approval of the Office of the Secretary

I. Authority and Background

Title III of the Energy Policy and Conservation Act (42 U.S.C. 6291, et seq.; "EPCA" or, "the Act") sets forth a variety of provisions designed to improve energy efficiency. (All references to EPCA refer to the statute as amended through the Energy Independence and Security Act of 2007 (EISA 2007), Pub. L. 110-140 (Dec. 19, 2007)). 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), establishes the "Energy Conservation Program for Consumer Products Other Than Automobiles."

Under EPCA, this program consists of four parts: (1) testing, (2) labeling, (3) Federal energy conservation standards, and (4) certification and enforcement procedures. This rulemaking establishes test procedures that manufacturers of light-emitting diode (LED) lamps would use to meet obligations under labeling requirements promulgated by the Federal Trade Commission (FTC) under section 324(a)(6) of EPCA (42 U.S.C. 6294(a)(6)).

Test Procedure Rulemaking Process

When the U.S. Department of Energy (DOE) proposes test procedures, it must offer the public an opportunity to present oral and written comments on them. (42 U.S.C. 6293(b)(2)) EISA 2007 section 321(b) amended EPCA (42 U.S.C. 6294(a)(2)(C)) to direct FTC to consider the effectiveness of lamp labeling for power levels or watts, light output or lumens, and lamp lifetime. This test procedure rulemaking for LED lamps is being conducted to support FTC's

determination that LED lamps, which had previously not been labeled, require labels under EISA section 321(b) and 42 U.S.C. 6294(a)(6) in order to assist consumers in making purchasing decisions. 75 FR 41696, 41698 (July 19, 2010)

FTC has published a final rule for light bulb[1] labeling (Lighting Facts) that went into effect on January 1, 2012. 75 FR 41696 (July 19, 2010) The FTC Lighting Facts label covers three types of medium screw base lamps: general service incandescent lamps (GSIL), compact fluorescent lamps (CFL), and general service LED lamps[2]. The label requires manufacturers to disclose information about the lamp's brightness[3] (lumen output), estimated annual energy cost, life[4] (rated lifetime), light appearance (correlated color temperature (CCT)), and energy use (input power). FTC requires that the estimated annual energy cost is calculated by multiplying the energy used by annual operating hours and an estimate for energy cost per kilowatt-hour. FTC references DOE test procedures, when available, for testing lamps for the FTC Lighting Facts label. This test procedure rulemaking would enable FTC to reference a DOE test procedure for LED lamps.

In this notice of proposed rulemaking (NOPR), DOE proposes test procedures for determining the lumen output, input power, CCT, and rated lifetime of LED lamps. DOE invites comment on all aspects of the proposed test procedure for LED lamps.

II. Summary of the Notice of Proposed Rulemaking

[1] FTC uses the term 'bulb,' while DOE uses the term 'lamp.' Bulb and lamp refer to the same product.
[2] FTC defines general service LED lamps as a lamp that is a consumer product; has a medium screw base; has a lumen range not less than 310 lumens and not more than 2,600 lumen; and, is capable of being operated at a voltage range at least partially within 110 and 130 volts. This test procedure rulemaking could be applied to general service LED lamps as defined by FTC as well as all other integrated LED lamps as discussed in section III.A of this NOPR.
[3] FTC uses the term 'brightness' on the Lighting Facts label even though 'light output' is the technically correct term because FTC's research indicated that consumers prefer the term 'brightness' to 'light output.'
[4] FTC uses the term 'life' while DOE uses the term 'rated lifetime.' Life and rated lifetime have the same meaning.

In this NOPR, DOE proposes test procedures for determination of lumen output, input power, CCT, and rated lifetime of an LED lamp. Specifically, DOE proposes to incorporate by reference IES[5] LM-79-2008[6] for determination of lumen output, input power, and CCT, UL[7] 1993-2009[8] for support of the in-situ temperature measurement test (ISTMT), IES standards LM-80-2008[9] and TM-21-2011[10] for determination of rated lamp lifetime, and ANSI[11]/IESNA[12] RP-16-2010[13] for the definition of integrated LED lamps. DOE reviewed several potential approaches to testing lamp lumen output, input power, CCT, and rated lifetime, and determined that these UL and IES standards are the best standards based on discussions with industry experts. These standards are adequately specified to generate reliable results and are generally used by industry for determining photometric characteristics of LED lamps.

DOE conducted literature research and determined that IES LM-79-2008 is the standard used by industry to determine the electrical and photometric characteristics of LED lamps. IES LM-79-2008 provides the test setup, test conditions including instrumentation and electrical settings, test method, and calculations for determining the input power, lumen output, and CCT of LED lamps. Section III.B details the relevant sections of IES LM-79-2008 that are incorporated by reference, and any proposed changes, if required.

[5] Illuminating Engineering Society of North America
[6] "Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products." Approved December 31, 2007.
[7] Underwriters Laboratories Inc.
[8] "Standard for Safety, Self-Ballasted Lamps and Lamp Adapters." Published August 28, 2009.
[9] "Approved Method: Measuring Lumen Maintenance of LED Sources." Approved September 22, 2008.
[10] "Projecting Long Term Lumen Maintenance of LED Light Sources." Approved July 25, 2011.
[11] American National Standards Institute.
[12] Illuminating Engineering Society of North America (also abbreviated as IES).
[13] "Nomenclature and Definitions for Illuminating Engineering." Approved by ANSI on October 16, 2009. Approved by IES on November 15, 2009.

To develop a Federal test procedure for determining the rated lifetime of LED lamps, DOE conducted literature research and interviewed several industry experts to understand the methods used by industry to determine the rated lifetime of LED lamps. Due to the infancy of the technology, there are no industry standards that describe a methodology for determining rated lifetime based on direct measurements of an LED lamp. Based on the information currently available, DOE determined that IES LM-80-2008 should be used to measure the lumen maintenance[14] of an LED source[15] at the in-situ temperature determined by performing an ISTMT. The test setup and conditions for conducting the ISTMT should be as specified in UL 1993-2009. Finally, the LED source rated lifetime should be projected using the method described in IES TM-21-2011. DOE is proposing that the lumen maintenance of the LED source be measured and projected rather than the lumen maintenance of the LED lamp because currently there are no well-specified and established methods for projecting LED lamp lumen maintenance data. The proposed method is based on industry accepted measurements and projection methods and does not require operating the lamp until it reaches its rated lifetime. DOE discusses this determination in more detail in section III.C.1. DOE is proposing to define rated lifetime as the time when the lumen output of the LED sources within the LED lamp falls below 70 percent of the initial light output. Section III.C details the test method to determine the rated lifetime and the relevant sections of UL 1993-2009, IES LM-80-2008, and IES TM-21-2011 that are incorporated by reference, and any changes, if required.

[14] Lumen maintenance is the lumen output at a given point of time, expressed as a percentage of the initial lumen output. While the lumen output of the LED source is measured for use in the lumen maintenance calculation, the term lumen maintenance is used in this NOPR to indicate that lumen output is measured over a period of time.
[15] The term "LED source" refers to the assembly of components or dies, including the electrical connections, printed on a circuit board or substrate. The LED source does not include the power source or base, but could possibly incorporate optical elements and additional thermal, mechanical, and electrical interfaces that are intended to connect to the load side of a LED driver. The LED source is the component of the LED lamp that produces light.

III. Discussion

A. Scope of Applicability

This rulemaking is applicable to LED lamps that fall within DOE's proposed definition of an LED lamp in 10 CFR Part 430.2, which is based on the term integrated LED lamps as defined by ANSI/IESNA RP-16-2010, "Nomenclature and Definitions for Illuminating Engineering." These integrated lamps comprise the LED source (the LED packages (components) or LED arrays (modules)), LED driver, ANSI standard base, and other optical, thermal, mechanical and electrical components such as phosphor layers, insulating materials, fasteners to hold components within the lamp together, and electrical wiring. The LED lamp is intended to connect directly to a branch circuit through a corresponding ANSI standard socket. EPCA, as amended by EISA 2007 section 321(a)(1)(B), adds the definition for LED as a p-n junction[16] solid state device, the radiated output of which, either in the infrared region, the visible region, or the ultraviolet region, is a function of the physical construction, material used, and exciting current[17] of the device. (42 U.S.C. 6291(30)(CC)) DOE invites interested parties to comment on the scope of applicability of this test procedure and the incorporation of ANSI/IESNA RP-16-2010 to define LED lamps.

B. Proposed Approach for Determining Lumen Output, Input Power, and Correlated Color Temperature

1. Overview of Test Procedure

[16] P-n junction is the boundary between p-type and n-type material in a semiconductor device, such as LEDs. P-n junctions are active sites where current can flow readily in one direction but not in the other direction—in other words, a diode.

[17] Exciting current is the current passing through an LED chip during steady state operation.

DOE reviewed industry standards and spoke with industry experts to determine the best method for measuring the lumen output, input power, and CCT of LED lamps. DOE reviewed the IEC[18]/PAS[19] pre-standard 62612[20] for determining the performance of self-ballasted LED lamps[21], but this standard did not specify a test method for measuring the lumen output of LED lamps and is not yet a finalized document. Next, DOE reviewed the method specified by the ENERGY STAR® program and observed that it references IES LM-79-2008 for determining the lumen output, input power, and CCT of integrated LED lamps. In review of IES LM-79-2008, DOE found IES is the recognized technical authority on illumination, and the IES LM-79-2008 standard was prepared by the IES subcommittee on Solid State Light Sources of the IESNA Testing Procedures Committee. IES LM-79-2008 was also developed in collaboration with the ANSI Solid State Lighting Joint Working Group C78-09 and C82-04 comprising individuals from several organizations. DOE's view is that the committee members that worked on developing the IES LM-79-2008 standard represent applicable industry groups and interested parties. Based on an independent review by DOE and general acceptance by industry, DOE concluded that IES LM-79-2008 specifies all the information that is required for providing a complete test procedure for determining lumen output, input power, and CCT of LED lamps. However, DOE is proposing some modifications so that the test method better serves DOE's needs.

IES LM-79-2008 specifies the test setup and conditions at which the measurements and calculations must be performed. These include ambient conditions, power supply characteristics,

[18] International Electrotechnical Commission.
[19] Publicly Available Specifications. An IEC PAS is a publication responding to an urgent market need.
[20] "Publically Available Specification, Pre-standard: Self-ballasted LED-lamps for General Lighting Services – Performance Requirements." Published June 2009.
[21] A self-ballasted LED lamp as defined by the IEC refers to the same product as the term integrated LED lamp.

lamp orientation, seasoning, and stabilization methods for LED lamps, and instrumentation and electrical settings. These requirements, and any modifications proposed by DOE, are further discussed in the sections III.B.2 through III.B.5. DOE requests comment on the proposed incorporation of IES LM-79-2008 for determining lumen output, input power, and CCT.

2. Test Conditions

DOE proposes that the ambient conditions for testing LED lamps be as specified in section 2.0[22] of IES LM-79-2008. DOE recognizes that lumen output of LED lamps can vary with changes in ambient temperature and air movement around the LED lamp. The test conditions outlined in IES LM-79-2008 ensure reliable, repeatable, and consistent test results without significant test burden. These conditions are discussed in further detail below.

Section 2.2 of IES LM-79-2008 specifies that photometric measurements should be taken at an ambient temperature of 25 degrees Celsius (°C) ± 1°C. DOE's view is that a tolerance of 1°C for the ambient temperature is practical, limits the impact of ambient temperature on measurements, and would not be burdensome because the instruments used to measure the temperature provide for a greater accuracy allowing the test laboratories to maintain the temperature within the required tolerance for testing. Section 2.2 further specifies that the temperature should be measured at a point not more than one meter from the LED lamp and at the same height as the lamp. The standard also requires that the temperature sensor that is used for measurements be shielded from direct optical radiation from the lamp or any other source to reduce the impact of radiated heat on the ambient temperature measurement. This setup for

[22] IES standards use the reference 2.0, 3.0, etc. for each primary section heading. Sub-sections under each of these sections are referenced as 2.1, 2.2, 3.1, 3.2, etc. This NOPR refers to each IES section exactly as it is referenced in the standard.

measuring and controlling ambient temperature would result in appropriate testing conditions because it requires that the lamp be tested at room temperature and in an environment that is used most commonly for testing lamp technologies.

DOE proposes that the requirement for air movement around the LED lamp be as specified in section 2.4 of IES LM-79-2008, which requires that the air flow around the LED lamp should be such that it does not affect the lumen output measurements of the lamp being tested. DOE understands that this requirement would ensure consistent LED lamp measurements and is a requirement for the test setup of other lamp types such as GSFLs.

DOE also considered whether a specific method for determination of a draft-free environment should be specified. Section 4.3 of IES LM-9-2009[23] requires that a single ply tissue paper be held in place of the lamp to allow for visual observation of any drafts. DOE requests comment on whether the specification from section 4.3 of IES LM-9-2009 should be required for specifying the air movement around LED lamps.

3. Test Setup

a. Power Supply

DOE proposes that section 3.1 of IES LM-79-2008 be incorporated by reference to specify requirements for both alternating current (AC) and direct current (DC) power supplies. This section specifies that an AC power supply should have a sinusoidal voltage waveshape at

[23] "IES Approved Method for the Electrical and Photometric Measurement of Fluorescent Lamps." Approved January 31, 2009.

the input frequency required by the LED lamp such that the root mean square (RMS)[24] summation of the harmonic components does not exceed three percent of the fundamental frequency[25] while operating the LED lamp. Section 3.2 of IES LM-79-2008 also requires that the voltage of an AC power supply (RMS voltage) or DC power supply (instantaneous voltage) applied to the LED lamp should be within ± 0.2 percent. These requirements are achievable with minimal testing burden and provide reasonable stringency in terms of power quality based on their similarity to voltage tolerance requirements for testing of other lamp types. These requirements ensure that the power supplied to the LED lamps is consistent and, in combination with other specifications, would likely result in repeatable photometric measurements.

b. Lamp Mounting and Orientation

DOE proposes that the LED lamp be mounted as specified in section 2.3 of IES LM-79-2008 and be positioned in the base-up, base-down, and horizontal orientations for testing. Section 2.3 of IES LM-79-2008 requires that the LED lamp should be mounted to the measuring instrument (integrating sphere or goniophotometer as described in section III.B.4.c) in such a manner that the heat flow through supporting objects does not affect the measurement results. This is important because the lumen output of LED lamps is sensitive to thermal changes. DOE's view is that the examples specified in section 2.3 of IES LM-79-2008 (such as suspending a ceiling-mounted LED lamp in open air and using support materials such as Teflon that have low heat conductivity instead of mounting it in close thermal contact with the sphere wall) ensure negligible cooling effects through the supporting objects of the LED lamps and minimal

[24] Root mean square (RMS) voltage/current is a statistical measure of the magnitude of a voltage/current signal. RMS voltage/current is equal to the square root of the mean of all squared instantaneous voltages/currents over one complete cycle of the voltage/current signal.
[25] Fundamental frequency, often referred to as fundamental, is defined as the lowest frequency of a periodic waveform.

disturbance of the air flow around the lamp. DOE proposes that these materials, or other materials with low heat conductivity, should be used to mount the LED lamp.

DOE understands that the orientation of the lamp could affect the thermal conditions within the lamp, which may affect the light output. DOE considered testing the LED lamps as specified in section 6.0 of IES LM-79-2008, which states that the LED lamp should be tested in the operating orientation recommended by the lamp manufacturer for the intended use of the LED lamp. However, manufacturers do not typically specify the operating orientation for the LED lamp in their product literature. Further, it is possible that manufacturers would recommend an orientation for testing that provides the highest lumen output rather than the orientation in which the lamp is most frequently operated in practice. Therefore, DOE proposes that the lamp units should be positioned such that an equal number of units are oriented in the base up, base down, and horizontal orientations each (see section III.D for the sampling requirements). This would ensure that testing is carried out in all possible[26] orientations potentially used in practice, instead of only the highest performance orientation. DOE also requires that the lamps be positioned in the same orientation throughout testing, which would include lamp seasoning (section III.B.4.a), lamp stabilization (section III.B.4.b), and input power (section III.B.3.c) and lumen output measurements (section III.B.4.c). DOE requests comment on the appropriateness of orienting lamps, in the base-up, base-down, and horizontal positions for testing, and requests data on the impact of lamp orientation on the thermal characteristics of the LED lamp, and hence, the light output.

[26] An infinite number of orientations are possible, but base-up, base-down, and horizontal cover the three main possibilities.

c. Instrumentation

DOE proposes that the instrumentation requirements for the AC power meter and the AC and DC voltmeter and ammeter, as well as the acceptable tolerance for these instruments, be as specified in section 8.0 of IES LM-79-2008. Section 8.1 of IES LM-79-2008 specifies that for DC-input LED lamps, a DC voltmeter and DC ammeter should be connected between the DC power supply and the LED lamp under test. The DC voltmeter should be connected across the electrical power input of the LED lamp, and the input electrical power should be calculated as the product of the measured input voltage and current. Section 8.2 of IES LM-79-2008 specifies that the tolerance for the DC voltage and current measurement instruments should be ± 0.1 percent. For AC-input LED lamps, section 8.1 of IES LM-79-2008 further specifies that an AC power meter should be connected between the AC power supply and the LED lamp under test. The AC power, input voltage, and current should be measured. Section 8.2 of IES LM-79-2008 specifies that the tolerance of the AC voltage and current measurement instruments should be ± 0.2 percent and the tolerance of the AC power meter should be ± 0.5 percent. DOE's view is that the instrumentation requirements set forth in section 8.0 of IES LM-79-2008 are achievable and provide reasonable stringency in terms of measurement tolerance based on their similarity to instrument tolerance requirements for testing of other lamp types.

d. Electrical Settings

DOE proposes that the electrical settings for testing LED lamps be as specified in section 7.0 of IES LM-79-2008. Section 7.0 provides guidance on settings such as input voltage, level of light output for dimming capable LED lamps, and the modes for testing lamps with variable CCT. Section 7.0 states that the lamp should be operated at the specified rated voltage during testing. As stated in section 7.0, DOE agrees that any method, such as pulsed input electrical

power and measurements synchronized with reduced duty cycle input power, intended to reduce the p-n junction temperature below that which is reached during operation with normal input power should not be used for testing the LED lamp. Further, for lamps with multiple voltages, DOE proposes that the LED lamp should be tested at 120 volts, unless it is not rated for 120 volts. DOE is proposing that lamps with multiple voltages should be tested at 120 volts because lamps rated at 120 volts are available most commonly in the market. If the LED lamp is not rated for 120 volts, DOE proposes that it should be tested at the highest rated voltage because the lamp is expected to have the best performance at the highest rated voltage. Further, section 7.0 of IES LM-79-2008 specifies that for LED lamps with dimming capabilities, the lamp should be operated at the maximum input power for testing. DOE invites interested parties to comment on the appropriateness of testing LED lamps at the rated voltage and testing lamps that are rated to operate at multiple voltages at either 120 volts or the highest rated voltage. DOE also requests comment on testing lamps with dimming capabilities at the maximum input power.

Lastly, section 7.0 of IES LM-79-2008 specifies that if an LED lamp has multiple modes of operation, including variable CCT, testing should be performed in each mode of operation for each unit. In its research, DOE did not come across any products that function at multiple modes of operation. DOE requests comment about whether LED lamps with variable CCT, or multiple modes of operation, are available in the market. If such lamps are available, DOE requests comment about whether such lamps should be tested at a particular CCT value rather than at each value.

4. Test Method

a. Lamp Seasoning

DOE proposes that the LED lamp under test be seasoned (energized and operated) for 1,000 hours before beginning photometric measurements, contrary to the requirements of section 4.0 of IES LM-79-2008 which indicates no seasoning is required. Though IES LM-79-2008 states that the increase in light output from zero to 1,000 hours of operation does not significantly affect light output or lifetime ratings, IES TM-21-2011 specifies that the data obtained from the first 1,000 hours of operating an LED source should not be used to project the lifetime of an LED source (and hence, LED lamp rated lifetime as discussed in section III.C). DOE is proposing a 1,000 hour seasoning time because it has been established by industry[27, 28] that light output of an LED source (and therefore, potentially the lamp) frequently increases during the first 1,000 hours of operation. If the lamp is not seasoned for 1,000 hours, then depending on the time required to stabilize the lamp (as specified in section III.B.4.b), the lumen output determined through testing may be much higher than the actual lumen output. This may create an incentive to increase the time required to stabilize the lamp such that the highest lumen output is achieved while taking lumen output measurements. Additionally, DOE understands that there may be some lamps that return to the initial lumen output (at zero hours) in less than 1,000 hours and others that may take longer, but proposes that 1,000 hours be used for seasoning all lamps to maintain uniformity. DOE invites interested parties to comment on the proposed seasoning time for the LED lamp under test and any increased testing burden due to seasoning the lamp for 1,000 hours. DOE also requests data on the degree to which the lumen output of the LED lamp changes during the first 1,000 hours of operation.

[27] Cheong, Kuan Yew. "LED Lighting Standards Update." CREE, August 5, 2011. Page 31. <www.nmc.a-star.edu.sg/LED_050811/Kuan_CREE.pdf>

[28] Richman, Eric. "Understanding LED Tests: IES LM-79, LM-80, and TM-21." DOE SSL Workshop, July 2011. Page 13. < http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/richman_tests_sslmiw2011.pdf>

b. Lamp Stabilization

After the lamp has been seasoned, DOE proposes that the time required for lamp stabilization be as specified in section 5.0 of IES LM-79-2008. The ambient conditions and operating orientation of the LED lamp while stabilizing should continue to be as specified in sections III.B.2 and III.B.3.b. DOE further proposes that stability of the LED lamp is reached when the variation [(maximum – minimum)/minimum] of at least three readings of light output and electrical power over a period of 30 minutes, taken 15 minutes apart, is less than 0.5 percent. This calculation in included to add clarification to the method specified in section 5.0 of IES LM-79-2008. For stabilization of a number of products of the same model, section 5.0 of IES LM-79-2008 suggests that preburning[29] of the product may be used if it has been established that the method produces the same stabilized condition as when using the standard method described above. DOE invites interested parties to comment on adopting section 5.0 of IES LM-79-2008 for LED lamp stabilization prior to taking photometric measurements and whether its clarification on the variation calculation is appropriate.

c. Lumen Output Measurement

After the lamp has been seasoned and stabilized, DOE proposes that the test method for measuring the lumen output of the LED lamp under test be as specified in section 9.0 of IES LM-79-2008. This section requires that the lumen output of the LED lamp be measured with an integrating sphere system or a goniophotometer. An integrating sphere system is an optical device that is useful for measuring the lumen output and color measurement of LED lamps. The hollow sphere contains two or more openings for introducing the LED lamp under test as well as

[29] IES LM-79-2008 defines preburning as the operation of a light source prior to mounting on a measurement instrument, to shorten the required stabilization time on the instrument.

attaching a detector (an instrument that is used to measure light output or the spectral radiant flux), such as a photometer or spectroradiometer. A goniophotometer is another device that measures the luminous intensity distribution and the lumen output of the LED lamp under test. It does so by measuring the light intensity of the LED lamp when reflected from a surface at various angles. DOE invites interested parties to comment on the appropriateness of using either an integrating sphere system or a goniophotometer for testing LED lamps. DOE also requests feedback on how the lumen output measured using a sphere-photometer system, sphere-spectroradiometer system, or a goniophotometer compare with each other.

This notice proposes the same method of measurement of lumen output for all LED lamps, including directional[30] LED lamps. For directional LED lamps, DOE proposes that the total lumen output emanated from the lamp should be measured because other directional lamp technologies currently measure and report total lumen output on the FTC Lighting Facts label. DOE understands that the beam lumen output, which is present in the zone bounded by the beam angle, is the "useful" lumen output for directional lamps. However, at this time, DOE is not proposing that beam lumen output be measured because inconsistency and confusion could arise in the industry if LED lamps measure beam lumen output (a portion of the total lumen output) while other lamp technologies measure total lumen output. Additionally, a comparison of performance among the different directional lamp technologies could not be made. DOE understands that beam lumen output or center-beam candle power (CBCP) metrics are useful for comparing and describing directional lamps but does not propose these metrics because they are

[30] Directional lamps are designed to provide more intense light to a particular region or solid angle. Light provided outside that region is less useful to the consumer, as directional lamps are typically used to provide contrasting illumination relative to the background or ambient light.

not required for the FTC Lighting Facts label. DOE requests comment on the appropriateness of measuring total lumen output for directional LED lamps.

d. Determination of Correlated Color Temperature

DOE proposes that the CCT of the LED lamp under test should be calculated as specified in section 12.4 of IES LM-79-2008. The CCT is determined by measuring the relative spectral distribution, calculating the chromaticity coordinates, and then matching the chromaticity coordinates to a particular CCT of the Planckian radiator. The setup for measuring the relative spectral distribution, which is required to calculate the CCT of the LED lamp, should be as specified in section 12.0 of IES LM-79-2008. This section describes the test method to calculate CCT using a sphere-spectroradiometer system and a spectroradiometer or colorimeter system. Section 12.0 of IES LM-79-2008 also specifies the spectroradiometer parameters that affect CCT and the method to evaluate spatial non-uniformity of chromaticity.

5. Test Calculations and Rounding

DOE is proposing calculation and rounding requirements to be used for determining brightness, energy use, light appearance, and estimated annual energy cost, should a DOE test procedure be referenced by the FTC through a future rulemaking process in support of the FTC Lighting Facts label. DOE proposes that the input power of all test units be averaged and the average value be rounded to the nearest tenths digit (see section III.D for proposed sampling requirements). DOE found that LED lamp datasheets typically provide input power values to the ones digit or the tenths digit. DOE proposes that average input power be rounded to the tenths digit because for products with input power less than 10 watts, tenths digit would be useful for discerning differences in power consumption, and input power measurements can be made to this

level of accuracy. DOE also proposes that the lumen output of all units be averaged and the value be rounded to the nearest tens digit because this level of resolution is necessary for differentiating the light output of lamps that frequently have lumen output of less than 1,000 lumens. DOE's view is that this level of accuracy is achievable because manufacturers typically report lumen output for LED lamps to the tens digit in catalogs. For CCT, DOE proposes that CCT of all units be averaged and the value be rounded to the tens digit. In the 2009 GSFL test procedure final rule, DOE determined that all laboratories are able to measure CCT to three significant digits. 74 FR 31829 (July 6, 2009). Because a typical CCT is in the thousands (such as 4200 Kelvin), maintaining three significant digits requires rounding to the tens digit. Finally, consistent with FTC's final rule establishing the Lighting Facts label, DOE proposes that the estimated annual energy cost for LED lamps, expressed in dollars per year, be calculated as the product of the average input power, in kilowatts, the electricity cost rate of 11 cents per kilowatt-hour, and the estimated average annual use at three hours per day, which is 1,095 hours per year. 75 FR 41702 (July 19, 2010) DOE proposes that the estimated annual energy cost should be rounded to the nearest cent because the cost of electricity is specified to the nearest cent. DOE invites interested parties to comment on the proposed calculation and rounding requirements for determining lumen output, input power, CCT, and estimated annual energy cost.

C. Proposed Approach for Rated Lifetime Measurements

1. Overview of Test Procedures

DOE reviewed several methods to measure the rated lifetime of LED lamps, such as those contained in industry standards and based on DOE and ENERGY STAR working groups. Of the methods researched, the first three methods mentioned in Table III.1 test the LED lamp to determine the rated lifetime and the final method in Table III.1 test the LED source to determine

the rated lifetime of the lamp. While it would be preferred to project the rated lifetime of the LED lamp rather than the LED source, currently, a standardized method only exists for projecting the lumen maintenance of the LED source and not the LED lamp. The approaches researched, and listed in Table III.1, include: (1) measuring the lumen output of the LED lamp until it reaches 70 percent of the initial lumen output (L_{70}) based on IES LM-79-2008; (2) measuring the lumen output of the LED lamp for 6,000 hours and projecting the L_{70} lifetime in number of hours based on the minimum lumen maintenance at 6,000 hours, as specified in the ENERGY STAR Specification for Integral LED Lamps Version 1.4; (3) measuring the lumen output of the LED lamp for a minimum of 6,000 hours based on IES LM-79-2008 and projecting the time at which the lumen output would reach 70 percent of the initial lumen output; and (4) measuring the lumen output of the LED sources at regular intervals for a minimum of 6,000 hours based on IES LM-80-2008 and projecting the time at which the lumen output would reach 70 percent of the initial lumen output based on IES TM-21-2011. These approaches, and the benefits and limitations of each approach, are listed in Table III.1 below.

Table III.1 Approaches to Define Rated LED Lamp Lifetime

Approach	Description of method	Advantages	Disadvantages
1	Measure lamp lumen output as specified in IES LM-79-2008. Lifetime of LED lamp is time when half the product population is below 70 percent of initial lumen output (L_{70}).	• Not a projection; accounts for performance of entire LED lamp until it reaches L_{70}. • True representation of LED lamp L_{70} lifetime.	• Performing complete IES LM-79-2008 test is time consuming and expensive. • Product may be obsolete when testing is complete (up to six years).
2	Measure lamp lumen output for 6,000 hours as specified in IES LM-79-2008. Maximum L_{70} life claim is dependent on minimum lumen maintenance at 6,000	• Final lifetime claims are based on LED lamp (rather than just LED source) tests. • Lumen maintenance projection is based on 6,000 hours of IES LM-	• Method used to develop projection of lifetime is unverified. • Does not account for catastrophic LED lamp failure mechanisms beyond 6,000 hrs.

	hours as specified in ENERGY STAR specification for integral LED lamps version 1.4. Perform rapid-cycle stress test to assess catastrophic lamp failure.	79-2008 and hence, is not as time consuming as performing full IES LM-79-2008 test to L_{70}.	• Cycling is not a proven source of catastrophic failure for LED lamps.
3	Measure LED lamp lumen output as specified in IES LM-79-2008 for 6,000 hours minimum. Lumen output data is projected to L_{70} life of the LED lamp and this value is the rated lifetime.	• Lifetime is determined based on LED lamp lumen maintenance data, rather than source data. • Lifetime projection based on 6,000 hours of data which is not as time consuming as performing a full IES LM-79-2008 test to L_{70}.	• Standard method not yet developed to project lumen output of LED lamp. • May not be feasible to develop a method for projecting IES LM-79-2008 lumen output data in a timely manner for the FTC Lighting Facts label.
4	Measure LED source lumen output as specified in IES LM-80-2008 and use IES TM-21-2011 to project number of hours at which the lumen output reaches 70 percent of initial lumen output (L_{70}). The life of LED lamp is the value projected by IES TM-21-2011 with a maximum limit of 25,000 hours.	• Uses latest industry standards IES TM-21-2011 and IES LM-80-2008 to determine lumen maintenance of source accounting for temperature effects. • Not as time consuming or expensive as IES LM-79-2008 testing – utilizes test data commonly provided by LED package manufacturers.	• Not a complete representation of LED lifetime. Determined value may underestimate or overestimate actual lifetime. • Does not account for other LED lamp lumen degradation methods.

For approach 1, measuring the lumen output of the LED lamp until it reaches 70 percent of the initial lumen output is not practical because it may require up to six years of testing, by which time the LED lamp may be obsolete. Approaches 2 and 3 specify measuring the lumen output of the LED lamp for 6,000 hours according to IES LM-79-2008 and projecting the rated lifetime of the lamp from this data. These methods have the advantage of projecting rated lifetime directly from LED lamp lumen maintenance data, but a standardized method for making

this projection has not yet been developed. Approach 4 determines the rated lifetime of the LED lamp using projected life of the LED source contained in the lamp based on IES LM-80-2008 data and the IES TM-21-2011 projection method with a maximum limit of 25,000 hours. This method limits required testing time to 6,000 hours and is based on IES standards. It would be preferable to consider the performance of the entire LED lamp to determine rated lifetime, but the current methods for measurement and projection of the lamp are not practical or sufficiently specified. Therefore, based on currently available information, DOE preliminarily has determined that approach 4 is the best approach to determine rated LED lifetime. DOE invites comment on relative costs and benefits of the four approaches.

Regarding the proposed method, approach 4, using IES LM-80-2008 and IES TM-21-2011, DOE recognizes that the LED driver component degradation and failure rates, the interactions among the LED sources and between LED sources and other components within the lamp, as well as color shift, are known to affect the rated lifetime of the LED lamp. However, standardized test methods do not currently exist to determine the impact of each of these components on the overall rated lifetime of LED lamps. In the absence of this information, the rated lifetime of the LED lamp can be determined only through testing and projecting lumen maintenance of the LED source. As new standards to define the life of LED drivers and components are developed, this test procedure can be revised.

Further, DOE proposes that the maximum projection of rated lifetime not exceed 25,000 hours, expressed in number of years, based on three hours per day of use. This would ensure that exceedingly large rated lifetime projections are not made based only on IES LM-80-2008 data and IES TM-21-2011 projections. This method could lead to inaccurate projections if the driver

installed in an LED lamp does not operate as long as the source is projected to survive. Another issue could arise if the operation of the driver compensates for degradation of the LED source in the first 6,000 hours of operation. In this situation, the LED source lumen maintenance data could decrease rapidly once the driver is unable to compensate for degradation of the LED source. However, an extrapolation of the first 6,000 hours of data would not be able to predict when the rapid degradation of the LED source would occur, and consequently would project a longer rated lifetime than is realistic. IES TM-21-2011 also sets an upper limit to the maximum allowable projection, such as 5.5 times the test duration for 10 – 19 units and six times the test duration for 20 units. However, these limits are defined with a 90 percent confidence on the projection of LED source lifetime, and the proposed upper limit of 25,000 hours is based on a conservative estimate of the overall LED lamp's lifetime.

Therefore, DOE proposes to incorporate IES standards LM-80-2008 and TM-21-2011 for projecting the rated lifetime of LED lamps. As discussed in section III.B, IES is the recognized technical authority on illumination and the standards that DOE proposes to incorporate are prepared by the IES subcommittee on Solid State Light Sources of the IESNA Testing Procedures Committee. DOE's view is that the committee members that worked on developing both of these IES standards represent applicable industry groups and interested parties. DOE reviewed IES LM-80-2008 and IES TM-21-2011 to determine whether any additional information would be required for providing a test procedure for determining the rated lifetime of LED sources, and thus, LED lamps. DOE concluded that IES LM-80-2008 and IES TM-21-2011 provide most of the information that is required for setting up the LED sources for testing, measuring the lumen output of the LED sources, and projecting the rated lifetime of the LED source. Additionally, DOE proposes to incorporate UL standard 1993-2009 to describe the test

setup and conditions for an ISTMT to determine the temperature at which IES LM-80-2008 data should be used to project the rated lifetime of the LED lamp. These requirements, and any variations, are further discussed in sections III.C.3 through III.C.8. DOE requests comment on the proposed incorporation of IES standards LM-80-2008 and TM-21-2011 and UL standard 1993-2009.

2. Definition of the Rated Lifetime of an LED Lamp

Based on the proposed approach to determine lifetime, DOE proposes that the rated lifetime of an LED lamp be defined as the time when the lumen output of the LED sources within the lamp falls below 70 percent of the initial light output (L_{70}). DOE understands that the L_{70} metric is the standard reference level to define rated LED lamp lifetime[31] and is widely accepted by industry as well. DOE invites interested parties to comment on the definition of the rated lifetime of an LED lamp.

3. Overview of the Proposed Test Method to Project Rated Lifetime

DOE proposes that the rated lifetime of an LED lamp should be obtained by following the three steps listed below. First, the in-situ temperature of the LED source when it operates within the lamp should be measured. Second, the lumen maintenance data at the in-situ temperature should be obtained. Finally, the lumen maintenance data should be projected to determine the rated lifetime.

DOE proposes that the in-situ temperature of the LED source should be obtained by performing an ISTMT. Section III.C.6.a discusses the test setup and conditions, as well as the

[31] "LED Luminaire Lifetime: Recommendations for Testing and Reporting." Second Edition. June 2011. < http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/led_luminaire-lifetime-guide_june2011.pdf>

method of measuring the in-situ temperature for the ISTMT. To obtain the lumen maintenance data at the in-situ temperature, DOE proposes that the data can be obtained through any one of the following three options: (1) directly from the source manufacturer; (2) by interpolating the data provided by a source manufacturer from two case temperatures not at the in-situ temperature; or (3) by measuring the lumen maintenance of the LED source at the in-situ case temperature. DOE understands that LED source manufacturers typically test LED sources at three temperatures as required by IES LM-80-2008. These three temperatures are 55°C, 85°C, and a third temperature suggested by the source manufacturer. Further, DOE understands that source manufacturers can provide the lumen maintenance data at these three temperatures to LED lamp manufacturers as needed. If the lumen maintenance data is available at the in-situ temperature (option 1 above) or if the lumen maintenance data can be interpolated from the data provided by the LED source manufacturer (option 2 above), then the LED lamp manufacturer would not need to test the LED sources. However, if the lumen maintenance data is not available directly or through interpolation from the LED source manufacturer, LED lamp manufacturers would need to test the LED sources at the in-situ temperature to obtain the lumen maintenance data to project the rated lifetime (option 3 above). Section III.C.8 discusses the proposed approach to interpolate lumen maintenance data for option 2 above. Further, sections III.C.4 through III.C.6.b discuss the proposed approach to test the LED sources to obtain lumen maintenance data, which would only be required for option 3 above.

Finally, section III.C.7 discusses the method to project the lumen maintenance data (gathered from option 1, 2, or 3) and obtain the rated lifetime.

4. Test Conditions

DOE proposes that the vibration, temperature, drive current, humidity, and airflow requirements for testing the LED sources be as specified in section 4.4 of IES LM-80-2008. Section 4.4.1 of IES LM-80-08 requires that the LED source not be subjected to excessive vibration or shock during testing.

For the operation of the LED sources between photometric measurements, DOE does not propose to require the lamp manufacturer to test the LED sources at three case temperatures as specified in section 4.4.2 of IES LM-80-2008. Instead, DOE proposes that the LED source under test be operated at the same case temperature it reaches when assembled and operated within the LED lamp. This temperature can be determined by performing an ISTMT as described in section III.C.6.a. Further, DOE proposes that each of the LED sources must be operated at this in-situ temperature with the same drive current passing through each LED source (see section III.D for sampling requirements). DOE proposes that the drive current flowing through the LED source under test should be greater than or equal to the subcomponent drive current in the LED lamp. DOE invites comment on the appropriateness of operating the LED sources at the in-situ case temperature and drive current.

Section 4.4.2 of IES LM-80-2008 further specifies that the temperature should be maintained between the desired case temperature and 2°C less than the desired case temperature during testing, and the temperature of the air surrounding the LED sources should be maintained between the desired case temperature and 5°C less than the desired case temperature during testing. Section 6.3 of IES LM-80-2008 also specifies that the LED sources be allowed to cool to room temperature before each lumen output measurement and that the ambient temperature

during this measurement be 25°C ± 2°C. Finally, section 4.4.2 of IES LM-80-2008 specifies that the relative humidity (RH) should be maintained to less than 65 RH during testing.

Further, DOE considered whether the measurement location for the air surrounding the LED sources and the measurement location for the ambient temperature while measuring lumen output should be specified. IES LM-79-2008 specifies that the ambient temperature must be measured at a point not more than one meter from the LED lamp. DOE requests comment on whether a similar requirement, one meter from the LED source, should be specified for measuring air and ambient temperature around the source.

Finally, DOE proposes that the airflow around the LED sources under test should be as specified in section 4.4.3 of IES LM-80-2008, which states that the airflow should be maintained to minimize air drafts but allow some movement of the air to avoid thermal stratification. DOE invites interested parties to comment on the appropriateness of adopting section 4.4.3 of IES LM-80-2008 for acceptable airflow around the LED sources under test. Further, DOE requests comment on whether testing with a single ply tissue paper, as specified in section 4.3 of IES LM-9-2009, should be used to ensure a draft free environment for testing LED sources.

5. Test Setup

a. Operating Orientation

DOE proposes that the LED sources be operated in accordance with section 4.4.4 of IES LM-80-2008, which states that the LED sources must be operated in the orientation specified by the source manufacturer. DOE understands that there may be effects from convection airflow due to heat-sinks and thermal management, and therefore also proposes that the LED sources should

be spaced to allow airflow around each test unit as recommended in section 4.4.4 of IES LM-80-2008.

DOE notes that it is not specifying the orientation for testing LED sources but is specifying the orientation for testing LED lamps (as discussed in section III.B.3.b). Because the LED source case temperature is not controlled during an LED lamp test and LED lamp orientation can change the LED source case temperature, specification of operating orientation is necessary for an LED lamp. By contrast, the case temperature of the LED source is controlled during testing, minimizing the effect of operating orientation on the light output of the LED source. DOE invites interested parties to comment on whether the operating orientation of LED sources during testing affects the lumen depreciation over time.

b. Electrical Setup

DOE proposes that the electrical setup including input voltage, input current, and driver used for testing LED sources be as specified in section 5.0 of IES LM-80-2008. Section 5.1 of IES LM-80-2008 specifies that the input voltage should conform to the rated input voltage (RMS) and frequency of the driver. For drivers that require DC, ripple voltage should not exceed two percent of the DC output voltage. Section 5.2 of IES LM-80-2008 further specifies that the power supply should have a voltage waveshape such that the total harmonic distortion does not exceed three percent of the fundamental frequency.

Section 5.3 of IES LM-80-2008 specifies that the input current should be within ± three percent of the rated RMS value during testing and within ± 0.5 percent of the rated RMS value during lumen output measurements. Section 5.3 of IES LM-80-2008 further specifies that the

current can be de-rated as a function of temperature in accordance with the manufacturer's recommendation. This requirement ensures that the LED source is operated at the same current that it would be operated at within the LED lamp.

Section 5.4 of IES LM-80-2008 requires that the external driver used for testing LED sources be compliant with manufacturer's guidance. DOE believes that this requirement would ensure that the LED sources operate at the rated input current and would provide consistent lumen output measurements for rated lifetime projections. DOE invites comment on the appropriateness of adopting section 5.4 for the external driver specification to test LED sources. DOE understands that the driver used for testing LED sources per IES LM-80-2008 is a simple power supply that converts AC input power to DC output power and it is not similar to the drivers used in LED lamps. DOE requests comment on whether more specifications should be provided for the driver used to test LED sources.

c. Thermal Setup

DOE proposes that the thermal setup for testing LED sources be as specified in section 5.5 of IES LM-80-2008. It states that the case temperature should be measured directly on the LED source at the case temperature measurement point designated by the manufacturer using a thermocouple. A manufacturer-recommended heat sink should be used for temperature maintenance.

d. Instrumentation

DOE proposes that the instrumentation required for recording time and measuring the lumen output of LED sources should be as specified in section 6.1 of IES LM-80-2008 and

section 9.0 of IES LM-79-2008 respectively. Section 6.1 of IES LM-80-2008 specifies that if an elapsed time meter is used, it should be connected to the particular test position and should accumulate time only when the LED sources are energized. Monitoring devices should not accumulate time if there is a power failure to a source. Additionally, section 6.1 of IES LM-80-2008 recommends using video monitoring, current monitoring, or other means to determine the elapsed operating time if they are designed to provide sufficient temporal accuracy. This section also requires that the total time uncertainty should be within ± 0.5 percent.

DOE further proposes that the lumen output measurement should be made as specified in section 9.0 of IES LM-79-2008. The lumen output should be measured at the drive current used throughout rated lifetime testing. DOE finds that consistently maintaining the drive current across all measurements would ensure an accurate representation of the rated LED lamp lifetime. DOE is not proposing section 6.2 of IES LM-80-2008 for measuring the lumen output of the LED sources because it recommends that the lumen output measurement should be determined from the total spectral radiant flux measurements using a spectroradiometer only. DOE understands that the sphere-photometer system and goniophotometer methods recommended in section 9.0 of IES LM-79-2008 could be used for measuring the lumen output of the LED sources in addition to the sphere-spectroradiometer system. DOE invites interested parties to comment on the appropriateness of adopting section 9.0 of IES LM-79-2008 for the instrumentation required for photometric measurements of the LED sources under test. In particular, DOE requests comment about whether the spectroradiometer should be the only instrument used for photometric measurements of LED sources or whether a sphere-photometer system and goniophotometer system could be used as well.

6. Test Method and Measurements

a. In-situ Temperature Measurement Test

DOE proposes that an ISTMT be performed to determine the case temperature at which the lumen maintenance data should be used to project the rated lifetime of the LED source. DOE proposes that the test setup and conditions for the ISTMT be as specified in sections 8.5, 8.13, 8.14, 8.15, and 9 of UL 1993-2009. Section 9 of UL 1993-2009 specifies the test equipment, ambient temperature, relative humidity, instrumentation, test box material and construction, as well as the test setup for lamps that are intended to be operated in a wet environment. Section 8.5 of UL 1993-2009 provides specifications for the temperature test of the LED lamp including the ambient temperature and the temperature of the components within the lamp. Section 8.5.8 further specifies that the in-situ temperature of the LED lamp should be recorded after the test has been running for at least three hours, and three successive readings taken at 15 minute intervals are within 1°C of one another and are still not rising. Sections 8.13, 8.14, and 8.15 specify the test setup for lamps that are intended to be operated in a damp environment, wet environment, and cold environment, respectively.

Further, DOE proposes that, as specified in Appendix D of the ENERGY STAR® Program Requirements for Integral LED Lamps, Eligibility Criteria – Version 1.4[32], the in-situ temperature should be measured at the temperature measurement point (TMP) that is defined by LED package, array, or module manufacturer on its product to act as surrogate points for measuring the junction temperature. To perform the ISTMT, a temporary thermocouple should be attached to the TMP of the highest temperature LED package, array, or module in the LED

[32] ENERGY STAR® Program Requirements for Integral LED Lamps <www.energystar.gov/ia/partners/product_specs/program_reqs/Integral_LED_Lamps_Program_Requirements.pdf>

lamp, as specified by the LED source manufacturer. The temporary hole for inserting the thermocouple should be tightly resealed during testing with putty or other flexible sealant, as mentioned in the ENERGY STAR specification. Lastly, DOE proposes that the guidance specified in the ENERGY STAR specification for attaching the thermocouple in the LED lamp be followed.

DOE invites interested parties to comment on the appropriateness of adopting sections 8.5, 8.13, 8.14, 8.15, and 9 of UL 1993-2009 for performing the ISTMT to determine the LED source case temperature at which rated lifetime projections should be made using the temporary thermocouple attachment to the TMP as specified in Appendix D of the ENERGY STAR® Program Requirements for Integral LED Lamps, Eligibility Criteria – Version 1.4.

b. Lumen Maintenance Testing Duration and Interval

DOE proposes that the test method for determining the LED source lifetime be as specified in section 7.0 of IES LM-80-2008 and section 4.3 of IES TM-21-2011. Section 7.1 of IES LM-80-2008 specifies that the LED sources should be operated for at least 6,000 hours and data should be collected at a minimum of every 1,000 hours, at ambient temperature. Section 4.3 of IES TM-21-2011 further recommends that after the first 1,000 hours of operation of the LED source, data should be collected at an interval smaller than 1,000 hours. Additional measurements beyond 6,000 hours are encouraged and recommended for more accurate projections. Section 7.2 of IES LM-80-2008 further specifies that LED sources should be operated at a constant current throughout testing. Finally, as specified in section 7.3 of IES LM-80-2008, if an LED source fails during testing, it should be determined if the failure is due to the auxiliary equipment or if it is an actual LED source failure. DOE proposes that if the failure is

due to the auxiliary equipment, the failed auxiliary equipment should be replaced and testing of the LED source should be continued from the time when the auxiliary equipment failed. It should be possible to determine the elapsed time by using a video monitor or other equipment as specified in section III.C.5.d. If it is an actual LED source failure, it should be included in the lifetime projection calculation as described in section III.C.7.

DOE further proposes that the relevant guidelines from the ENERGY STAR® guidance document for measuring the lumen maintenance of LED sources should be used for testing the LED sources[33]. This document specifies that all case temperature subsets of the sample used for testing should be of the same CCT. Secondly, the drive current flowing through the LED source under test should be greater than or equal to the subcomponent drive current in the LED lamp; the drive current in the LED lamp could be determined during ISTMT. The document further specifies that for an LED lamp that has both phosphor-converted white and single-color LED packages, the lumen maintenance should be measured for a sample of LED arrays that incorporate both types of LED packages. Additionally, for LED arrays constructed as an assembly of LED dies on a printed circuit board or substrate (a.k.a. chip-on-board) with one common phosphor layer overlaying all dies, or with phosphor layers overlaying individual dies with or without single-color dies incorporated, a single test could be used to represent the performance of a range of LED array sizes, if the following two conditions are satisfied: (1) testing is conducted on the largest LED array that the manufacturer believes will be used in the LED lamp; and, (2) the average calculated current-per-die in the LED array under test is greater than or equal to the average calculated current-per-die employed in the LED lamp. Finally, for

[33] ENERGY STAR® Program Guidance Regarding LED Package, LED Array and LED Module Lumen Maintenance Performance Data Supporting Qualification of Lighting Products, September 9, 2011 <www.energystar.gov/ia/partners/prod_development/new_specs/downloads/luminaires/ENERGY_STAR_Final_Lumen_Maintenance_Guidance.pdf >

LED arrays constructed as an assembly of LED packages on a printed circuit board, each with their own phosphor layer, the in-situ TMP temperature of the hottest package in the array should be used for lumen maintenance projection purposes. DOE invites interested parties to comment on the appropriateness of adopting these guidelines from the ENERGY STAR guidance document for testing LED sources.

7. Method to Project Lumen Maintenance Data

DOE proposes that the lumen maintenance of the LED source should be projected as specified in section 5.0 of IES TM-21-2011. This section specifies that a curve-fit method should be used for projecting the lumen maintenance for each LED source at a given drive current and case temperature. Section 5.2 of IES TM-21-2011 further gives a detailed description of the procedure, including normalization of data, averaging of data, using the curve-fit method, adjusting the results based on the sample size, and whether the projected value is positive or negative. DOE proposes that L_{70}, the time it takes for the LED source to reach 70 percent of its initial light output, should be used for projecting the lifetime of the LED source with a maximum projection of 25,000 hours. That is, even if the method described in section 5.0 of IES TM-21-2011 projects a lifetime of 36,000 hours, the rated lifetime of the LED lamp cannot be more than 25,000 hours. If the projection method described in IES TM-21-2011 projects a lifetime that is less than 25,000 hours, then the projected value should be the rated lifetime of the LED lamp. As explained in section III.C.1 above, DOE is making this proposal to ensure that exceedingly large rated lifetime projections are not made based only on IES LM-80-2008 data and IES TM-21-2011 projections. Twenty-five thousand hours was selected as the maximum value because it is currently unknown if the LED driver will last beyond 25,000 hours. Furthermore, twenty-five thousand hours is also the lifetime estimate that several reputable manufacturers already use in

their catalogs, and it is the maximum ENERGY STAR criteria for full qualification of LED lamp lifetime based on 6,000 hours of test data. Finally, DOE proposes that, the life of the LED lamp should be determined in number of years based on three hours per day of operation, which is consistent with the FTC Lighting Facts label requirements for other lamp technologies. DOE proposes that the resulting value should be rounded to the nearest tenth of a year. Rounding the rated lifetime to the nearest tenths place is necessary to have sufficient resolution for discerning differences in rated lifetime expressed in years. DOE invites interested parties to comment on the appropriateness of using the methodology specified in section 5.0 of IES TM-21-2011 for projecting the L_{70} lifetime of LED sources with a maximum projection of 25,000 hours. DOE also requests comment on the proposed rounding requirement for rated lifetime.

For LED sources that fail during lifetime testing due to LED source failure, DOE proposes that the data for these LED sources be included for projecting the lifetime. At the first measurement interval after the LED source fails, the recorded value should be zero lumens for the source. Values for the remaining tests between the time of failure and end of testing should be recorded as zero as well and these values should be included while averaging the normalized values as explained in section 5.2 of IES TM-21-2011.

8. Method to Interpolate Lumen Maintenance Data

For option 2 discussed in section III.C.3 above, DOE proposes that the method of interpolation should be as specified in section 6.0 of IES TM-21-2011. This section describes the case temperatures that should be used for interpolating the data and the methodology used for calculating the lumen output at the desired temperature, which includes converting the

temperature to units of Kelvin, using the Arrhenius Equation[34] to calculate the lumen maintenance life, and the applicability and limitations of the method.

D. Sampling Plan

DOE is proposing a sampling plan for determining input power, lumen output, CCT, and rated lifetime of an LED lamp. DOE reviewed the sampling requirements of other lamp technologies to develop the sampling plan for LED lamps. For testing LED sources, DOE reviewed the requirements specified in IES TM-21-2011 and identified that those requirements are necessary to project the rated lifetime.

DOE proposes a minimum of 21 LED lamps should be tested for determining the input power, lumen output, and CCT as described in section III.B. A minimum of three lamps should be selected per month for seven months of production out of a 12 month period. If lamp production occurs in fewer than seven months of the year, three or more lamps should be selected for each month that production occurs as evenly as possible to meet the minimum 21 unit requirement. The seven months need not be consecutive and could be a combination of seven months out of the 12 months. Sample sizes greater than 21 should be multiples of three so that an equal number of lamps in each orientation are tested. This selection of a minimum of 21 lamps is consistent with DOE's regulation for GSFLs and GSILs, specified at 10 CFR Part 429.27, Subpart B, which specify a sampling size of a minimum of three lamps for each month of production for a minimum of seven months (not necessarily consecutive) out of the 12 month period, totaling a minimum of 21 lamps.

[34] Arrhenius Equation is an equation that accounts for the temperature dependence of a reaction. It is useful for determining the temperature dependent lumen maintenance of LED sources.

DOE further proposes that the input power, lumen output, and CCT of the units should be averaged and the value of each of these parameters should be rounded as specified in section III.B.5. The average value of each parameter should be calculated using the following equation:

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

where, $\bar{x}$ is the sample mean; n is the number of units; and x_i is the i^{th} unit. DOE invites interested parties to comment on the proposed sample size for determining input power, lumen output, and CCT.

DOE proposes that the sample size for testing LED sources for determining the rated lifetime of LED lamps be as specified in section 4.2 of IES TM-21-2011. This section recommends that all data from a sample set at a given case temperature and drive current from the LM-80-2008 test should be used for projecting the lifetime of the LED source. The recommended sample set is 20 units for projecting the lifetime of the LED sources. If at least 20 units are used, the lifetime could be projected up to six times the test duration, with a maximum limit of 25,000 hours as described in section III.C.7. If the number of units tested is between 10 and 19 units, the lifetime could be projected up to 5.5 times the test duration, with a maximum of 25,000 hours. Less than 10 units cannot be used for the IES TM-21-2011 projection method. This requirement is different from the sample size proposed above for testing the LED lamp to determine input power, lumen output, and CCT. The differences are primarily because the rated lifetime is determined by testing a different device (the LED source) and the proposed method for projecting lifetime provides specific projection calculations based on sample sizes outlined in that IES TM-21-2011. DOE requires that the same number of units should be tested at each case

temperature for projecting the rated lifetime. DOE invites interested parties to comment on the appropriateness of adopting section 4.2 of IES TM-21-2011 for the required sample size for rated lifetime testing.

IV. Procedural Issues and Regulatory Review

A. Review Under Executive Order 12866

The Office of Management and Budget 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 the Office of Management and Budget (OMB).

B. Review under the Regulatory Flexibility Act

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

DOE reviewed the test procedures considered in today's NOPR under the provisions of the Regulatory Flexibility Act (RFA) and the policies and procedures published on February 19, 2003. As discussed in more detail below, DOE found that because the proposed test procedures have not previously been required of manufacturers, all manufacturers, including small manufacturers, may potentially experience a financial burden associate with new testing requirement. While examining this issue, DOE determined that it could not certify that the proposed rule, if promulgated, would not have a significant impact on a substantial number of small entities. Therefore, DOE has prepared an IRFA for this rulemaking. The IRFA describes the potential impacts on small businesses associated with LED lamp testing and labeling requirements.

DOE has transmitted a copy of this IRFA to the Chief Counsel for Advocacy of the Small Business Administration (SBA) for review.

1. Reasons, Objectives of, and Legal Basis for, the Proposed Rule

EISA 2007 section 321(b) amended EPCA (42 U.S.C. 6294(a)(2)(C)) to direct FTC to consider the effectiveness of lamp labeling for power levels or watts, light output or lumens, and lamp lifetime. This test procedure rulemaking for LED lamps is being conducted to support FTC's determination that LED lamps, which had previously not been labeled, require labels under EISA section 321(b) and 42 U.S.C. 6294(a)(6) in order to assist consumers in making purchasing decisions. 75 FR 41696 (July 19, 2010)

2. Description and Estimated Number of Small Entities Regulated

SBA has set a size threshold for electric lamp manufacturers to describe those entities that are classified as "small businesses" for the purposes of the RFA. DOE used the SBA's small business size standards to determine whether any small manufacturers of LED lamps would be subject to the requirements of the rule. 65 FR 30836, 30849 (May 15, 2000), as amended at 65 FR 53533, 53545 (Sept. 5, 2000) and codified at 13 CFR part 121. The size standards are listed by North American Industry Classification System (NAICS) code and industry description and are available at www.sba.gov/sites/default/files/Size_Standards_Table.pdf. LED lamp manufacturing is classified under NAICS 335110, "Electric Lamp Bulb and Part Manufacturing." The SBA sets a threshold of 1,000 employees or less for an entity to be considered as a small business for this category.

DOE estimated that the test procedure requirements proposed in this NOPR will apply to about 32 manufacturers of LED lamps. Of these manufacturers, DOE compiled a preliminary list of potential small businesses by searching the SBA databases, ENERGY STAR's list of qualified products[35], as well as performing a general search for LED manufacturers. DOE determined which companies manufacture LED lamps by reviewing company websites, the SBA website when applicable, and/or calling companies directly. Through this process, DOE identified 17 potential small businesses that manufacture LED lamps. DOE requests comment on the estimated number of entities that would be impacted by the proposed rulemaking and the number of these companies that are "small businesses".

3. Description and Estimate of Burden on Small Businesses

[35] ENERGY STAR Qualified Lamps Product List <http://downloads.energystar.gov/bi/qplist/Lamps%20Qualified%20Product%20List.pdf?fd91-d291>

The proposed test procedures for LED lamps, if adopted by FTC, would potentially require re-testing of any previously tested product. Further, if adopted by FTC, the proposed test procedures would require manufacturers to update their existing package and product labeling and online and hardcopy retailers to update their catalogs. The estimated cost of testing, packaging and labeling, and revising catalogs are discussed below.

Testing

To estimate the cost of testing, DOE determined the initial cost for setup and the costs to perform tests for determining the input power, lumen output, CCT, and rated lifetime of LED lamps. The initial setup for testing input power, lumen output, and CCT would require a custom-built rack for mounting lamps for testing. DOE estimated that up to 120 hours of labor may be required for building a rack that can hold up to 100 lamps. DOE estimated that the cost to build a rack by an electrical engineer whose rate is $39.79 per hour[36] would be approximately $4,770. DOE estimated that the material cost to build a custom-built rack holding 100 sockets would be $3,000 and the power supply and regulator costs would be $3,300 and $1,250 respectively. DOE estimated the total cost to build a rack to be approximately $12,000. DOE expects that manufacturers of LED lamps would already have other instrumentation necessary for testing, because IES LM-79-2008 is the recommended standard for testing LED lamps for the FTC Lighting Facts label.

In addition to setup, the labor cost associated with carrying out the testing contributes to the overall testing burden. As discussed in section III.D, for testing lumen output, input power,

[36] Obtained from the Bureau of Labor Statistics (National Compensation Survey: Occupational Earnings in the United States 2008, U.S. Department of Labor (August 2009), Bulletin 2720, Table 3 (''Full-time civilian workers,'' mean and median hourly wages) < http://bls.gov/ncs/ocs/sp/nctb0717.pdf>

and CCT, manufacturers would be required to test a total of 21 LED lamps. DOE estimated that this testing would require approximately four hours per lamp by an electrical engineer whose rate is $39.79 per hour. DOE estimated about 19 small business manufacturers of LEDs would be impacted, each typically manufacturing about 17 basic models. In total, the use of this test method for determining light output, input power, and CCT would result in testing related labor costs of $57,000 for each manufacturer.

For lifetime testing, as discussed in section III.D, LED source manufacturers would be required to test at least 10 units of the LED source, though 20 units are recommended and allow for projection of a longer lifetime. DOE's understanding is that LED source manufacturers already perform this test during the normal course of business; therefore, adoption of this test method should not present an incremental burden. However, LED lamp manufacturers must perform the ISTMT on one lamp for each basic model to determine the case temperature of the LED source and perform the lifetime extrapolation calculations described in section III.C.7. DOE estimated these tests and calculations would require approximately 16 hours per basic model by an electrical engineer whose rate is $39.79 per hour. DOE understands that LED lamp manufacturers would already have the materials required for the ISTMT. DOE estimated about 19 manufacturers of LED lamps would be impacted, each typically manufacturing about 17 basic models. In total, the use of this test method for determining rated lifetime would result in related labor costs of $11,000 for each manufacturer. Finally, DOE expects that the incremental burden to develop a model for projecting rated lifetime per IES TM-21-2011 should be insignificant and that most companies would already have this calculation method in place.

For each manufacturer producing 17 basic models, assuming testing instrumentation is already available, DOE estimates the initial setup cost would be $12,000 and the labor costs to carry out testing would be approximately $68,000. DOE expects the setup cost to be a onetime cost to manufacturers. Further, DOE expects that the labor costs to perform testing would be smaller than $68,000 after the first year because only new products or redesigned products would need to be tested. DOE requests comments on its analysis of initial setup and labor costs as well as the average annual burden for conducting testing of LED lamps.

Packaging, Labeling, Catalogs

In addition to testing costs, LED lamp manufacturers may potentially incur the cost to update existing package and product labeling and online and hardcopy retailers may be required to update catalogs. In the final rule establishing FTC's Lighting Facts label, FTC determined the cost for changing package and product labeling as well as retail catalogs would not impose a significant burden on small entities. 75 FR 41696, 41712 (July 19, 2010). The required updates for labeling and catalogs, if FTC adopts this proposed test procedure, would involve revisions of values, not a full redesign of packaging or catalog format. Therefore, the burden imposed by the adoption of this proposed test procedure by the FTC would have an even smaller impact on small entities than the original rulemaking establishing that label. DOE requests comment on its estimated burden to small LED lamp manufacturers and retailers to change product packaging and labeling and retail catalogs.

In summary, DOE cannot certify that the impact on small businesses associated with FTC adopting the proposed LED lamp test procedure would not be significant. DOE requests comment on the potential burden and its impact on small businesses.

4. Duplication, Overlap, and Conflict with Other Rules and Regulations

DOE is not aware of any other federal statutes, rules, or policies that would duplicate, overlap, or conflict with the proposed rule. DOE invites comment and information on this issue.

5. Significant Alternatives to the Rule

DOE considered a number of alternatives to the proposed test procedure as discussed in sections III.B.1 and III.C.1. DOE seeks comment and information on the need, if any, for alternative test methods that, consistent with the statutory requirements, would reduce the economic impact of the rule on small entities. DOE will consider any comments received regarding alternative methods of testing that would reduce economic impact of the rule on small entities. DOE will consider the feasibility of such alternatives and determine whether they should be incorporated into the final rule.

C. Review Under the Paperwork Reduction Act of 1995

There is currently no information collection requirement related to the test procedure for LED lamps. In the event that DOE proposes to require the collection of information derived from the testing of LED lamps according to this test procedure, DOE will seek OMB approval of such information collection requirement.

DOE established regulations for the certification and recordkeeping requirements for certain covered consumer products and commercial equipment. 76 FR 12422 (March 7, 2011). The collection-of-information requirement for the certification and recordkeeping was subject to review and approval by OMB under the Paperwork Reduction Act (PRA). This requirement was approved by OMB under OMB Control Number 1910-1400. Public reporting burden for the

certification was estimated to average 20 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.

As stated above, in the event DOE proposes to require the collection of information derived from the testing of LED lamps according to this test procedure, DOE will seek OMB approval of the associated information collection requirement. DOE will seek approval either through a proposed amendment to the information collection requirement approved under OMB control number 1910-1400 or as a separate proposed information collection requirement.

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

D. Review Under the National Environmental Policy Act of 1969

In this proposed rule, DOE is proposing a test procedure for LED lamps that it expects will be used to support the FTC's Lighting Facts labeling program. 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 proposed rule would adopt existing industry test procedures for LED lamps, so it would not affect the amount, quality or distribution of energy usage, and, therefore, would not result in any environmental impacts. Thus, this rulemaking is

covered by Categorical Exclusion A5 under 10 CFR part 1021, subpart D. 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 has examined this proposed rule and has determined that it would not have a substantial direct effect on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government. EPCA governs and prescribes Federal preemption of State regulations as to energy conservation for the products that are the subject of today's proposed rule. States can petition DOE for exemption from such preemption to the extent, and based on criteria, set forth in EPCA. (42 U.S.C. 6297(d)) No further action is required by Executive Order 13132.

F. Review Under Executive Order 12988

Regarding the review of existing regulations and the promulgation of new regulations, section 3(a) of Executive Order 12988, "Civil Justice Reform," 61 FR 4729 (Feb. 7, 1996),

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

G. Review Under the Unfunded Mandates Reform Act of 1995

Title II of the Unfunded Mandates Reform Act of 1995 (UMRA) requires each Federal agency to assess the effects of Federal regulatory actions on State, local, and Tribal governments and the private sector. Pub. L. No. 104-4, sec. 201 (codified at 2 U.S.C. 1531). For a proposed regulatory action likely to result in a rule that may cause the expenditure by State, local, and Tribal governments, in the aggregate, or by the private sector of $100 million or more in any one year (adjusted annually for inflation), section 202 of UMRA requires a Federal agency to publish a written statement that estimates the resulting costs, benefits, and other effects on the national economy. (2 U.S.C. 1532(a), (b)) The UMRA also requires a Federal agency to develop an

effective process to permit timely input by elected officers of State, local, and Tribal governments on a proposed "significant intergovernmental mandate," and requires an agency plan for giving notice and opportunity for timely input to potentially affected small governments before establishing any requirements that might significantly or uniquely affect small governments. On March 18, 1997, DOE published a statement of policy on its process for intergovernmental consultation under UMRA. 62 FR 12820; also available at www.gc.doe.gov. DOE examined today's proposed rule according to UMRA and its statement of policy and determined that the rule contains neither an intergovernmental mandate, nor a mandate that may result in the expenditure of $100 million or more in any year, so these requirements do not apply.

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

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

I. Review Under Executive Order 12630

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

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

Section 515 of the Treasury and General Government Appropriations Act, 2001 (44 U.S.C. 3516 note) provides for agencies to review most disseminations of information to the public under guidelines established by each agency pursuant to general guidelines issued by OMB. OMB's guidelines were published at 67 FR 8452 (Feb. 22, 2002), and DOE's guidelines were published at 67 FR 62446 (Oct. 7, 2002). DOE has reviewed today's proposed rule under the OMB and DOE guidelines and has concluded that it is consistent with applicable policies in those guidelines.

K. Review Under Executive Order 13211

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

Today's regulatory action to establish a test procedure for measuring the lumen output, input power, CCT, and rated lifetime of LED lamps is not a significant regulatory action under

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

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

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

The proposed rule incorporates testing methods contained in the following commercial standards: ANSI/IESNA RP-16-2010, "Nomenclature and Definitions for Illuminating Engineering;" IES LM-79-2008, "Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products;" UL 1993-2009, "Standard for Safety, Self-Ballasted Lamps and Lamp Adapters;" IES LM-80-2008, "Approved Method: Measuring Lumen Maintenance of LED Light Sources;" and IES TM-21-2011, "Projecting Long Term Lumen Maintenance of LED Light Sources". The Department has evaluated these 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

will consult with the Attorney General and the Chairman of the FTC concerning the impact of these test procedures on competition, prior to prescribing a final rule.

V. Public Participation

A. Attendance at Public Meeting

The time, date and location of the public meeting are listed in the DATES and ADDRESSES sections at the beginning of this document. If you plan to attend the public meeting, please notify Ms. Brenda Edwards at (202) 586-2945 or Brenda.Edwards@ee.doe.gov. As explained in the ADDRESSES section, foreign nationals visiting DOE Headquarters are subject to advance security screening procedures.

In addition, you can attend the public meeting via webinar. Webinar registration information, participant instructions, and information about the capabilities available to webinar participants is available on the public meeting registration website www1.gotomeeting.com/register/952826176. Participants are responsible for ensuring their systems are compatible with the webinar software.

B. Procedure for Submitting Prepared General Statements For Distribution

Any person who has plans to present a prepared general statement may request that copies of his or her statement be made available at the public meeting. Such persons may submit requests, along with an advance electronic copy of their statement in PDF (preferred), Microsoft Word or Excel, WordPerfect, or text (ASCII) file format, to the appropriate address shown in the ADDRESSES section at the beginning of this notice. The request and advance copy of statements must be received at least one week before the public meeting and may be emailed,

hand-delivered, or sent by mail. DOE prefers to receive requests and advance copies via email. Please include a telephone number to enable DOE staff to make a follow-up contact, if needed.

C. Conduct of Public Meeting

DOE will designate a DOE official to preside at the public meeting and may also use a professional facilitator to aid discussion. The meeting will not be a judicial or evidentiary-type public hearing, but DOE will conduct it in accordance with section 336 of EPCA (42 U.S.C. 6306). A court reporter will be present to record the proceedings and prepare a transcript. DOE reserves the right to schedule the order of presentations and to establish the procedures governing the conduct of the public meeting. After the public meeting, interested parties may submit further comments on the proceedings as well as on any aspect of the rulemaking until the end of the comment period.

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

At the end of all prepared statements on a topic, DOE will permit participants to clarify their statements briefly and comment on statements made by others. Participants should be prepared to answer questions by DOE and by other participants concerning these issues. DOE

representatives may also ask questions of participants concerning other matters relevant to this rulemaking. The official conducting the public meeting will accept additional comments or questions from those attending, as time permits. The presiding official will announce any further procedural rules or modification of the above procedures that may be needed for the proper conduct of the public meeting.

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

D. Submission of Comments

DOE will accept comments, data, and information regarding this proposed rule before or after the public meeting, but no later than the date provided in the DATES section at the beginning of this proposed rule. Interested parties may submit comments using any of the methods described in the ADDRESSES section at the beginning of this notice.

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

difficulties and cannot contact you for clarification, DOE may not be able to consider your comment.

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

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

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

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

Include contact information each time you submit comments, data, documents, and other information to DOE. If you submit via mail or hand delivery, please provide all items on a CD, if feasible. It is not necessary to submit printed copies. No facsimiles (faxes) will be accepted.

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

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

Confidential Business Information. According to 10 CFR 1004.11, any person submitting information that he or she believes to be confidential and exempt by law from public disclosure should submit via email, postal mail, or hand delivery two well-marked copies: one copy of the document marked confidential including all the information believed to be confidential, and one copy of the document marked non-confidential with the information believed to be confidential deleted. Submit these documents via email or on a CD, if feasible. DOE will make its own determination about the confidential status of the information and treat it according to its determination.

Factors of interest to DOE when evaluating requests to treat submitted information as confidential include: (1) A description of the items; (2) whether and why such items are customarily treated as confidential within the industry; (3) whether the information is generally known by or available from other sources; (4) whether the information has previously been made available to others without obligation concerning its confidentiality; (5) an explanation of the competitive injury to the submitting person which would result from public disclosure; (6) when such information might lose its confidential character due to the passage of time; and (7) why disclosure of the information would be contrary to the public interest.

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

E. Issues on Which DOE Seeks Comment

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

1. DOE requests comment on the proposed scope and incorporation of ANSI/IESNA RP-16-2010 for the definition of LED lamps. See section III.A for further detail.

2. DOE requests comment on the proposed incorporation of IES LM-79-2008 for determining lumen output, input power, and CCT. See section III.B for further detail.

3. DOE requests comment on whether air movement should be specified in more detail than that provided by IES LM-79-2008. See section III.B.2 for further detail.

4. DOE requests comment on operating an equal number of lamps in the base up, base down, and horizontal orientations throughout testing. See section III.B.3.b for further detail.

5. DOE requests comment on testing LED lamps at the rated voltage for single voltage lamps and testing lamps with dimming capability at the maximum input power. Further, DOE requests comment about testing LED lamps that are rated to operate at multiple voltages at 120 volts or the highest rated voltage. Finally, DOE requests comment on whether LED lamps with multiple modes of operation are available and the CCT value at which these lamps should be tested. See section III.B.3.d for further detail.

6. DOE requests comment on seasoning the LED lamp for 1,000 hours before collecting lumen output data. See section III.B.4.a for further detail.

7. DOE requests comment on stabilizing the lamp until the variation of at least three readings of the lumen output and electrical power, taken 15 minutes apart, is less than 0.5 percent. DOE also requests comment on its clarification of the variation calculation to be the difference of the maximum and minimum values divided by the minimum value. See section III.B.4.b for further detail.

8. DOE requests comment on measuring the lumen output of the LED lamp using a sphere-spectroradiometer system, sphere-photometer system, and goniophotometer system. In particular, DOE requests comment on whether the measurements from each method are similar and consistent. See section III.B.4.c for further detail.

9. DOE requests comment on measuring total lumens for directional LED lamps instead of beam lumens. See section III.B.4.c for further detail.

10. DOE requests comment on the proposed calculation and rounding requirement for lumen output, input power, CCT, and estimated annual energy cost. See section III.B.5 for further detail.

11. DOE requests comment on the relative costs and benefits of the four approaches described in Table III.1 to determine rated lifetime of an LED lamp. See section III.C.1 for further detail.

DOE requests comment on the proposed incorporation of IES standards LM-80-2008 and TM-21-2011 and UL standard 1993-2009 for determining the rated lifetime of LED lamps. See section III.C.1 for further detail.

12. DOE requests comment on the proposed definition of the rated lifetime of an LED lamp. See section III.C.2 for further detail.

13. DOE requests comment on operating the LED sources at the in-situ case temperature and drive current as well as the ambient conditions for testing. DOE also requests comment on whether the measurement location for air temperature near the LED source and airflow around the LED source should be further specified. See section III.C.4 for further detail.

14. DOE requests comment on whether the operating orientation of LED sources affects the lumen depreciation over time. See section III.C.5.a for further detail.

15. DOE requests comment on whether the requirement that the external driver used for testing LED sources be as specified by the manufacturer needs further clarification. See section III.C.5.b for further detail.

16. DOE requests comment on using a sphere-photometer system or a goniophotometer for measuring the lumen output of LED sources in addition to the sphere-

spectroradiometer system specified in section 6.2 of IES LM-80-2008. See section III.C.5.d for further detail.

17. DOE requests comment on adopting sections 8.5, 8.13, 8.14, 8.15, and 9 of UL 1993-2009 and the practicality of the thermocouple attachment requirements for performing the ISTMT. See section III.C.6.a for further detail.

18. DOE requests comment on adopting relevant guidelines from the ENERGY STAR® guidance document for measuring lumen maintenance. See section III.C.6.b for further detail.

19. DOE requests comment on adopting section 5.0 of IES TM-21-2011 for projecting the lifetime of the LED sources with a maximum projection of 25,000 hours. See section III.C.7 for further detail.

20. DOE requests comment on the proposed rounding requirement for rated lifetime. See section III.C.7 for further detail.

21. DOE requests comment on the proposed sample size requirements for testing LED lamps and LED sources. See section III.D for further detail.

22. DOE requests comment on its estimated number of small businesses impacted by this rulemaking as well as its estimated cost and associated burden to small businesses. See section IV.B for further detail.

23. DOE requests comment on its estimate of costs and associated burden under the Paperwork Reduction Act. See section IV.C for further detail.

VI. Approval of the Office of the Secretary

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

List of Subjects 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 April 3, 2012.

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Kathleen B. Hogan
Deputy Assistant Secretary of Energy
Energy Efficiency and Renewable Energy

For the reasons stated in the preamble, DOE is proposing to amend parts 429 and 430 of Chapter II of Title 10, Subchapter D of the 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 429.55 is added to read as follows:

§429.55 Light-emitting diode lamps.

(a) *Sampling plan for selection of units for testing.* (1) The requirements of §429.11 are applicable to light-emitting diode lamps; and

(2)(i) For determining input power, lumen output, and correlated color temperature, for each basic model of light-emitting diode lamp, units shall be obtained from a 12-month period, tested, and the results averaged. A minimum sample size of 21 lamps shall be tested. The manufacturer shall randomly select a minimum of three lamps from each month of production for a minimum of seven out of the 12 month period. In the instance where production occurs during fewer than seven of such 12 months, the manufacturer shall randomly select three or more lamps from each month of production, where the number of lamps selected for each month shall be distributed as

evenly as practicable among the months of production to attain a minimum sample size of 21 lamps. Sample sizes greater than 21 shall be a multiple of three. The value of input power, lumen output, and correlated color temperature shall be based on the sample and shall be equal to the mean of the sample, where:

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

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

(ii) For measurements of rated lifetime, for each basic model of light-emitting diode lamp, the sample size of the light-emitting diode source packaged in the LED lamp shall be as specified in section 4.2 of IES TM-21 (incorporated by reference; see §430.3).

(b) *Reserved.*

PART 430—ENERGY CONSERVATION PROGRAM FOR CONSUMER PRODUCTS

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

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

4. Section 430.2 is amended by adding in alphabetical order the definition of "light-emitting diode lamp" to read as follows:

§ 430.2 Definitions.

* * * * *

Light-emitting diode lamp means an integrated LED lamp as defined in ANSI/IESNA RP-16 (incorporated by reference; see §430.3).

* * * * *

5. Section 430.3 is amended by:

a. Adding paragraphs (k)(8) through (k)(11).

b. Redesignating paragraph (o) as paragraph (p) and adding a new paragraph (o).

The additions read as follows:

§ 430.3 Materials incorporated by reference.

* * * * *

(k) *IESNA*. * * *

(8) ANSI/IESNA RP-16-10, Nomenclature and Definitions for Illuminating Engineering, approved October 15, 2005; IBR approved for Appendix AA to Subpart B.

(9) IES LM-79-08 ("IES LM-79"), Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products, approved December 31, 2007; IBR approved for Appendix AA to Subpart B.

(10) IES LM-80-08 ("IES LM-80"), Approved Method: Measuring Lumen Maintenance of LED Light Sources, approved September 22, 2008; IBR approved for Appendix AA to Subpart B.

(11) IES TM-21-11 ("IES TM-21"), Projecting Long Term Lumen Maintenance of LED Light Sources, approved on July 25, 2011; IBR approved for Appendix AA to Subpart B.

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(o) *UL*. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096, 847-272-8800, or go to *http://www.ul.com/*.

(1) UL 1993-2009 ("UL 1993"), Standard for Safety, Self-Ballasted Lamps and Lamp Adapters, approved August 28, 2009; IBR approved for Appendix AA to Subpart B.

(2) Reserved.

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6. Section 430.23 is amended by adding paragraph (cc) to read as follows:

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

* * * * *

(cc) *Light-emitting diode lamp.* (1) The input power and lumen output for a light-emitting diode lamp shall be tested and determined in accordance with section 3 of appendix AA of this subpart. The average measured input power shall be rounded to the nearest tenths of a watt. The average lumen output shall be rounded to the nearest 10 lumens.

(2) The correlated color temperature of a light-emitting diode lamp shall be tested and determined in accordance with section 3 of appendix AA of this subpart. The resulting correlated color temperature shall be averaged over all units tested and rounded to the nearest 10 Kelvin.

(3) The rated lifetime of a light-emitting diode lamp shall be equal to the time at which the lumen output of the light-emitting diode sources within the lamp has fallen below 70 percent of the average initial lumen output with a maximum limit of 25,000 hours as determined in section 4 of appendix AA of this subpart. The rated lifetime shall be determined in number of years based on an estimated three hours of use per day of the light-emitting diode lamp. The resulting rated lifetime shall be rounded to the nearest tenth of a year.

(4) The estimated annual energy cost for a light-emitting diode lamp, expressed in dollars per year, shall be the product of the average input power in kilowatts as determined in accordance with appendix AA to this subpart, an electricity cost rate of 11 cents per kilo-watt hour, and an estimated average annual use of three hours per day (that is, 1,095 hours per year). The resulting estimated annual energy cost shall be rounded to the nearest cent per year.

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

Appendix AA to Subpart B of Part 430—Uniform Test Method for Measuring the Input Power, Lumen Output, Correlated Color Temperature (CCT), and Rated Lifetime of Light-Emitting Diode (LED) Lamps

1. *Scope:* This appendix applies to the measurement of lumen output, input power, and CCT for LED lamps, and to the measurement of lumen maintenance of LED sources for the projection of rated LED lamp lifetime.
2. *Definitions*

   2.1. To the extent that definitions in the referenced IES standards do not conflict with the DOE definitions, the definitions specified in section 1.3 of IES LM-79 except section 1.3(f) (incorporated by reference; see §430.3), section 3.0 of IES LM-80 except section 3.5 (incorporated by reference; see §430.3), and section 3.0 of IES TM-21 (incorporated by reference; see §430.3) shall be included.

   2.2. *IES* means the Illuminating Engineering Society of North America.

2.3. *Lamp lumen output* means the total luminous flux produced by the lamp, in units of lumens.

2.4. *LED source* means within an LED lamp, the assembly of components or dies, including the electrical connections, printed on a circuit board or substrate. The LED source does not include the power source or base, but possibly incorporates optical elements and additional thermal, mechanical, and electrical interfaces that are intended to connect to the load side of an LED driver.

2.5. *Rated lifetime* means the time when the lumen output of the LED source has fallen below 70 percent of the average initial lumen output.

3. Test Method for Determining Lumen Output, Input Power, and CCT

3.1. Test Conditions and Setup

3.1.1. The ambient conditions, power supply, electrical settings, and instruments required shall be as described in sections 2.0, 3.0, 7.0, and 8.0 of IES LM-79 (incorporated by reference; see §430.3) respectively.

3.1.2. An equal number of LED lamps shall be set up in the base up, base down, and horizontal orientations throughout testing.

3.1.3. For an LED lamp with multiple operating voltages, the lamp shall be operated at 120 volts throughout testing. If the lamp is not rated for 120 volts, it shall be operated at the highest rated voltage.

3.2. Test Method and Measurements

3.2.1. The LED lamp shall be seasoned for 1,000 hours prior to stabilizing the lamp and collecting photometric data.

3.2.2. The LED lamp shall be stabilized as described in section 5.0 of IES LM-79 (incorporated by reference; see §430.3). The lamp reaches stabilization when the variation [(maximum – minimum)/minimum] of at least three readings of input power and lumen output over a period of 30 minutes, taken 15 minutes apart, is less than 0.5 percent.

3.2.3. The input power in watts shall be measured and recorded as specified in section 8.0 of IES LM-79 (incorporated by reference; see §430.3).

3.2.4. The measurement of lumen output of the LED lamp shall conform to section 9.0 of IES LM-79 (incorporated by reference; see §430.3).

3.2.5. CCT shall be determined according to the method specified in section 12.0 of IES LM-79 (incorporated by reference; see §430.3).

4. *Test Method for Projecting Rated Lifetime*

4.1. *Overview of the Method to Project Rated Lifetime*

4.1.1. Determine the in-situ case temperature of the LED source when it is operated within the lamp by performing the in-situ temperature measurement test (ISTMT) as described in section 4.3.1 below.

4.1.2. Obtain LED source lumen maintenance data per IES LM-80 (incorporated by reference; see §430.3) from the LED source manufacturer.

4.1.2.1. If lumen maintenance data for the LED source is available from the LED source manufacturer at the in-situ temperature, use this data to project the rated lifetime as described in section 4.1.3.

4.1.2.2. If the in-situ temperature of the LED source falls between the case temperatures associated with the lumen maintenance data available from the

LED source manufacturer, lumen maintenance data for the LED source can be interpolated as described in section 6.0 of IES TM-21 (incorporated by reference; see §430.3).

4.1.2.3. If lumen maintenance data for the LED source cannot be obtained through the methods outlined in section 4.1.2.1 or section 4.1.2.2, it must be obtained by testing the LED source directly. The test conditions, test setup, and test measurements for measuring lumen maintenance are described in section 4.2 through section 4.3.

4.1.3. The time required to reach 70 percent lumen maintenance (70 percent of light output after 1,000 hours of testing) of the LED source shall be projected as specified in section 5.0 of IES TM-21 (incorporated by reference; see §430.3) using the sample size specified in section 4.2 of IES TM-21. This duration shall be the rated lifetime of the LED lamp. However, the maximum projection of rated lifetime shall be limited to 25,000 hours. If the projection of rated lifetime as calculated by IES TM-21 is less than 25,000 hours, the rated lifetime shall be the projected rated lifetime. If the projection of rated lifetime as calculated by IES TM-21 is more than 25,000 hours, the rated lifetime shall be 25,000 hours.

4.1.3.1. If an LED source itself fails during lifetime testing for reasons other than auxiliary equipment failure or human error, the data of such an LED source shall be included while averaging the normalized values as explained in section 5.2 of IES TM-21 (incorporated by reference; see §430.3) for projecting the rated lifetime of the lamp.

4.2. *Test Conditions and Setup*

4.2.1. The acceptable vibration, humidity, and airflow around the LED source shall be as described in section 4.4 of IES LM-80 (incorporated by reference; see §430.3).

4.2.2. The case temperature and drive current at which the LED source must be operated shall be the in-situ temperature (as defined in section 4.3.1) of the LED source when it is operated within the LED lamp. Lumen maintenance data shall be measured at the in-situ temperature of the LED source as described in section 4.3.

4.2.3. The operating orientation, electrical setup, thermal setup, and instrumentation required for recording the time elapsed for measuring the lumen maintenance of LED sources shall be as described in sections 4.4.4, 5.0, 5.5, and 6.1 of IES LM-80 (incorporated by reference; see §430.3) respectively.

4.2.4. The instrumentation required for measuring the lumen output of the LED sources shall be as described in section 9.0 of IES LM-79 (incorporated by reference; see §430.3).

4.3. Test Method and Measurements

4.3.1. The ISTMT shall be performed to determine the case temperature of the hottest LED source within the LED lamp. The test setup and conditions for the ISTMT shall be as specified in sections 8.5, 8.13, 8.14, 8.15, and 9 of UL 1993 (incorporated by reference; see §430.3). The test is performed by attaching a thermocouple to specific locations designated by the LED source manufacturer that act as surrogate points for measuring junction temperature (T_j). The temperature measurement point (TMP) on the LED source shall be such that it has the highest temperature in the LED lamp. In general, the individual LED in the middle of symmetric arrays is the hottest. For square, rectangular, or circular arrays, the LED

closest to the center is typically the hottest. For other configurations, manufacturers shall sample several LEDs within the lamp to identify the source with highest temperature. The temporary hole for inserting the thermocouple shall be tightly resealed during testing with putty or other flexible sealant. The temperature probes shall be in contact with the TMP and permanently adhered. The steady-state temperature shall be recorded after the test has been running for at least three hours, and three successive readings taken at 15 minute intervals are within 1°C of one another and are still not rising. The temperature measured during the ISTMT should be the temperature at which lumen maintenance data of the LED source is obtained.

4.3.2. The lumen maintenance of the LED sources shall be determined as specified in section 7.0 of IES LM-80 (incorporated by reference; see §430.3) and section 4.3 of IES TM-21 (incorporated by reference; see §430.3). Additionally, the following conditions shall be adhered to:

4.3.2.1. All case temperature (T_s) subsets of the sample used for IES LM-80 (incorporated by reference; see §430.3) testing shall be of the same CCT.

4.3.2.2. The drive current flowing through the LED source during IES LM-80 (incorporated by reference; see §430.3) testing shall be greater than or equal to the subcomponent drive current employed in the LED lamp.

4.3.2.3. For an LED lamp employing both phosphor-converted white and single-color LED packages, the lumen maintenance shall be measured for a sample of LED arrays incorporating both types of LED packages.

4.3.2.4. For LED arrays constructed as an assembly of LED dies on a printed circuit board or substrate (a.k.a. chip-on-board) with one common phosphor

layer overlaying all dies, or with phosphor layers overlaying individual dies with or without single-color dies incorporated, a single IES LM-80 (incorporated by reference; see §430.3) test shall represent the performance of a range of LED array sizes, if all of the following are satisfied:

4.3.2.4.1. IES LM-80 (incorporated by reference; see §430.3) testing has been conducted on the largest LED array that the manufacturer believes will be used in a qualified product; and,

4.3.2.4.2. The average calculated current-per-die in the tested LED array is greater than or equal to the average calculated current-per-die employed in the LED lamp.

4.3.2.5. For LED arrays constructed as an assembly of LED packages on a printed circuit board, each with their own phosphor layer, the TMP temperature of the hottest package in the array shall be used for lumen maintenance projection purposes.

4.3.2.6.

4.3.2.7.

4.3.2.8. [FR Doc. 2012-8469 Filed 04/06/2012 at 8:45 am; Publication Date: 04/09/2012]