



ENERGY STAR® Program Requirements Product Specification for Lamps (Light Bulbs)

Eligibility Criteria Version 1.0, DRAFT 3

Following is the Version 1.0 ENERGY STAR Product Specification for Lamps. A product shall meet all of the identified criteria if it is to earn the ENERGY STAR.

Note: Partners are strongly encouraged to read the cover letter distributed with this draft, and all note boxes located throughout this draft to learn about the changes proposed.

For purposes of this specification development process, EPA invites stakeholders to send comments to lamps@energystar.gov, with “ENERGY STAR Lamps V1.0 Draft 3 Comments” in the subject line.

1. SPECIFICATION SCOPE & LAMP CLASSIFICATION

1.1. Included Products

The ENERGY STAR Lamps specification (“this specification”) scope includes the lamp types outlined in table 1. The scope is limited to lamps with integrated ballasts and drivers intended to be connected to the electric power grid with the following ANSI standard base types: E26, E26d, E17, E11, E12, GU24, GU10, GU5.3, GX5.3. The scope is also limited to lamps with rated nominal operating voltages of 120, 240 or 277 VAC, or 12 or 24 VAC or VDC.

Table 1: Specification Scope and Classification

Lamp Purpose and Performance Description	Standard Lamp Form Factor (Solid-State and CFL) ¹	Non-Standard Lamp Form Factor (CFL only) ²
Omni-directional – Lamps intended for general purpose that meet applicable omnidirectional performance requirements in this specification.	ANSI standard lamp shapes - A, BT, P, PS, S and T.	Lamps intended to replace ANSI standard general purpose lamps and do not meet Lamp Shape and Dimensional Requirements (p. 30). The following self-ballasted compact fluorescent lamps are included: <ul style="list-style-type: none"> • Bare spiral • Bare mini-spiral • Bare twin tube • Bare triple tube • Bare quadruple tube • Covered lamps
Decorative - Lamps of common decorative shapes meeting applicable decorative performance requirements in this specification.	ANSI standard lamp shapes - B, BA, C, CA, DC, F, G	Lamps intended to replace ANSI standard decorative shapes but do not meet Lamp Shape Dimensional Requirements (p. 30).
Directional - Lamps meeting applicable directional performance requirements in this specification.	ANSI standard lamp shapes - R, BR, ER, MR and PAR.	Lamps intended to replace ANSI standard reflector lamps but do not meet Lamp Shape Dimensional Requirements (p. 30).

¹ Standard form factor lamps must meet the lamp shape dimensional requirements in the specification and may claim wattage and ANSI lamp type equivalency. All solid-state lamps must conform to a standard lamp form factor.

² Non-standard form factor lamps may claim wattage equivalency but may not claim ANSI lamp type equivalency.

1.2. Excluded products:

- Lamps, other than MR types that operate only on an external (i.e. not integral to the lamp) ballast, driver or transformer, e.g. pin-based fluorescent lamps (linear and compact).
- Solid-state lamps intended to replace linear fluorescent or high-intensity discharge lamps.
- Lamps powered by an internal power source, e.g. solar-powered cell.
- Lamps incorporating power-consuming features in the on or off state which do not provide illumination (e.g. audio functions, air fresheners).
- Lamp technologies lacking applicable industry standardized methods of measurement.
- Lamps with bases not detailed in ANSI standards.
- Zhaga compliant LED light engines.
- Solid-state lighting lamps with non-standard form factors.

Note: In order to enhance clarity around product certification pathways, EPA has reorganized the scope and classification table, classifying lamps according to lamp purpose and performance and according to ANSI standard or non-standard form factors/shapes. Due to stakeholder concerns and confusion surrounding the non-standard SSL and semi-directional category introduced in Draft 2, the Agency has excluded these products from the scope. After analysis of the current use of the non-standard SSL pathway it is clear that it is not being used as intended, and is being used as a loophole for products that cannot meet performance requirements. Recent market surveillance indicates packaging requirements are not an adequate solution to the challenges posed by these products.

2. EFFECTIVE DATE

The ENERGY STAR Lamps Version 1.0 specification shall take effect in early 2014. To qualify for ENERGY STAR, a product model shall meet the ENERGY STAR specification in effect on its date of manufacture. The date of manufacture is specific to each unit and is the exact date on which a unit is considered to be completely assembled.

3. FUTURE SPECIFICATION REVISIONS

EPA reserves the right to change this specification should technological and/or market changes affect its usefulness to consumers, industry, or the environment. In keeping with current policy, revisions to the specification are arrived at through stakeholder discussions. In the event of a specification revision, please note that ENERGY STAR qualification is not automatically granted for the life of a product model.

While this document currently refers to industry standards and test procedures for fluorescent and solid-state lighting sources, as new technologies emerge that have equal or better performance to the levels proposed here, consistent with a technology neutral approach, EPA may amend the program requirements by adding additional requirements, methods of measurement and reference documents.

3.1. CONSIDERATIONS FOR FUTURE REVISIONS

3.1.1. Lamps incorporating power-consuming features in the off-state e.g. Wi-Fi.

EPA is committed to continuing to develop performance levels for lamps that account for special features and functionality that benefit consumers, and anticipates that lamps with new features will become more prevalent over the coming years as technology advances, particularly with solid-state lamps. EPA is interested in better understanding the power consumption associated with these products and will work with stakeholders to monitor the growth of lamps with power-consuming features in the off state for additional consumer benefit. EPA will explore the possibility of expanding the scope of this specification to include these products with appropriate off state power consumption requirements in a future revision.

3.1.2. Directional lamp beam quality

EPA proposed beam quality requirements in draft 2 of this specification but has removed these requirements based on concerns that the method specified is unlikely to achieve EPA's goal of eliminating poor beam performance. Further, these requirements may result in unnecessarily restricting performance to limitations of incumbent technology, when new technology may be better in meeting consumers' needs. EPA will continue to monitor the

market and work with stakeholders to explore other methods for evaluating beam performance to avoid consumer dissatisfaction with ENERGY STAR certified lamps.

3.1.3. Enhanced requirements for dimmable lamps

EPA is committed to continuing to develop performance requirements for lamps that incorporate special features and functionality that benefit consumers such as dimming. Basic dimming requirements are included in this specification as a first step. EPA will continue to explore opportunities to improve the dimming experience and accurately capture the performance of dimmable lamps. For example, EPA understands that useful life of dimmable products may be significantly reduced for some products when they are operated in a dimmed state. EPA hopes to better understand the actual use of dimmable products in the field to examine expanding requirements for dimmable lamps.

3.1.4. Color

As indicated in previous drafts of this specification, EPA sees color quality as a potential barrier to broader consumer adoption of energy efficient lighting. EPA will continue to monitor the market and explore opportunities for improving color quality and consistency of lamps to appropriately address this barrier while balancing other considerations such as cost and performance trade-offs.

3.1.5. Zhaga Compliant LED light engines

EPA will continue to monitor the development and proliferation of these products.

3.1.6. Industry test methods in development

EPA actively monitors the activities of lighting standards working groups and the applicability of this work to ENERGY STAR specifications. Several relevant test methods and technical memoranda are in development, such as LM-84 and TM-28 for testing and projecting lumen maintenance for solid-state lighting end products, which the agency will consider adopting for this specification when complete.

4. DEFINITIONS

ANSI: American National Standards Institute.

ASTM: American Society for Testing of Materials.

Beam Angle: The angle, in degrees, between the two opposite directions in which the average intensity is 50% of the center beam intensity as measured in at least two rotational planes, 90° from each other, around and through the beam axis (ANSI C78.379-2006).

CFL: See Compact Fluorescent Lamp.

CIE: Commission Internationale de l'Eclairage (International Commission on Illumination).

Color Rendering: Effect of an illuminant on the color appearance of objects by conscious or subconscious comparison with their color appearance under a reference illuminant (CIE 17.4, ANSI/IES RP-16-10).

Color Rendering Index of a Light Source (CRI): The measured degree of color shift objects undergo when illuminated by a light source as compared with the color of those same objects when illuminated by a reference source of comparable color temperature (10CFR430.2).

Compact Fluorescent Lamp (CFL): A fluorescent lamp with a small diameter glass tube (T5 or less) that is folded, bent, or bridged to create a long discharge path in a small volume. The lamp design generally includes an amalgam and a cold chamber, or a cold spot to control the mercury vapor pressure and light output (ANSI/IES RP-16-10). For purposes of this specification, compact fluorescent lamps include integral electronic ballasts and are equipped with an ANSI standard base.

Correlated Color Temperature of a Light Source (CCT): The absolute temperature of a blackbody whose chromaticity most nearly resembles that of the light source (10CFR430.2).

Covered Lamp: A lamp with an integral ballast or driver and a translucent envelope over the light source(s). See Envelope.

Decorative Lamp: A lamp with a candle-like or globe shape envelope including shapes B, BA, C, CA, DC, G and F as defined in ANSI C79.1-2002.

Dimmable Lamp: A lamp that is capable of producing varying levels of light, for the purposes of this specification, the lamp must be capable of reducing light output to at least 20% when paired with a control or dimmer.

Directional Lamp: A lamp having at least 80% light output with a solid angle of π sr, corresponding to a cone with an angle of 120°. (Commission of the European Communities (EC) No 244/2009). For purposes of this specification, ANSI standard R, BR and ER shapes are considered to be directional regardless of compliance with this definition.

Envelope: A transparent or translucent enclosure over a light source. An envelope can also consist of a reflector with integral front cover (adapted from ANSI C78.357-2010).

FTC: United States Federal Trade Commission.

Field Angle: The angle between the two directions for which the intensity is 10% of the maximum intensity as measured in a plane through the nominal beam centerline (ANSI/IES RP-16-10).

Flicker: Luminous flux modulation made perceptible by the motion of objects or by the motion of the observer's eye when the observer's eye is still.

GU24 Based Integrated Lamp: A lamp unit that integrates the lamp and its ballast. It does not include any replaceable or interchangeable parts, and utilizes the ANSI standardized GU24 base type.

IEC: International Electrotechnical Commission.

IES: Illuminating Engineering Society.

Input Power: The power draw in watts of a ballast or driver and a light source system operating in a normal mode, as determined in accordance with 10 CFR 430.

Integrated LED Lamp: An integrated assembly comprised of LED packages (components) or LED arrays (modules), LED driver, ANSI standard base and other optical, thermal, mechanical and electrical components. The device is intended to connect directly to the branch circuit through a corresponding ANSI standard lamp-holder (socket). (ANSI/IES RP-16-10)

Lamp: A generic term for a man-made source created to produce optical radiation. By extension, the term is also used to denote sources that radiate in regions of the spectrum adjacent to the visible (ANSI/IES RP-16-10).

LED: See Light-emitting Diode.

LED Array or Module: An assembly of LED packages (components) or dies on a printed circuit board or substrate, possibly with optical elements and additional thermal, mechanical, and electrical interfaces that are intended to connect to the load side of a LED driver. Power source and ANSI standard base are not incorporated into the device. The device cannot be connected directly to the branch circuit (ANSI/IES RP-16-10).

LED Driver Case Temperature Measurement Point (TMP_C): A location on an LED driver case, designated by its manufacturer, which will have the highest temperature of any point on the driver case during normal operation.

LED Package: An assembly of one or more LED dies that includes wire bond or other type of electrical connections, possibly with an optical element and thermal, mechanical, and electrical interfaces. Power source and ANSI standardized base are not incorporated into the device. The device cannot be connected directly to the branch circuit (ANSI/IES RP-16-10).

LED Temperature Measurement Point (TMP_{LED}): A location on an LED package/module/array, designated by its manufacturer, which provides a surrogate temperature measurement location for the actual LED junction. The TMP_{LED} may be a solder joint at the board attachment site, a point on the LED package case, or a location on the board of an LED module or array.

Light-emitting Diode (LED): A p-n junction solid-state device of which the radiated output, either in the infrared region, the visible region, or the ultraviolet region, is a function of the physical construction, material used, and exciting current of the device. (10CFR430.2).

Lumen Maintenance: The luminous flux or lumen output at a given time in the life of the lamp and expressed as a percentage of the rated luminous flux or rated lumen output, respectively (10CFR430 Appendix W to Subpart B). Lumen maintenance is the converse of lumen depreciation.

Lumens per Watt (lm/W): The quotient of the total luminous flux emitted by the total light source power input. It is expressed in lm/W. (Adapted from ANSI/IES RP-16-10: "Luminous Efficacy of a Source of Light")

MacAdam Color Ellipse: A space around a chromaticity coordinate that sets the boundary at which a given percentage of people are able to determine that two colors, one with chromaticity coordinates at the center of the ellipse, and one with chromaticity coordinates on the ellipse, are just noticeably different (adapted from IES Handbook 10th Edition).

Multi-power Lamp: A lamp designed to produce multiple discrete light levels when inserted into a lamp socket controlled by a switching mechanism and is designated on the lamp packaging as being a multi-power lamp, e.g. 3-way lamp.

NEMA: National Electrical Manufacturers Association.

NRTL: Nationally Recognized Testing Laboratory as recognized by OSHA's NRTL Program, which is a part of OSHA's Directorate of Technical Support.

Omnidirectional Lamp: A general service replacement lamp with an ANSI standard base that emits the majority of light produced in an even distribution about the lamp with intensities in the 0-135° zone varying by no more than 20% from the average of all measured values, and having at least 5% of the total flux (lumens) emitted in the 135° to 180° zone. These lamps can be standard; having an ANSI standard lamp shape of A, BT, G, P, PS, S or T, or non-standard; a self-ballasted compact fluorescent that utilizes a bare spiral, or multiple (twin, triple, quadruple) tube arrangement.

OSHA: Occupational Safety & Health Administration.

Power Factor: The input power in watts divided by the product of RMS input voltage and RMS input current of a ballast or driver.

Rated Lumen Maintenance Life (L_p): The elapsed operating time over which the LED light source will maintain the percentage, p, of its initial light output, e.g., L₇₀ (hours): time to 70% lumen maintenance (IES LM-80-08).

Rated Wattage: The wattage marked on the lamp (10 CFR 430 Appendix W to Subpart B).

Referenced Incandescent Lamp: A traditional incandescent lamp that predates the federal efficiency standards in the 2007 Energy Independence and Security Act.

Run-up Time: The time between the application of power to the device and the time when the light output first reaches a specified percentage of stable light output, i.e., 80%, 90%, etc.

Secondary Optics: Materials modifying the distribution of light from, but not integral to a light source, including but not limited to lamp envelopes, reflectors, and total internal reflection optics.

Solid-State Lighting (SSL): The term "solid-state" refers to the fact that the light is emitted from a solid object – a block of semiconductor – rather than from a vacuum or gas tube, as in the case of an incandescent and fluorescent lighting. There are two types of solid-state light emitters: inorganic light-emitting diodes (LEDs) or organic light-emitting diodes (OLEDs). (Sandia National Laboratories)

Standardized Color Ellipse: A MacAdam color ellipse defined by center chromaticity coordinates (CIE x, y) and a measure of certainty for detecting a color difference specified in standard deviation units called steps (ANSI C78.376-2001).

TMP_C: See LED Driver Case Temperature Measurement Point.

TMP_{LED}: See LED Temperature Measurement Point.

UL: Underwriters Laboratories.

Note: The definitions for color rendering (CRI) of a light source, correlated color temperature (CCT) of a light source, input power, light-emitting diode (LED), lumen maintenance, and rated wattage have been updated to align with the definitions in the U. S. Department of Energy Code of Federal Regulations CFR Title 10. The definition for run-up time was revised to align with the ENERGY STAR Run-Up Test Method, and the compact fluorescent definition was updated to clarify these lamps include integral electronic ballasts and ANSI base types. The definition for decorative has been updated to align with changes made in this draft. New definitions have been added for dimmable lamp, flicker, multi-power lamps and omnidirectional lamps.

5. TEST CRITERIA

Performance requirements in this specification are determined in part by referencing the performance data of a traditional incandescent lamp (the "referenced incandescent lamp"). Referenced incandescent lamp performance data shall include shape designations appearing in ANSI C79.1-2002 (e.g. A, C, G, MR, PAR etc.), lamp diameter in eighths of an inch (e.g. MR-16 dia. = 16 eighths), nominal wattage, and beam angle for directional types.

Performance requirements in this specification are also determined by the replacement lamps' type and standard form factor per table 1. Lamps claiming equivalency with an ANSI lamp shape on the lamp, its base or packaging, product literature or point-of-purchase materials, either printed or electronic, shall meet all requirements detailed in this specification for ANSI standard lamps.

When testing lamps, the methods of measurement identified for each performance characteristic in the “Methods of Measurement and/or Reference Documents” column of the performance requirements tables presented within this specification shall be used to determine ENERGY STAR qualification.

All tests shall be conducted with the lamp connected to a supply circuit of rated frequency. For lamps 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.

IES LM-9, LM-65 and LM-66 are applied to both hot and cold cathode lamps.

Note: EPA has removed the language associated with the commercial grade requirements proposed in Draft 2, in response to concerns that its implementation would create potential complications in the marketplace with existing “commercial” lighting products, as well as potentially confuse consumers. The commercial tier designation was introduced to allow large purchasers or efficiency program implementers to distinguish between the performance and longevity of ENERGY STAR lamps; however, the Agency believes that a better solution is to rely on the new filtering capabilities of the certified product list. The advanced features will allow users to screen for specific performance attributes that meet individual programmatic needs such as lifetime, CRI and power factor - all elements that were originally included in EPA’s proposed “commercial” tier.

Low voltage lamps, which were added to the scope of the specification in Draft 2, will not be required to meet more stringent requirements such as 35,000 hour rated life. This section also has been revised to indicate tests shall be conducted at rated frequency and that lamps with various operating voltages must be tested at 120 volts or the highest rated voltage.

6. FEDERAL STANDARDS AND DOE RULEMAKING

The scope of this specification includes bare and covered (no reflector) medium base compact fluorescent lamps which are regulated by the U. S. Department of Energy Code of Federal Regulations CFR Title 10. Lamp types covered by the federal regulations and submitted for ENERGY STAR certification may leverage test data generated to meet federal standards and also must complete additional testing to meet ENERGY STAR performance requirements. CFR references, such as CFR Title 10 Part 429, are provided throughout the specification as guidance, highlighting the program’s efforts to align the overlapping testing requirements.

Luminous Efficacy - The sample set for the Luminous Efficacy testing requirement for lamps covered by the CFR shall include 5 lamps tested base-up in accordance with IES LM-66-11. In order to meet the luminous efficacy requirement for ENERGY STAR certification, 5 additional samples tested base-down must be tested.

Lumen Maintenance - The sample set for the Lumen Maintenance testing requirement for lamps covered by the CFR shall include 5 lamps tested base-up in accordance with IES LM-65-10 at 25°C. For ENERGY STAR certification, the 5 samples in the base-up orientation at 25°C for DOE may be leveraged but manufacturers must test an additional 5 samples base-down in accordance with the Elevated Temperature Life Test procedure or IES LM-66, as dictated by lamp wattage and type in this specification. For example, the Lumen Maintenance sample size for a medium base bare-spiral lamp rated 9W with no orientation restrictions is 10 lamps, 5 base-up and 5-base down tested in accordance with IES LM-65-10 at 25°C. If the bare-spiral lamp is rated 12W, the sample size required for ENERGY STAR certification is 10 lamps; 5 base-up tested in accordance with IES LM-65-10 at 25°C and 5 lamps tested base-down in accordance with the Elevated Temperature Life Test procedure.

Rated Life - The sample set for the Rated Life testing requirement for lamps covered by the CFR shall include 5 lamps tested base-up and 5 lamps tested base-down in accordance with IES LM-65-10 at 25°C. In order to meet the rated life requirement for ENERGY STAR certification, 5 of the 10 samples tested at 25°C for DOE may be leveraged but manufacturers must test an additional 5 samples in the base-down position in accordance with the Elevated Temperature Life Test procedure or IES LM-66, as dictated by lamp wattage and type. For example, the Rated Life testing sample size for ENERGY STAR certification of a 12W medium base covered compact fluorescent lamp with no orientation restrictions is 10 lamps; the 5 base-up lamps tested in accordance with IES LM-65-10 at 25°C and 5 additional base down lamps tested in accordance with the Elevated Temperature Life Test.

Lamps not covered by the federal code shall use the sampling requirements in the Supplemental Testing Guidance section in order to meet the specification performance requirement for Lumen Maintenance and Rated Life.

Note: The specification has been updated to more clearly align with federal standards for compact fluorescent lamps and clarify where data can be shared and where testing for the ENERGY STAR specification may differ. Partners are reminded that testing for federal lighting standards must be conducted by a NVLAP laboratory, and not all EPA-recognized laboratories have been accredited by NVLAP.

7. PRODUCT CERTIFICATION

7.1. Product Variations

Any variation in lamp design or composition that impacts the performance of the lamp is considered a new, unique model which shall be tested in accordance with all requirements detailed in this specification. Allowances are detailed below for variations in lamp composition or construction that do not negatively impact lamp performance.

The model which the laboratory expects to have the greatest difficulty meeting the performance requirements outlined in this specification shall be tested (“tested representative model”). Variants shall be identical to the tested representative model with the exception of allowed variations listed in table 2. In addition, variants are permitted to reference the test reports of the tested representative model to satisfy certification requirements with the exception of the required tests outlined in table 2.

The following shall be satisfied for product variations listed below:

- 7.1.1. The tested representative model and the variant(s) shall have the same rated input voltage(s).
- 7.1.2. Across a sample of up to five units of a variant, the average of in situ temperatures of critical components shall be no greater than 2.5°C above the same average of in situ temperatures in a sample of up to five units of the tested representative model. Critical components include (as applicable) the highest temperature LED package/array/module measured at TMP_{LED} , LED driver measured at TMP_C , ballast case temperature at T_C , capacitors and fuses.
- 7.1.3. For solid-state lamps, variation not allowed where, the *in situ* temperatures measured at each unit’s highest temperature or the average of up to 5 unit samples TMP_{LED} is greater than the maximum case temperature tested in the corresponding IES LM-80 report.
- 7.1.4. OSHA NRTL safety listing or certification report shall be available that includes descriptions of both the tested representative model and variant(s) demonstrating their identical construction except for the allowable variations detailed in table 2, as applicable.
- 7.1.5. Test report(s) shall be available from EPA-recognized laboratory(ies) for the tested representative model and the variant(s) demonstrating that variant performance for the following parameters varies by no more than $\pm 5\%$ while meeting this specification’s requirements:
 - i. Input current and input wattage
 - ii. Power factor
 - iii. Maximum overall length, except as affected only by variations in lamp base or envelope shape.
 - iv. Maximum overall diameter

Table 2: Allowable Variations

Lamp Attribute	Allowable Variation	Additional Test Data Required For Each Variant
Heat Sink Paint Color (solid-state only)	Lamp body color/pigment. (Not the type of paint or plastic).	None
Beam Angle (solid-state only)	The dimensions of lamp secondary optics (e.g. lens thickness, refractor patterns). Variation in secondary optical material not allowed.	Center Beam Intensity, Color Angular Uniformity
Lamp Base (ANSI base adapter)	Lamp base type (e.g. ANSI E26, GU24, etc.)	None
Correlated Color Temperature (CFL only)	Correlated color temperature so long as representative lamp model has completed 100% of rated life testing.	Lumen Maintenance testing to 40% of rated life
Envelope Shape (decorative shapes only)	Lamp envelope shape, so long as the envelope material and thickness are unchanged. The surface area and volume of the tested representative model’s envelope shall be less than or equal to that of the variant.	None
Envelope Finish (decorative shapes only)	Lamp envelope finish, so long as the envelope material and thickness are unchanged. The surface area and volume of the tested representative model’s envelope shall be less than or equal to that of the variant.	Luminous Efficacy Light Output Correlated Color Temperature Color Rendering

Note: EPA has added a column to the Allowable Variations table which identifies the tests that cannot be shared among allowable variations. EPA has clarified this table in response to stakeholder comments. Additionally, EPA has proposed altering the *in situ* tolerance for beam angle and lamp base variations. The proposal allows manufacturers the flexibility of testing the temperature variation of one or more samples for variation testing. The Agency has proposed CCT as an allowable variation for compact fluorescent lamps only, requiring only lumen maintenance testing at 40% of rated life of the variant model when the representative model is tested to 100% of rated life. CCT was not added as an allowable variant for solid-state lamps because EPA did not receive compelling data to make such an allowance.

7.2. Solid-State Lumen Maintenance Performance Data

Content and application of IES LM-80 reports for LED lamps shall comply with [ENERGY STAR Program Guidance](#) Regarding LED Package, LED Array and LED Module Lumen Maintenance Performance Data Supporting Qualification of Lighting Products.

7.3. Temperature Measurements

All temperature measurements including *in situ* measurements (i.e. TMP_{LED} , ballast case, driver case) shall be made in accordance with temperature test methods and apparatus outlined in ANSI/UL 1993. For purposes of thermocouple access, minimally sized holes may be drilled into lamps under test and tightly sealed with flexible sealant. All access holes shall be photographed for repeatability.

7.4. Photographs

Photographs shall be taken of lamp optics, lamp profile and lamp labeling, and shall be maintained in records.

7.5. Significant Digits and Rounding

7.5.1. Record measurements at the resolution of the test instrumentation.

7.5.2. All calculations shall be carried out with directly measured (unrounded) values.

7.5.3. Compliance with the specification limits shall be evaluated using values rounded to the nearest significant digit as expressed in the corresponding specification limit.

7.5.4. If a specification limit is modified by a tolerance, take the tolerance first, and then determine compliance according to 7.5.3

7.5.5. Rounding is defined as follows:

- (i) A fractional number at or above the midpoint between two consecutive decimal places or whole numbers shall be rounded up to the higher of the two decimal places or whole numbers; or
- (ii) A fractional number below the midpoint between two consecutive decimal places or whole numbers shall be rounded down to the lower of the two decimal places or whole numbers; and
- (iii) Round initial efficacy values to one decimal place. Round lumen maintenance at 1,000 hours, lumen maintenance at 40 percent of rated life, number of rapid cycles, and the final lamp life to whole numbers.

Note: In Draft 3, EPA has proposed updating the Significant Digits and Rounding guidance to align with rounding practices in 10 CFR 430.23.

8. METHODS OF MEASUREMENT AND REFERENCE DOCUMENTS

Organization	Identifier	Description
ANSI/IEEE	C62.41.2-2002	IEEE Recommended Practice on Characterization of Surges in Low Voltage (1000V and Less) AC Power Circuits
ANSI	C78.20-2003	Electric Lamps—A, G, PS and Similar Shapes with E26 Medium Screw Bases
ANSI	C78.21-2011	Electric Lamps—PAR and R Shapes
ANSI	C78.23-1995 (R2003)	Incandescent Lamps—Miscellaneous Types
ANSI/ANSLG	C78.357-2010	For Incandescent Lamps: Tungsten Halogen Lamps (non-vehicle)
ANSI	C78.376-2001	Specifications for the Chromaticity of Fluorescent Lamps
ANSI/ANSLG	C78.377-2011	Specifications for the Chromaticity of Solid State Lighting Products
ANSI	C79.1-2002	Nomenclature for Glass Bulbs Intended for Use with Electric Lamps
ANSI/ANSLG	C81.61-2009	Specifications for Bases (Caps) for Electric Lamps
ANSI/NEMA	C82.2-2002	Fluorescent Lamp Ballasts, Methods of Measurement of (includes supplements)
ANSI	C82.77-2002	Harmonic Emission Limits—Related Power Quality Requirements for Lighting Equipment
ANSI/IES	RP-16-10	Nomenclature and Definitions for Illuminating Engineering
ANSI/UL	1993-2012	Standard for Safety of Self-Ballasted Lamps and Lamp Adapters
ANSI/UL	8750-2009	Standard for Light Emitting Diode (LED) Equipment for Use in Lighting Products
CIE	Pub. No. 13.3-1995	Method of Measuring and Specifying Color Rendering of Light Sources
CIE	Pub. No. 15:2004	Colorimetry
Commission of the European Communities	(EC) No 244/2009	Commission Regulation (EC) No 244/2009 of 18 March 2009 Implementing Directive 2005/32/EC of the European Parliament and of the Council
DOE	10 CFR 429	Certification, Compliance, and Enforcement for Consumer Products and Commercial and Industrial Equipment
DOE	10 CFR 430	Energy Conservation Program for Consumer Products
IEC	62321:2008 (Ed. 1)	Electrotechnical Products - Determination Of Levels Of Six Regulated Substances (lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls, polybrominated diphenyl ethers)
IES	LM-9-09	Electrical and Photometric Measurements of Fluorescent Lamps
IES	LM-20-13	Photometric Testing of Reflector-Type Lamps (renewal anticipated in 2013)
IES	LM-40-10	Life Testing of Fluorescent Lamps
IES	LM-54-12	Guide to Lamp Seasoning
IES	LM-65-10	Life Testing of Compact Fluorescent Lamps
IES	LM-66-11	Electrical and Photometric Measurements of Single-Ended Compact Fluorescent Lamps
IES	LM-79-08	Electrical and Photometric Measurements of Solid-State Lighting Products
IES	LM-80-08	Measuring Lumen Maintenance of LED Light Sources
IES	TM-21-11	Projecting Long Term Lumen Maintenance of LED Light Sources

Note: In Draft 3, EPA has updated the Methods of Measurement and Reference Documents table to more accurately reflect the requirements and guidance in the Draft. References for the DOE CFR Title 10 Part 429 and 430 have been added since EPA has worked to align requirements in Draft 3 with the requirements in the CFR. References to CFR 47 have been removed since FCC requirements are no longer referenced in the proposed requirements. Finally, ANSI C78.5-2003 (Specification for Performance of Self-ballasted Compact Fluorescent Lamps), ANSI C78.389-2004 (Electric Lamps - High-Intensity Discharge (HID) - Methods of Measuring Characteristics), IES LM-47-12 (Life Testing of High Intensity Discharge (HID) Lamps), and IES LM-51-00 (Electrical and Photometric Measurements of High Intensity Discharge Lamps) have been removed from the table as they are no longer applicable to the specification.

9. PHOTOMETRIC PERFORMANCE

9.1. Luminous Efficacy: All Lamps

Lamp Type	ENERGY STAR Requirements		Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
	Lamp shall meet the applicable requirement in the table below.		Measurement (fluorescent): IES LM-9-09 IES LM-66-11 CFR Title 10 Parts 429 and 430 Measurement (solid-state): IES LM-79-08 Reference Documents: IES LM-54-12	Sample Size: 10 units per model: 5 units tested base-up and 5 units tested base-down unless the manufacturer restricts specific use or position. If position is restricted, all units shall be tested in restricted position. Passing Test: Average of unit values shall meet the applicable requirement, and ≥ 8 units individually shall meet the requirement. For fluorescent lamps, measurements shall be taken at the end of 100 hours of seasoning according to IES LM-54-12. For dimmable or multi-power lamps, measurements shall be taken at the highest wattage setting listed for the model. The reported value shall be the average of the unit values or shall be the result of one of the samples randomly selected and tested where the value is less than or equal to the lower of 1) the mean of the samples or 2) the lower 97.5 percent confidence limit (LCL) of the true mean divided by 0.95.
	Lamp Rated Wattage (watts)	Minimum Lamp Efficacy (initial lm/W)		
Omnidirectional	<15	55		
	≥ 15	65		
Directional	<20	40		
	≥ 20	50		
Decorative	<15	45		
	$15 \leq W < 25$	50		
	≥ 25	60		

Note: EPA has restructured the proposed efficacy requirements in Draft 3 based, in part on stakeholder feedback and to align with the DOE CFR. Comments received reflected a mix of opinions regarding the proposed efficacy levels in Draft 2 with some advocating for higher efficacy levels and other suggesting lower levels for certain types of products. After further analysis the Agency has more closely aligned wattage bins with the DOE CFR and adjusted the efficacy by wattage for directional and decorative lamps to ensure that a wide range of products are available to consumers at various price points and that address certain barriers to wider adoption of ENERGY STAR lamps. The guidance for reported values has also been updated to align with the DOE CFR.

9.2. Light Output (Exemption: ANSI Standard MR and PAR Shapes)

Wattage equivalency claims on the lamp, its base or packaging, product literature or point-of-purchase materials, either printed or electronic may not exceed values certified according to the tables below.

Lamp Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance																								
Omnidirectional	Lamp minimum initial light output (total luminous flux) shall be greater than or equal to that of the referenced incandescent lamp per the table below.	Measurement (fluorescent): IES LM-9-09 IES LM-66-11 Measurement (solid-state): IES LM-79-08 Reference Documents: IES LM-54-12	Sample Size: 10 units per model: 5 units tested base-up and 5 units tested base-down unless the manufacturer restricts specific use or position. If position is restricted, all units shall be tested in restricted position. Passing Test: Average of unit values shall meet the requirement, and ≥ 8 units individually shall meet the requirement.																								
	<table border="1"> <thead> <tr> <th>Rated Wattage of the Referenced Incandescent Lamp (watts)</th> <th>Light Output (Lumens)</th> </tr> </thead> <tbody> <tr><td>25</td><td>250-449</td></tr> <tr><td>40</td><td>450-799</td></tr> <tr><td>60</td><td>800-1,099</td></tr> <tr><td>75</td><td>1,100-1,599</td></tr> <tr><td>100</td><td>1,600-1,999</td></tr> <tr><td>125</td><td>2,000-2,549</td></tr> <tr><td>150</td><td>2,550-3,000</td></tr> </tbody> </table>			Rated Wattage of the Referenced Incandescent Lamp (watts)	Light Output (Lumens)	25	250-449	40	450-799	60	800-1,099	75	1,100-1,599	100	1,600-1,999	125	2,000-2,549	150	2,550-3,000								
Rated Wattage of the Referenced Incandescent Lamp (watts)	Light Output (Lumens)																										
25	250-449																										
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75	1,100-1,599																										
100	1,600-1,999																										
125	2,000-2,549																										
150	2,550-3,000																										
Directional (R, BR and ER)	Lamp initial light output (in lumens) shall be greater than or equal to ten times the incandescent lamp's rated wattage for the following referenced incandescent lamps: <ul style="list-style-type: none"> • 65 watt BR30, BR40 and ER40 lamps • BR30, ER30, BR40 and ER40 lamps ≤ 50 watts • R20 lamps ≤ 45 watts • Lamps ≤ 40 watts • Lamps smaller than 2.25" diameter For example - a lamp replacing a 25W incandescent shall produce ≥ 250 lumens. For all other directional lamps not included above, light output (in lumens) shall be greater than or equal to that of the referenced incandescent lamp per the table below.		For fluorescent lamps, measurements shall be taken at the end of 100 hours of seasoning according to IES LM-54-12. For dimmable or multi-power lamps, measurements shall be taken at the highest wattage setting listed for the model. Average of the unit values shall be reported.																								
	<table border="1"> <thead> <tr> <th>Rated Wattage of the Referenced Incandescent Lamp (watts)</th> <th>Light Output for R20 (Lumens)</th> <th>Light Output for Lamps Larger Than R20 (Lumens)</th> </tr> </thead> <tbody> <tr><td>45</td><td>-</td><td>750</td></tr> <tr><td>50</td><td>720</td><td>850</td></tr> <tr><td>65</td><td>1,010</td><td>1,190</td></tr> <tr><td>75</td><td>1,210</td><td>1,420</td></tr> <tr><td>90</td><td>1,520</td><td>1,790</td></tr> <tr><td>100</td><td>1,740</td><td>2,050</td></tr> <tr><td>120</td><td>2,190</td><td>2,580</td></tr> <tr><td>150</td><td>2,910</td><td>3,430</td></tr> </tbody> </table>			Rated Wattage of the Referenced Incandescent Lamp (watts)	Light Output for R20 (Lumens)	Light Output for Lamps Larger Than R20 (Lumens)	45	-	750	50	720	850	65	1,010	1,190	75	1,210	1,420	90	1,520	1,790	100	1,740	2,050	120	2,190	2,580
Rated Wattage of the Referenced Incandescent Lamp (watts)	Light Output for R20 (Lumens)	Light Output for Lamps Larger Than R20 (Lumens)																									
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Decorative Except Globe (G) Shape (see below)	Lamp minimum initial light output (total luminous flux) shall be greater than or equal to that of the referenced incandescent lamp per the table below.																										
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Rated Wattage of the Referenced Incandescent Lamp (watts)	Light Output (Lumens)																										
10	70-89																										
15	90-149																										
25	150-299																										
40	300-499																										
60	500-699																										

Decorative - Globe (G) Shape	Lamp minimum initial light output (total luminous flux) shall be greater than or equal to that of the referenced incandescent lamp per the table below.			
	Rated Wattage of the Referenced Incandescent Lamp (watts)	Light Output (Lumens)		
	25	250-349		
	40	350-499		
	60	500-574		
	75	575-649		
	100	650-1099		
	150	1100-1300		

Note: In Draft 3, EPA has removed the light output requirement for semidirectional lamps since the category was eliminated from the specification. EPA also removed references to wattage levels required under the Energy Independence and Security Act, because they are considered maximums, are unfamiliar to consumers and equivalency claims to them would add to consumer confusion on purchasing light bulbs. Globe type lamps were moved to the decorative section after further analysis on the performance and energy savings of these products compared to the incumbent technology. EPA also changed the light output passing language from 9 to 8 so that the average of unit values must meet the requirement, and ≥ 8 units individually must meet the requirement due to concerns that the average and 9 or more samples was too restrictive for typical manufacturing variance.

9.3. Elevated Temperature Light Output Ratio: All Directional Lamps (Exemption: Omnidirectional and Decorative Lamps)

Lamp Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
All Directional	Lamp shall maintain $\geq 90\%$ of initial light output (total luminous flux) measured at ambient temperature ($25^{\circ}\text{C} \pm 5^{\circ}\text{C}$) when tested in the same elevated temperature condition required by the lumen maintenance requirement.	Measurement: ENERGY STAR Elevated Temperature Light Output Ratio Test	Sample Size: One unit tested base-up. Passing Test: The unit shall meet the requirement.

Note: The Elevated Temperature Light Output Ratio has been revised to only apply to Directional Lamps, as semidirectional lamps were removed from the specification.

EPA revised this section to provide additional clarity. The initial light output ambient measurement temperature has been explicitly defined as $25^{\circ}\text{C} \pm 5^{\circ}\text{C}$. The requirement for the elevated temperature condition has been clarified to be the same elevated temperature condition that the model is tested under to undergo for lumen maintenance and life testing.

9.4. Center Beam Intensity: ANSI Standard PAR and MR Shapes (Exemption: All Other Lamps)

Lamp Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance																
ANSI Standard PAR Shapes and Low-Voltage MR Lamps	Lamp center beam intensity shall be greater than or equal to the minimum center beam intensity value calculated by the ENERGY STAR Center Beam Intensity Benchmark Tool for the referenced incandescent lamp. (http://www.energystar.gov/ia/products/lighting/iled/IntLampCenterBeamTool.zip)	Measurement (fluorescent): IES LM-66-11 Measurement (solid-state): IES LM-79-08	Sample Size: One new unit. The sample may be the same unit for testing color angular uniformity as applicable. Passing Test: The unit shall meet the requirement.																
Line-Voltage MR Lamps	Lamp minimum initial center beam intensity shall be greater than or equal to that of the referenced incandescent lamp per the table below. <table border="1" data-bbox="370 1199 883 1482"> <thead> <tr> <th>Rated Wattage of the Referenced Incandescent Lamp (watts)</th> <th>Minimum Center Beam Intensity (candelas)</th> </tr> </thead> <tbody> <tr><td>20</td><td>150</td></tr> <tr><td>25</td><td>300</td></tr> <tr><td>35</td><td>400</td></tr> <tr><td>45</td><td>600</td></tr> <tr><td>50</td><td>600</td></tr> <tr><td>75</td><td>1,200</td></tr> <tr><td>100</td><td>2,500</td></tr> </tbody> </table>	Rated Wattage of the Referenced Incandescent Lamp (watts)	Minimum Center Beam Intensity (candelas)	20	150	25	300	35	400	45	600	50	600	75	1,200	100	2,500	Reference Documents: IES LM-54-12	For fluorescent lamps, measurements shall be taken at the end of 100 hours of seasoning according to IES LM-54-12.
Rated Wattage of the Referenced Incandescent Lamp (watts)	Minimum Center Beam Intensity (candelas)																		
20	150																		
25	300																		
35	400																		
45	600																		
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9.5. Luminous Intensity Distribution: ANSI Standard Omnidirectional and Decorative (Exemption: Compact Fluorescent Lamps)

Lamp Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
ANSI Standard Omnidirectional Lamps A, BT, P, PS, S, and T.	Lamp luminous intensity distribution shall emulate that of the referenced incandescent lamp as follows. Each luminous intensity measured value (candelas) shall vary by no more than 20% from the average of all measured values. No less than 5% of total flux (lumens) shall be emitted in the 135° to 180° zone.	Measurement (solid-state): IES LM-79-08	Sample Size: One new unit. Passing Test: The unit shall meet the requirement. Lamp luminous intensity shall be measured in vertical

Lamp Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
	See Appendix A for illustration.		planes 0°, 45°, and 90° about the lamp axis, at 5° increments (max) within each plane's 0° to 135° zone.
ANSI Standard Decorative Lamps B, BA, C, CA, DC, F, and G.	Lamp luminous intensity distribution shall emulate that of the referenced incandescent lamp as follows. No less than 5% of total flux (lumens) shall be emitted in the 135° to 180° zone. See Appendix A for illustration.		Sample Size: One new unit. Passing Test: The unit shall meet the requirement.

Note: In Draft 2, EPA proposed intensity distribution requirements for ANSI Standard PAR shapes and Low Voltage MR lamps based on beam performance generated by the incandescent and halogen lamps being replaced. Comments received in response to Draft 2 expressed concern about the effectiveness of the requirements, indicating it would not achieve EPA's goal of providing consumers with a consistent and quality beam performance and may unnecessarily penalize good products that can meet or exceed consumer expectations but are not identical to traditional lighting. Stakeholders also expressed that the perceived problem is not wide-spread or likely to result in any negative impact on consumers because retail buyers routinely filter out the bad performing beams prior to ordering products. Based on these comments, EPA has removed the luminous intensity distribution requirements for directional lamps. EPA will continue to follow developments in this area to see if the problem persists and work with stakeholders to explore alternative objective methods for assessing beam performance.

In Draft 3, EPA has introduced limited intensity distribution requirements for decorative lamp shapes to ensure that the efficient replacements more accurately deliver the light distribution performance consumers expect from these product types.

Compact fluorescent lamps are exempt from this requirement due to the technology's inherent omnidirectional performance.

9.6. Correlated Color Temperature (CCT): All Lamps

Lamp Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
Compact Fluorescent	Lamp light output shall correlate to one of the following nominal CCTs: <ul style="list-style-type: none"> • 2700K • 3000K • 3500K • 4000/4100K • 5000K • 6500K 	Measurement: IES LM-9-09 IES LM-66-11 Calculation: CIE 15.2004 Reference Documents: ANSI C78.376-2001 sections 2 and 4, and table 2 IES LM-54-12	Sample Size: 10 units per model: 5 units tested base-up and 5 units tested base-down unless the manufacturer restricts specific use or position. If position is restricted, all units shall be tested in restricted position. Passing Test: All units shall fall within a 7-step MacAdam ellipse for the designated CCT, with ellipses constructed per ANSI C78.376-2001 sections 2 and 4, and table 2. <hr/> For dimmable or multi-power lamps, measurements shall be taken at the highest wattage setting listed for the model. Measurements shall be taken at the end of 100 hours of seasoning according to IES LM-54-12. Reported CCT shall be the average of the unit measured values.
Solid-State		Measurement: IES LM-79-08 Calculation: CIE 15.2004 Reference Document: ANSI C78.377-2011	Sample Size: 10 units per model: 5 units tested base-up and 5 units tested base-down unless the manufacturer restricts specific use or position. If position is restricted, all units shall be tested in restricted position. Passing Test: All units shall fall within the defined 7-step ANSI quadrangle for the target correlated color temperature. <hr/> For dimmable or multi-power lamps, measurements shall be taken at the highest wattage setting listed for the model. Reported CCT shall be the average of the passing unit measured values.

9.7. Color Rendering: All Lamps

Lamp Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
Compact Fluorescent	Lamp shall have a color rendering index (R_a) \geq 80, and an $R_9 > 0$.	Measurement: IES LM-9-09 IES LM-66-11 Calculation: CIE 13.3-1995	Sample Size: 10 units per model: 5 units tested base-up and 5 units tested base-down unless the manufacturer restricts specific use or position. If position is restricted, all units shall be tested in restricted position. Passing Test: Average of units tested shall meet the requirements and no more than 3 units shall have $R_a < 77$. No unit shall have $R_a < 75$.
Solid-State		Measurement: IES LM-79-08 Calculation: CIE 13.3-1995	<hr/> For dimmable or multi-power lamps, measurements shall be taken at the highest wattage setting listed for the model. Reported R_a and R_9 shall be the averages of the unit measured values.

9.8. Color Maintenance: All Solid-State Lamps (Exemption: Compact Fluorescent Lamps)

Lamp Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
Solid-State	Lamp change in chromaticity from 0-hour measurement, at any measurement point during the first 6,000 hours of lamp operation, shall be within a total distance of 0.007 on the CIE 1976 u'v' diagram.	Measurement: IES LM-79-08 Reference Document: ANSI C78.377-2011	Sample Size: 10 units per model: 5 units tested base-up and 5 units tested base-down unless the manufacturer restricts specific use or position. If position is restricted, all units shall be tested in restricted position. Passing Test: ≥ 9 units shall meet the requirement.
			<hr/> For dimmable or multi-power lamps, measurements shall be taken at the highest wattage setting listed for the model. Reported maintenance shall be the average of the unit measured values.

**9.9. Color Angular Uniformity: Solid-State Directional Lamps
(Exemption: All Other Lamps)**

Lamp Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
Solid-State Directional	Variation of chromaticity across the beam angle of the lamp shall be within a total distance of 0.006 from the weighted average point on the CIE 1976 (u'v') diagram.	Measurement: IES LM-79-08 Reference Document: ANSI C78.377-2011	<p>Sample Size: One new unit. The sample shall be the same unit for testing Center Beam Intensity, as applicable.</p> <p>Passing Test: The unit shall meet the requirement.</p> <hr/> <p>For dimmable or multi-power lamps, measurements shall be taken at the highest wattage setting listed for the model.</p> <p>Lamp shall be scanned on two vertical axes separated by 90 degrees. Vertical scanning resolution shall be 1° for beam angles less than 10° and 2° for beam angles 10° or greater.</p>

Note: In previous drafts, EPA called for variation of chromaticity across the field angle of the lamp to be within a total distance of 0.004 from the weighted average point on the CIE 1976 (u'v') diagram to align with the Luminaires specification. Due to continued problems with the equipment sensitivity in measuring color angular uniformity in the edge of the field angle, EPA has adjusted the color angular uniformity requirement to be measured across the beam angle which will increase accuracy of the measurement. The variance level has been adjusted from 0.004 to 0.006, the level used in the current ENERGY STAR Integral LED Lamps specification. EPA has proposed scanning angles fine enough to accurately evaluate the variation in chromaticity across the beam forming source and in alignment with current practices for photometry scan resolution. EPA believes these changes will increase accuracy and reliability of measurements.

10. LUMEN MAINTENANCE AND RATED LIFE

Note: Required durations of lumen maintenance and rapid cycle stress testing corresponding to lamp's rated life claim shall be completed. Rated life claims on the lamp, its base or packaging, product literature or point-of-purchase materials, either printed or electronic may not exceed values certified according to this specification. Rated life claims may be upgraded as ongoing testing satisfies all requirements associated with longer life claims.

10.1. Lumen Maintenance: All Lamps

Lamp Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
Compact Fluorescent	Lamp shall maintain $\geq 90\%$ of initial lumen output at 1000-hours; and $\geq 80\%$ of initial lumen output at 40% of rated life.	<p>Measurement: <i>ENERGY STAR Elevated Temperature Life Test</i></p> <p>IES LM-65-10</p> <p>CFR Title 10 Parts 429 and 430</p> <p>Reference Documents: IES LM-54-12</p>	<p>Sample Size: 10 units per model: 5 units tested base-up and 5 units tested base-down unless the manufacturer restricts specific use or position. If position is restricted, all units shall be tested in restricted position.</p> <p>Passing Test: Average lumen maintenance of the surviving samples shall meet the requirement. All lamp samples shall be surviving at 1000-hours. No more than 3 units may have lumen maintenance $< 75\%$ at 40% of rated life. The average lumen maintenance of the ≥ 9 surviving units shall meet the minimum requirement for the designated life claim.</p> <hr/> <p>All decorative lamps, and omnidirectional lamps < 10 watts, shall be tested in accordance with IES LM-65-10 in an ambient temperature condition 25°C.</p> <p>All directional lamps ≤ 20 watts, and all omnidirectional lamps ≥ 10 watts, shall be tested in accordance with the ENERGY STAR Elevated Temperature Life Test using the Option A test method or using test methods Option B or C with an operating temperature of 45°C.</p> <p>All directional lamps > 20 watts shall be tested in accordance with the ENERGY STAR Elevated Temperature Life Test using the Option A test method or Option B test method with an operating temperature of 55°C $\pm 5^\circ\text{C}$.</p> <p>Prescribed test time is the total ON time and shall not include the OFF time during lamp cycling.</p> <p>Initial lumen output measurements shall be taken at the after 100 hours of seasoning according to IES LM-54-12.</p> <p>For dimmable or multi-power lamps, measurements shall be taken at the highest wattage setting listed for the model.</p> <p>A tolerance of -3% may be applied to lumen maintenance averages.</p> <p>The reported value for units tested in a restricted position shall be the average of the surviving unit values. The reported value for</p>

			units tested both base-up and base-down shall be the lesser average of surviving units measured values calculated for each orientation. Alternately the reported value shall be the result of one of the samples randomly selected and tested where the value is less than or equal to the lower of 1) the mean of the samples or 2) the lower 97.5 percent confidence limit (LCL) of the true mean divided by 0.95.																																									
Solid-State	<p>Lamp shall maintain minimum percentage of 0-hour light output after completion of the test duration corresponding to lamp's life claim (hours to 70% lumen maintenance or L₇₀) per the table(s) below. Lamp may earn optional early interim qualification after 3,000 hours, with a rated life claim ≤ 25,000 hours, per the provisions below.</p> <table border="1" data-bbox="337 598 764 911"> <thead> <tr> <th>Maximum Life Claim (hours to L₇₀)</th> <th>Minimum Lumen Maintenance After Test Duration</th> <th>Status After Completion of Test Duration</th> </tr> </thead> <tbody> <tr> <td>15,000</td> <td>86.7%</td> <td rowspan="3">Final qualification testing completed.</td> </tr> <tr> <td>20,000</td> <td>89.9%</td> </tr> <tr> <td>25,000</td> <td>91.8%</td> </tr> <tr> <td>30,000</td> <td>93.1%</td> <td rowspan="5">Interim qualification; continue testing per below.</td> </tr> <tr> <td>35,000</td> <td>94.1%</td> </tr> <tr> <td>40,000</td> <td>94.8%</td> </tr> <tr> <td>45,000</td> <td>95.4%</td> </tr> <tr> <td>50,000</td> <td>95.8%</td> </tr> </tbody> </table> <p>For Extended Lifetime Claims: For lamp life claims > 25,000 hours, lamp shall maintain ≥ 91.5% of 0-hour light output after completion of the test duration corresponding to lamp's life claim per the table below.</p> <table border="1" data-bbox="337 1081 656 1287"> <thead> <tr> <th>Maximum Life Claim (hours to L₇₀)</th> <th>Test Duration (hours) *</th> </tr> </thead> <tbody> <tr> <td>30,000</td> <td>7,500</td> </tr> <tr> <td>35,000</td> <td>8,750</td> </tr> <tr> <td>40,000</td> <td>10,000</td> </tr> <tr> <td>45,000</td> <td>11,250</td> </tr> <tr> <td>50,000</td> <td>12,500</td> </tr> </tbody> </table> <p>To Qualify For Early Interim Qualification After 3,000 Hours: Lamp shall maintain minimum percentages of 0-hour light output corresponding to the lamp's life claim per the table below, and shall meet all other requirements in this specification. A lumen maintenance projection calculation using the applicable LM-80-08 test report for the employed LED package/module/ array model ("device"), the <i>in situ</i> temperature of highest temperature TMP_{LED}, and the forward drive current applied to each device shall support a rated lumen maintenance life greater than or equal to the lamp rated life value to be claimed on product packaging.</p> <table border="1" data-bbox="337 1703 776 1856"> <thead> <tr> <th>Maximum Life Claim (hours to L₇₀)</th> <th>Minimum Lumen Maintenance After 3,000 Hours</th> </tr> </thead> <tbody> <tr> <td>15,000</td> <td>93.1%</td> </tr> <tr> <td>20,000</td> <td>94.8%</td> </tr> <tr> <td>25,000</td> <td>95.8%</td> </tr> </tbody> </table> <p>* designates total on time, not including off time</p>	Maximum Life Claim (hours to L ₇₀)	Minimum Lumen Maintenance After Test Duration	Status After Completion of Test Duration	15,000	86.7%	Final qualification testing completed.	20,000	89.9%	25,000	91.8%	30,000	93.1%	Interim qualification; continue testing per below.	35,000	94.1%	40,000	94.8%	45,000	95.4%	50,000	95.8%	Maximum Life Claim (hours to L ₇₀)	Test Duration (hours) *	30,000	7,500	35,000	8,750	40,000	10,000	45,000	11,250	50,000	12,500	Maximum Life Claim (hours to L ₇₀)	Minimum Lumen Maintenance After 3,000 Hours	15,000	93.1%	20,000	94.8%	25,000	95.8%	<p>Measurement (lamps): ENERGY STAR Elevated Temperature Life Test</p> <p>ENERGY STAR Ambient Temperature Life Test</p> <p>Measurement (devices): IES LM-80-08</p> <p>Lumen Maintenance Projection: IES TM-21-11</p>	<p>Lamp Sample Size: 10 lamps per model: 5 units tested base-up and 5 units tested base-down unless the manufacturer restricts specific use or position. If position is restricted, all units shall be tested in restricted position.</p> <p>Lamp Sample Size for Early Interim Qualification Temperature Test: One lamp per model for <i>in situ</i> measurement of highest temperature TMP_{LED}.</p> <p>Device Sample Size for Early Interim Qualification: Minimum sample size of 20 units for LED packages, or 10 units for LED arrays or LED modules, for each T_S and drive current combination (refer to IES TM-21-11, section 4.2).</p> <p>Final Qualification Passing Test: The average lumen maintenance of the ≥ 9 surviving units shall meet the minimum requirement for the designated life claim.</p> <p>Early Interim Qualification Passing Test: The average lumen maintenance of the 10 units shall meet the 3,000 hour requirement for the lamp's life claim. The 3,000 hour testing for the rated life requirement (next section), and the lumen maintenance projection requirement shall be met.</p> <hr/> <p>All decorative lamps, and omnidirectional lamps < 10 watts, shall be tested in accordance with the ENERGY STAR Ambient Temperature Life Test in an ambient temperature condition 25°C.</p> <p>All directional lamps ≤ 20 watts, and all omnidirectional lamps ≥ 10 watts, shall be tested in accordance with the ENERGY STAR Elevated Temperature Life Test using the Option A test method or using test methods Option B or C with an operating temperature of 45°C.</p> <p>All directional lamps > 20 watts shall be tested in accordance with the ENERGY STAR Elevated Temperature Life Test using the Option A test method or Option B test method with an operating temperature of 55°C ± 5°C.</p> <p>Testing for early interim and final qualification shall be conducted on the same samples, which shall also satisfy the 6,000 hour testing for the rated life requirements (next section).</p> <p>For dimmable or multi-power lamps, measurements shall be taken at the highest</p>
Maximum Life Claim (hours to L ₇₀)	Minimum Lumen Maintenance After Test Duration	Status After Completion of Test Duration																																										
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25,000	91.8%																																											
30,000	93.1%	Interim qualification; continue testing per below.																																										
35,000	94.1%																																											
40,000	94.8%																																											
45,000	95.4%																																											
50,000	95.8%																																											
Maximum Life Claim (hours to L ₇₀)	Test Duration (hours) *																																											
30,000	7,500																																											
35,000	8,750																																											
40,000	10,000																																											
45,000	11,250																																											
50,000	12,500																																											
Maximum Life Claim (hours to L ₇₀)	Minimum Lumen Maintenance After 3,000 Hours																																											
15,000	93.1%																																											
20,000	94.8%																																											
25,000	95.8%																																											

		<p>wattage setting listed for the model.</p> <p>A tolerance of -3% may be applied to lumen maintenance averages.</p> <p>If units are tested both base-up and base-down, the average of surviving unit measured values shall be calculated for each orientation, and the reported lumen maintenance shall be the lesser of the two averages. If units are tested in restricted position, the average of surviving unit measured values shall be reported.</p>
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Note: In Draft 3, EPA has proposed the 1000-hour lumen maintenance requirement for CFLs from ENERGY STAR CFL V4.3, in part due to findings in CFL verification testing that this was a common test failure and is indicative of performance at 40% of rated life. Additionally, the Agency is proposing this requirement to harmonize with the DOE CFR. EPA has updated the passing requirement to ensure that no more than three samples are achieving less than 75% of lumen maintenance at 40% of rated life and removed the requirement that no samples could have less than 70% at this point. The Supplemental Testing Guidance has been updated to reflect the Elevated Temperature Test Options and the wattage levels for lamps required to undergo elevated temperature life testing. Requirements for CFL reported values have been written to align with the DOE CFR.

In Draft 2, EPA proposed the same cycling of solid-state lamps during lumen maintenance testing as is required for compact fluorescent lamps in an effort to align the test method and allow for both products to be tested on the same switching cycle. Due industry efforts in progress to establish new cycling recommendations for solid-state lighting products EPA has retained the non-cycling option from the Integrated LED Lamps specification until the new industry guidance is available for consideration. The 35,000 hour option for early interim qualification for SSL products is no longer relevant due to the elimination of the “Commercial Tier” option.

In response to stakeholder feedback and consultation with the National Institute of Standards’ National Voluntary Laboratory Accreditation Program (NVLAP), the Agency has proposed allowing EPA-recognized laboratories which are not OSHA Nationally Recognized Testing Laboratories (NRTL), but are accredited to conduct the *in situ* temperature measurement to submit test reports in support of the *in situ* temperature measurement requirement.

EPA has added examples of operating milestones for lumen maintenance and rated life testing for lamps of varying rated lifetimes in Appendix B of the specification.

10.2. Rated Life: All Lamps

Lamp Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
Compact Fluorescent	Lamp shall have a rated life $\geq 10,000$ hours. At 40% of rated life 90% of the tested units shall be operational. $\geq 50\%$ of the tested units shall be operational at rated life.	Measurement: <i>ENERGY STAR Elevated Temperature Life Test Method</i> IES LM-65-10 CFR Title 10 Parts 429 and 430 Reference Documents: IES LM-54-12	Sample: The same samples used for lumen maintenance testing. Passing Test: All of the requirements shall be met.
Solid-State	Decorative lamps shall have a rated life $\geq 15,000$ hours. All other lamps shall have a rated life of $\geq 25,000$ hours. All tested units shall be operational at 3,000 hours. $\geq 90\%$ of the tested units shall be operational at 6,000 hours.	See Lumen Maintenance Requirements Section.	

Note: In Draft 3 EPA removed the 6,000 hour test point for CFLs and included the 1,000-hour lumen maintenance requirement, which is required by the DOE CFR and has proven to be a reliable indicator of improved lumen maintenance performance in verification testing. EPA has also proposed allowing one sample failure at 40% of rated life in response to industry data referencing statistical failure analysis for products. An evaluation of CFL qualification data indicated that although rare, manufacturing defects or anomalies may result in a sample failure. In addition, the Agency anticipates that the new elevated temperature life testing requirements may be more stressful on CFLs than the precedent that also allowed for one failure.

10.3. Rapid Cycle Stress Test: All Lamps

Lamp Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
All Lamps	Lamps, when cycled at 5 minutes on, 5 minutes off, shall survive the lesser number of cycles : one cycle per hour of rated life or 15,000 cycles. Compact fluorescent lamps employing "instant start" technology, i.e. start time is ≤ 100 milliseconds, shall survive cycling once per every two hours of rated life, at 5 minutes on, 5 minutes off.	Measurement: IES LM-65-10 (clauses 2,3,5,6) CFR Title 10 Parts 429 and 430	Sample Size: 6 lamps per model: 6 units tested base-up. The samples shall be unique samples for this test. Passing Test: ≥ 5 units shall survive the minimum number of cycles. For dimmable or multi-power lamps, testing shall be conducted at the highest wattage setting listed for the model.

Note: In Draft 3, EPA has lowered the number of samples required from ten to six to align with federal regulations and to reduce the testing burden. EPA has also adjusted cycling requirements for instant start CFLs preferred by consumers in response to comments describing the technological trade-off of limited cycling capability for this feature.

11. ELECTRICAL PERFORMANCE REQUIREMENTS

11.1. Electrical Safety: All Lamps

Lamp Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
All Lamps	Lamp shall comply with ANSI/UL 1993-2012, and ANSI/UL 8750-2009 as applicable.	Measurement: ANSI/UL 1993-2012 ANSI/UL 8750-2009	Sample Size: As required to satisfy safety testing requirements. Passing Test: Units shall meet the requirement.

11.2. Power Factor: All Lamps (Exemption: Lamps ≤ 5 Watts)

Lamp Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
Compact Fluorescent	Lamp shall have a power factor ≥ 0.5.	Measurement: ANSI C82.2-2002	Sample Size: 10 units per model: 5 units tested base-up and 5 units tested base-down unless the manufacturer restricts specific use or position. If position is restricted, all units shall be tested in restricted position. Passing Test: Average of units tested shall meet the requirement.
Solid-State	Lamp shall have a power factor ≥ 0.7.	Measurement: ANSI C82.77-2002 sections 6 and 7	Tested units shall be operated at rated voltage. For dimmable or multi-power lamps, measurements shall be taken at the highest wattage setting listed for the model.

Note: EPA has removed the higher power factor value of 0.9 and the “residential application” and “commercial grade” language due to the elimination of the “Commercial Tier” option from the specification.

11.3. Operating Frequency: All Lamps

Lamp Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
Compact Fluorescent	Lamp shall have an operating frequency within 20 to 33kHz, or ≥ 40 kHz.	Measurement: None	<p>Sample Size: One unit per model.</p> <p>Passing Test: Unit shall meet the requirement.</p> <p>Lamp light output waveform shall be measured with a photodetector, transimpedance amplifier and oscilloscope. Employed equipment models and method of measurement shall be documented. Temporal response, amplification and filtering characteristics of the system shall be suitably designed to capture the photometric waveform. Digitized photometric waveform data and an image of the relative photometric amplitude waveform shall be recorded and frequency shall be reported.</p>
Solid-State	Lamp shall have an operating frequency ≥ 120 Hz.		

Note: In Draft 3, EPA has carried over the operating frequency requirement (≥ 120 Hz²) and supplemental testing guidance from ENERGY STAR Integral LED Lamps V1.4. EPA acknowledges that there is not an established method of measurement at this time, so manufacturers will simply be required to report the operating frequency value to their Certification Body as they have been. EPA will continue to work with the IEEE PAT 1789 working group, IES, and the Alliance for Solid-state Illumination Systems and Technologies (ASSIST) to identify appropriate methods of measurement to ensure that qualified lamps do not produce perceptible flicker, stroboscopic effects, or adverse health effects.

11.4. Start Time: All Lamps

Lamp Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
All Lamps	Lamp shall remain continuously illuminated within one second of application of electrical power.	Measurement: <i>ENERGY STAR Start Time Test</i>	<p>Sample Size: 10 units per model: 5 units tested base-up and 5 units tested base-down unless the manufacturer restricts specific use or position. If position is restricted, all units shall be tested in restricted position.</p> <p>Passing Test: Average of units tested shall meet the requirement.</p> <hr/> <p>For dimmable or multi-power lamps, measurements shall be taken at the highest wattage setting listed for the model.</p>

11.5. Run-Up Time: All Compact Fluorescent Lamps (Exemption: Solid-State Lamps)

Lamp Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
Covered Compact Fluorescent Lamps	Lamp shall achieve 80% stabilized light output in ≤ 120 seconds.	Measurement: <i>ENERGY STAR Run-Up Time Test</i> Reference Documents: IES LM-54-12	Sample Size: 10 units per model: 5 units tested base-up and 5 units tested base-down unless the manufacturer restricts specific use or position. If position is restricted, all units shall be tested in restricted position. Passing Test: Average of units tested shall meet the requirement. <hr/> For dimmable or multi-power lamps, measurements shall be taken at the highest wattage setting listed for the model. Measurements shall be taken at the end of 100 hours of seasoning according to IES LM-54-12.
All Other Compact Fluorescent Lamps	Lamp shall achieve 80% stabilized light output in ≤ 60 seconds.		

Note: As mentioned in previous drafts, a common consumer complaint about compact fluorescent lamps is that they are not bright enough, and that they take too long to reach full light output. Comments received about the run-up time requirement in Draft 2 continued to reflect a mix of views, with some expressing concern about the ability of manufacturers to meet these levels and about the financial costs associated with increases to these requirements. Others expressed concern about the cost of consumer dissatisfaction with slow run-up time impacting adoption of CFL technology.

An analysis of currently qualified CFLs found that 91% of non-covered lamps can achieve 80% stabilized light output in ≤ 60 seconds and 80% of covered lamps can achieve 80% stabilized light output in ≤ 120 seconds. Based on the analysis and the concerns mentioned above, in Draft 3, EPA has returned to the 80% stabilized light output requirement in CFL V4.3 for both covered and non-covered CFLs. In addition, for covered CFLs, EPA has increased the time allowed to reach 80% stabilized light output from ≤ 90 seconds in Draft 2 to ≤ 120 seconds. EPA has also removed the intermediate measurement points due to lack of data on product capability. EPA believes these levels will lead to continued improvement in lamp run-up time, while not placing an undo cost and technical burden upon manufacturers.

11.6. Transient Protection: All Line Voltage Lamps (Exemption: Low Voltage Lamps)

Lamp Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
All Line Voltage Lamps	Lamp shall survive 7 strikes of a 100 kHz ring wave, 2.5 kV level, for both common mode and differential mode.	Measurement: ANSI/IEEE C62.41.2-2002, Category A operation.	Sample Size: 5 units per model. The sample shall be a unique sample for this test. Passing Test: All units shall be fully operational at the completion of testing.

12. DIMMING PERFORMANCE: ALL LAMPS MARKETED AS DIMMABLE

If lamp is designed for a non-phase cut control device, lamp shall be tested using only the specified control(s). If lamp is designed for phase cut dimming operation, select 10 dimmers for testing. The 10 dimmers shall meet the following conditions:

1. From at least 3 different manufacturers
2. At least one must be specified for use with energy efficient lighting
3. At least one must be of the following types: Single Phase Shift; Double Phase Shift, Microprocessor with Power Supply, Voltage Compensation, Electronic Low Voltage, and/or Reverse Phase

Exception – If lamp is compatible with a limited set of dimmers/controls, the limited set of controls must be listed on the packaging and be tested with the lamp against all dimming performance requirements. An asterisk next to “dimmmable” on lamp packaging/online product listing marketing materials must be included and point to an “only compatible with ...” statement.

12.1. Maximum Light Output:

Lamp Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
All Lamps Marketed As Dimmable	Lamp light output on a dimmer/control shall not exceed the lamp’s rated light output by more than 10% or fall below the maximum light output by more than 20%.	Measurement: ENERGY STAR Dimming Range Test Method in development	Sample Size: TBD Passing Test: TBD

12.2. Minimum Light Output:

Lamp Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
All Lamps Marketed As Dimmable	Lamp light output on a dimmer/control shall be no more than 20% of initial light output of lamp on each tested dimmer/control.	Measurement: ENERGY STAR Dimming Range Test Method in development	Sample Size: TBD Passing Test: TBD Minimum light level meeting flicker or audible noise on a test dimmer(s) or control(s) shall be reported

12.3. Flicker:

Lamp Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
All Lamps Marketed As Dimmable	Lamp shall have a flicker index ≤ 0.15 at 100 Hz, increasing linearly to 0.50 at 800 Hz. Applies at full and dimmed measurement conditions.	Measurement: ENERGY STAR Flicker Test Method in development	Sample Size: TBD Passing Test: TBD Determine the dominant frequency in the light output waveform, by looking at a scope trace from a photodiode or from the LED driving current. Measure the flicker index over one period of that waveform.

12.4. Audible Noise:

Lamp Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
All Lamps	Lamp shall not emit noise above 24dBA.	Measurement: <i>ENERGY STAR Noise Test Method in development</i> <i>ANSI standard S12.55-2006/ISO3745:2003</i>	Sample Size: <i>TBD</i> Passing Test: <i>TBD</i> <i>Measurements shall be taken in an anechoic chamber. The microphone shall be placed at a distance of 1 foot or 1 meter (TBD) from the lamp. The dimmer shall be outside the anechoic chamber. The sound level of the lamp shall be measured at the maximum light level, 20% of maximum light output, and the lowest setting, if less than 20% of maximum light output (indicated by the manufacturer). The initial sound pressure level of the empty chamber shall be measured. Measurements shall be taken at six different positions around the lamp, spaced 90° apart. The loudest measurement of the set shall be reported as the sound level. The sound level of the lamp shall be calculated from the measurement taken, with the baseline level corrected for and in accordance with ISO 7574-4:1985, B.2.1. All other aspects of the measurements to be taken in accordance with ANSI standard S12.55-2006/ISO3745:2003 (anechoic chamber specifications, calibration, etc.)</i>

Dimming requirements and test methods are still in development.

EPA is examining the testing of a single lamp paired with a control and up to four lamps on the same control for each metric (dimming range, noise, and flicker). EPA is exploring testing at two to three dimming points, maximum light output on the control, 20 percent of maximum light output on the control, and a third manufacturer lowest dimming percentage, if below 20 percent. To inform the final test methods and requirements to support certification of ENERGY STAR dimmable lamps, such as sample size and passing criteria, round robin testing is underway and developments will be shared with stakeholders outside of this specification at the lamps specification development page www.energystar.gov/lamps. Additional guidance is in development for evaluating flicker on products employing pulse width modulation.

13. LAMP TOXICS REDUCTION

13.1. Lamp Toxics Reduction: All Lamps

Lamp Type	ENERGY STAR Requirements	Method of Compliance
All Lamps	<p>Lamps ≤ 23.0 rated watts shall contain ≤ 2.5 milligrams (mg) mercury per lamp</p> <p>Lamps > 23.0 rated watts shall contain ≤ 3.0 milligrams (mg) mercury per lamp</p> <p>When present, lamp shall contain restricted levels of the following materials, where the maximum concentration values allowed by weight in homogeneous materials are:</p> <ul style="list-style-type: none"> • Lead: 0.1% • Cadmium: 0.01% • Hexavalent chromium: 0.1% • Polybrominated biphenyls (PBB): 0.1% • Polybrominated diphenyl ethers (PBDE): 0.1% 	<p>For purposes of third-party certification, lamp toxics documentation shall not be reviewed when products are initially certified or during verification testing. Instead, consistent with EU RoHS requirements, manufacturer shall maintain documentation on file to demonstrate that certified products meet these requirements. EPA reserves the right to request this documentation at any time. For the purposes of documenting mercury content, the following test procedure shall be used: IEC 62554 ed 1.0 Sample Preparation for Measurement of Mercury Level in Fluorescent Lamps (2011-08-19).</p> <p>For materials other than mercury, manufacturer may rely on component suppliers to provide certification or declaration documents to show that homogenous materials used in lamps comply with the requirement. Alternatively, manufacturer may have lamp components tested in accordance with IEC 62321 or other appropriate analytical technique to verify that homogenous materials do not exceed the concentration limits of the six regulated substances. Handheld XRF analyzers/scanners may also be used to verify compliance.</p>

14. DIMENSIONAL REQUIREMENTS

14.1. Lamp Shape Dimensions: All ANSI Standard Lamps (Exemption: Non-Standard Lamps)

Lamp Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
All ANSI Standard Lamps	Lamp shall comply with ANSI minimum overall length (min OAL), maximum overall length (MOL) and maximum lamp diameter values, where they exist.	<p>Reference Documents:</p> <p>ANSI C78.20-2003</p> <p>ANSI C78.21-2011</p> <p>ANSI C78.23-1995 (R2003)</p>	None.

15. LAMP LABELING, PACKAGING & WARRANTY REQUIREMENTS

15.1. Lamp Labeling: All Lamps

Lamp Type	ENERGY STAR Requirement
All Lamps	<p>Each of the following shall be printed on the lamp:</p> <ul style="list-style-type: none"> • ENERGY STAR partner, lamp manufacturer or brand name • Lamp model or retail SKU number as it appears on the ENERGY STAR qualified product list • Lamp nominal correlated color temperature including "Kelvin" or "K"* • Rated wattage in watts (lamps not covered by FTC requirements)* • Lamp rated lumen output in lumens (lamps not covered by FTC requirements) • Lamp nominal beam angle in degrees (in lieu of lumen output for PAR and MR lamps) <p>*The lamp correlated color temperature and wattage may be included in the lamp model number and must use "K" or "W" after each respective number.</p>

Note: In Draft 3 EPA clarified that watts or CCT included in a model or retail numbers that use "W" or "K" after the appropriate number can be used to satisfy lamp labeling requirements. Beam angle was added for PAR and MR lamps in place of light output because it is more important to consumers selecting replacements for these products.

15.2. Lamp Packaging: All Lamps Except as Noted¹

Criteria	ENERGY STAR Requirement
Model Number	Lamp packaging shall include model number and retail SKU number (as applicable) as will appear on the ENERGY STAR qualifying product list.
Controls Compatibility	Lamp packaging exterior shall display on the front panel in ≥ 8 point type an indication of the lamp's dimming capability: "dimmable", "for dimmers", "non-dimmable", "do not use with dimmers" or the like. Dimmable lamp packaging shall indicate that the lamp may not be compatible with all dimmers, and shall reference a website providing regularly updated dimmer compatibility information for the lamp model. Lamps that are dimmable with a limited set of controls that elect to test and list compatibility with the limited set of controls must list all compatible controls on packaging. See Dimming section 12. Packaging for lamps not designed for operation with photosensors, motion sensors or timing devices shall indicate in ≥ 8 point type "not compatible with photosensors", "not compatible with timers", "not compatible with motion sensors", "not compatible with photosensors, motion sensors, or timers", or the like.
Application Exceptions	Lamp packaging exterior shall state specific applications that would compromise the performance of the lamp. This includes installations which would result in a lamp's noncompliance with the ENERGY STAR specification performance requirements. Examples include totally enclosed fixtures, insulated ceiling air-tight (ICAT) recessed downlights, damp locations, and any other application restrictions. LED MR Lamps Intended for use on Low-Voltage Circuits: Lamp package must state compatibility with low-voltage transformers. Lamp package and product information sheet must include a caution label indicating the lamp may not be compatible with all low-voltage transformers used in existing light fixtures and identifying the Web address (URL) to find up-to-date low-voltage transformer compatibility and appropriate use information. A voltage waveform (AC or DC) for which a low voltage MR lamp does not provide the certified performance shall be considered an application exception which shall be detailed on lamp packaging: "Not intended for AC operation." or "Not intended for operation on AC transformers." or "Not for use with AC transformers." or the like, where "DC" may be substituted for "AC", as applicable.
Restricted Position	Lamp packaging shall indicate restricted operating position as applicable (e.g. base up only).
Minimum Starting Temperature	Lamp packaging shall state the minimum starting ambient temperature and shall state any other conditions required for reliable starting.
Warranty	Lamp packaging shall include warranty information see Warranty Requirements section of this specification.

Note: Packaging requirements were added for lamps that are dimmable on a limited set of controls and for low voltage MR lamps. EPA has replaced the Minimum Operating Temperature requirement with the Minimum Starting Temperature packaging requirement to clarify the Agency's intent for this application-specific information to be reported on product packaging and included in the advanced certified product search to aid consumers procuring lamps.

15.3. Warranty: All Lamps

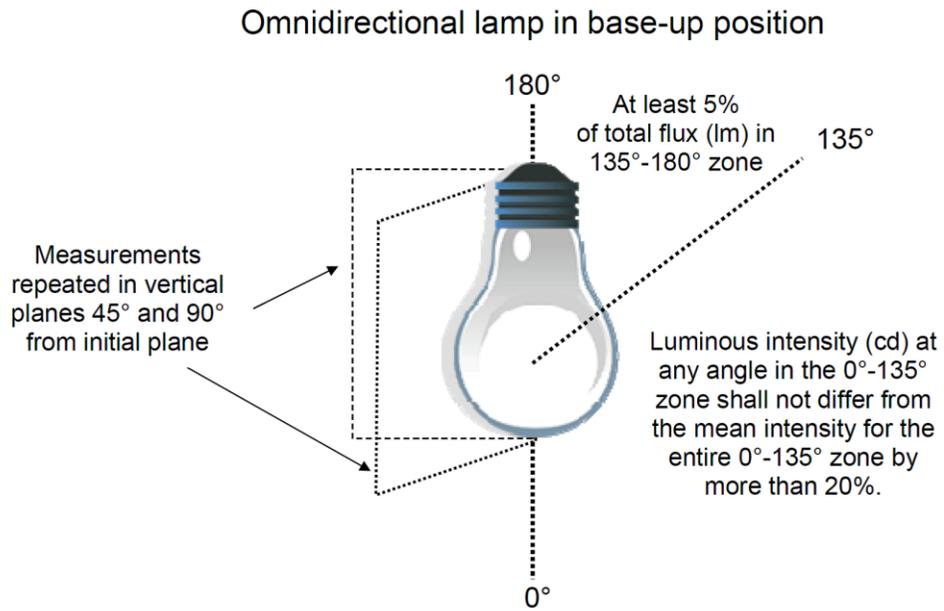
Criteria	ENERGY STAR Requirement									
Warranty	Per the table below lamps shall be backed by a minimum warranty corresponding to the lamp life rating and no less than the corresponding number of hours per day. <table border="1" data-bbox="300 1402 930 1533"> <thead> <tr> <th>Lamp Life Rating (Hours)</th> <th>Minimum Warranty (Years From Date of Purchase)</th> <th>Hours of Use Per Day</th> </tr> </thead> <tbody> <tr> <td>< 15,000</td> <td>2</td> <td>3</td> </tr> <tr> <td>≥ 15,000</td> <td>3</td> <td>3</td> </tr> </tbody> </table> <p>Lamp packaging exterior shall state "Warranty" or "Limited Warranty", the warranty period (in years) per the above table, and a phone number or website address for consumer complaint resolution. The complete written warranty shall be printed on packaging exterior or included within lamp packaging.</p>	Lamp Life Rating (Hours)	Minimum Warranty (Years From Date of Purchase)	Hours of Use Per Day	< 15,000	2	3	≥ 15,000	3	3
Lamp Life Rating (Hours)	Minimum Warranty (Years From Date of Purchase)	Hours of Use Per Day								
< 15,000	2	3								
≥ 15,000	3	3								

Note: EPA is no longer differentiating residential from commercial products and has eliminated the minimum warranty and usage values for commercial products.

END OF SPECIFICATION

¹ Packaging requirements must appear on the exterior of lamp packaging and not on the bottom of lamp packaging. The outermost package of bulk packaged (i.e. multi-pack) lamps facing the intended end user shall meet these requirements.

Appendix A: Luminous Intensity Distribution Diagram for Omnidirectional Lamp



Appendix B: Examples for Operating Milestones for Rated Life Testing for Various Lamps

Example Operating Hour Milestones for Rated Lifetime Lumen Maintenance Qualification			
Lifetime Rating	1 st (Early Interim) Qualification Milestone ¹	2nd (Interim) Qualification Milestone ²	Full Lifetime Qualification
CFL - 10,000 Hrs	4,000 Hrs (40% of Life)	-	10,000 Hrs (100% of Life) ³
CFL - 12,000 Hrs	4,800 Hrs (40% of Life)	-	12,000 Hrs (100% of Life) ³
CFL - 15,000 Hrs	6,000 Hrs (40% of Life)	-	15,000 Hrs (100% of Life) ³
LED - 15,000 Hrs	3,000 Hrs	6,000 Hrs	
LED - 20,000 Hrs	3,000 Hrs	6,000 Hrs	
LED - 25,000 Hrs	3,000 Hrs	6,000 Hrs	
LED - 30,000 Hrs	-	6,000 Hrs	7,500 Hrs
LED - 35,000 Hrs	-	6,000 Hrs	8,750 Hrs
LED - 40,000 Hrs	-	6,000 Hrs	10,000 Hrs
LED - 45,000 Hrs	-	6,000 Hrs	11,250 Hrs
LED - 50,000 Hrs	-	6,000 Hrs	12,500 Hrs

¹ 100% of solid-state lamps and 90% of compact fluorescent must be operational

² 90% of solid-state lamps must be operational

³ 50% of compact fluorescent lamps must be operational