



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

Eligibility Criteria Version 1.0, DRAFT 4

Following is the fourth draft of 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 4 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 intended to replace incandescent lamps as 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, GU5.3, and 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	ANSI Standard Lamp Shape ¹	Non-Standard Lamp Form Factor
Omnidirectional – Lamps intended for general purpose that meet applicable omnidirectional performance requirements in this specification.	A, BT, P, PS, S and T	Self-ballasted compact fluorescent lamps (CFLs) intended to replace ANSI standard incandescent lamps that do not meet Lamp Shape Dimension requirements. 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 CFLs • Covered CFLs with reflectors
Decorative - Lamps of common decorative shapes meeting applicable decorative performance requirements in this specification.	B, BA, C, CA, DC, F, G	
Directional - Lamps meeting applicable directional performance requirements in this specification.	R, BR, ER, MR and PAR	

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

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) or their solid-state replacements.
- 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 covered in ANSI standards.
- Zhaga compliant LED light engines.

Note: In this Draft 4, EPA has removed the GU-10 base from Section 1.1. Included Products to avoid confusion regarding the eligibility of line voltage MR-16 products with GU-10 bases that will not be covered by the program until maximum and minimum overall lengths (MOL) are established by ANSI. This base and product type combination is now listed in Section 3.1.7 Consideration for Future Revisions. In Section 1.2 Excluded Products the bullet for “Solid-state lighting lamps with non-standard form factors” was removed to avoid confusion over lamps that do not follow ANSI outlines but fit within the MOL and MOD of the ANSI shape per Lamp Shape Dimensions requirements in this specification. The second footnote included under Table 1 as presented in Draft 3 was also removed to avoid limitations on educating consumers about the means in which they can find efficient replacement bulbs. It remains EPA’s intent to provide consumers with efficient replacement products without sacrifice to performance and not award the ENERGY STAR label to products that look like common incandescent lamps but fail to deliver the necessary light distribution to properly replace currently installed products.

2. EFFECTIVE DATE

The ENERGY STAR Lamps Version 1.0 specification shall take effect TBD. 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.

Note: Lamps Version 1.0 is set to take effect 12 months after the release of the Final Program Requirements. This time will allow manufacturers with qualified products under the existing ENERGY STAR Compact Fluorescent Lamps V4.3 and Integral LED Lamps Version 1.4 specifications sufficient time to transition to the new specification. Manufacturers are encouraged to begin testing and certifying products to this specification as soon as it is final. EPA recognized certification bodies will be asked to stop certifying products to the ENERGY STAR Compact Fluorescent Lamps V4.3 and Integral LED Lamps V1.4 specifications nine months after the release of the final Lamps V1.0 specification. This transition period allows products in testing for the existing specifications to complete and be certified to the specification they were designed to. As of the Version 1.0 effective date, only those products that have been certified to the new requirements will appear on the Qualified Product List

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 certification 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 when off 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 may become more prevalent in 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 will continue to monitor the market and work with stakeholders to explore methods for evaluating beam performance to avoid consumer dissatisfaction with ENERGY STAR certified lamps. To support this effort EPA will be collecting luminous distributions test data for all directional 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 to address the most common types of dimmable lamps currently in the market. 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 or extended 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 an important aspect and 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, efficacy and other 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 and DOE actively monitor the activities of lighting standards working groups and regulatory activities that may impact 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 EPA and DOE will evaluate when final drafts become available.

3.1.7. Line voltage MR-16 lamps with GU-10 bases

EPA understands that industry is working on ANSI designated dimensions for this lamp type. Additionally due to stakeholder comments on previous proposals for benchmarking the performance of these lamps, EPA and DOE are exploring alternative approaches for benchmarking the performance of line voltage MR-16 lamps. Until ANSI publishes dimensional requirements and performance benchmarking is set for this combination, there is no pathway for these lamps to qualify for ENERGY STAR.

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. For purposes of this specification, lamps with candelabra bases and compact fluorescent lamps with purely decorative envelopes may be categorized as decorative lamps.

Dimmable Lamp: A lamp that is capable of producing varying levels of light when paired with a suitable control. For the purposes of this specification, the lamp must be capable of reducing light output to 20% (or lower) when paired with a control or dimmer while meeting the associated performance requirements in the specification.

Directional Lamp: ANSI standard PAR and MR lamps having at least 80% light output with a solid angle of π sr, corresponding to a cone with an angle of 120°, self-ballasted compact fluorescent forms that utilize a reflector, and ANSI standard R, BR and ER shapes.

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: The impression of unsteadiness of visual perception induced by a light stimulus whose luminance or spectral distribution fluctuates with time. (CIE 17.443 e-ILV)

Flicker Index: A measure of the cyclic variation in output of a light source taking into account the waveform of the light output. It is the ratio of the area under the light output curve that is above the average light output level to the total area under the light output curve for a single cycle. (ANSI/IES RP-16-10)

GU24 Based Integrated Lamp: A lamp unit that integrates the light source and its ballast or driver. 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.

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 initial luminous flux or initial lumen output, respectively. (See 10CFR430 Appendix W to Subpart B for lamps covered by the U.S. Department of Energy) 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 90% of measured intensities in the 0° to 135° zone varying by no more than 25% from the average of all of measured values, with no measured values more than 50% 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, P, PS, S or T, or non-standard, such as a self-ballasted compact fluorescent that utilizes a bare spiral, or multiple (twin, triple, quadruple) tube arrangement.

OSHA: Occupational Safety & Health Administration.

Percent Flicker: A relative measure of the cyclic variation in output of a light source (percent modulation). It is given by the expression $100(A-B)/(A+B)$, where A is the maximum and B is the minimum output during a cycle. (IES RP-16-10)

Periodic Frequency: The frequency at which the entire periodic flicker waveform pattern repeats.

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.

Reflector: A device used to redirect the flux from a source primarily by the process of reflection. (IES RP-16-10)

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 light is emitted from a material by a semiconducting process of electron transition from a conduction band to valence band process whether or not the wavelength of this light is converted by additional components.

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 decorative, directional and omnidirectional lamps have been updated to align with the changes made in this draft. The definitions for lumen maintenance, flicker and solid-state lighting (SSL) were revised based on stakeholder feedback. Definitions for flicker index, percent flicker, periodic frequency and reflector have been added.

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 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 along with the sampling requirements in the calculation of reported values to determine ENERGY STAR certification.

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.

For dimmable or multi-power lamps, measurements shall be taken at the highest wattage setting listed for the model, unless otherwise specified.

IES LM-65 and IES LM-66 are applicable to both hot and cold cathode lamps.

6. FEDERAL STANDARDS AND DOE RULEMAKING

The scope of this specification includes bare and covered medium base compact fluorescent lamps which are regulated by the U. S. Department of Energy (DOE). This specification includes references to the Code of Federal Regulations (CFR) such as CFR Title 10 Part 429, as guidance, highlighting efforts by EPA and DOE to align the testing requirements where there is overlap in scope.

This specification includes testing and sampling beyond that required by DOE for medium base compact fluorescent lamps; however certified ratings and reported values for those metrics referenced within the appropriate CFR (e.g. efficacy, lumen maintenance, etc.) and this ENERGY STAR specification must be identical and based on the same test data. For example, if ENERGY STAR requires 10 samples to be tested in specific positions, and DOE requires 5, the larger ENERGY STAR data set must also be used for DOE regulatory purposes.

Any DOE issued guidance for medium base CFLs must be used in determining ratings.
(<http://www1.eere.energy.gov/guidance/default.aspx?pid=2&spid=1>).

Note: This section has been updated to further clarify the alignment with DOE regulatory requirements for compact fluorescent lamps and update references to 10 CFR Part 430. Partners are reminded that testing for DOE regulatory metrics 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 partner 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:
- Input current and input wattage
 - Power factor
 - Maximum overall length, except as affected only by variations in lamp base or envelope shape.
 - 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.	<ul style="list-style-type: none"> Luminous intensity distribution data Center Beam Intensity Color Angular Uniformity
Lamp Base (ANSI base adapter)	Lamp base type (e.g. ANSI E26, GU24, etc.)	None
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.	<ul style="list-style-type: none"> Luminous Efficacy Light Output Correlated Color Temperature Color Rendering
Correlated Color Temperature	<p>This allows sharing of specific test data for CFL and SSL lamps where the only variation is in phosphor:</p> <ul style="list-style-type: none"> Safety Electrical - Rapid Cycle Stress, Power Factor, Transient Protection, Operating Frequency and Start Time Dimming Performance– Minimum and Maximum Light Output, Audible noise, and Flicker Lamp Shape Dimensions Lamp Toxics Reduction <p>For CFLs – Only the representative lamp model needs to complete full rated life testing.</p>	<ul style="list-style-type: none"> Luminous Efficacy Light Output Elevated Temperature Light Output Ratio (as applicable) Center Beam Intensity (as applicable) Luminous Intensity Distribution (as applicable) Correlated Color Temperature Color Rendering Color Maintenance (SSL only) Color Angular Uniformity (SSL only and as applicable) Lumen Maintenance and Rated Life testing to 40% of rated life (CFL only) Lumen Maintenance testing to 3,000, 6,000 hours, and final certification test duration (SSL only) Run-Up Time (CFL only)

Note: EPA has expanded the proposed CCT allowable variation to include the sharing of safety, electrical, and dimming performance test data. The list of additional tests required for each variant for CCT has been updated to provide guidance on the applicable tests.

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 Certification 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. Measurements shall be recorded at the resolution of the test instrumentation for each unit in the sample set.

7.5.2. All calculations shall be carried out on a per unit basis with directly measured (unrounded) values.

7.5.3. Compliance with the specification limits shall be evaluated against the reported value for each model.

7.5.4. 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 number.

Note: Draft 4 provided slight updates to align with DOE reported values. Any DOE issued guidance for medium base CFLs must be used in determining ratings. See <http://www1.eere.energy.gov/guidance/default.aspx?pid=2&spid=1>.

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
ASA	S12.55-2006 / ISO3745:2003	Determination of Sound Power Levels of Noise Sources Using Sound Pressure - Precision Methods Anechoic and Hemi-Anechoic Rooms
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-20-13	Photometric Testing of Reflector-Type Lamps
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
ISO	7574-4 B.2.1	Statistical Methods for Determining and Verifying Stated Noise Emission Values of Machinery and Equipment

Note: In Draft 4, reference standards for noise testing were added to the specification. The reference to LM-9-09 – Electrical and Photometric Measurements of Fluorescent Lamps has been removed from the table as it is 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
	Reported values for each lamp model shall meet the applicable requirement in the table below. Additionally eight or more units individually shall meet the requirement.		Measurement (fluorescent not covered by DOE): IES LM-66-11 Measurement (fluorescent covered by DOE): 10 CFR Part 430 Appendix W to Subpart B Measurement (solid-state): IES LM-79-08 Reference Documents for all lamps not covered by DOE: 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. For CFLs covered by DOE's regulatory program (medium base CFLs without reflectors or 3-way capabilities), lamp efficacy testing shall be conducted according to 10 CFR Part 430 Appendix W to Subpart B and sampling per 10 CFR 429.35. The reported value shall be in accordance with 10 CFR 429. For CFLs not covered by DOE's regulatory program , measurements shall be taken at the end of 100 hours of seasoning according to IES LM-54-12. For lamps not covered by DOE's regulatory program , all calculations of efficacy values shall be carried out on a per unit basis with directly measured (unrounded) values. A 3% tolerance may be applied to the initial luminous flux value of each unit (e.g. [initial luminous flux of a unit X 1.03]) prior to the calculation of efficacy for the unit. No other tolerances should be applied and the reported value for the sample shall be the average of the calculated efficacies for all units in the sample. The reported value shall be the average of the unit values rounded to the nearest hundredth.
	Lamp Rated Wattage (watts)	Minimum Lamp Efficacy (initial lm/W)		
Omnidirectional	<15	55		
	≥15	65		
Directional	<20	40		
	≥20	50		
Decorative	<15	45		
	15 ≤ W < 25	50		
	≥25	60		

Note: EPA has further clarified the program requirements for lamps covered by 10 CFR Part 430. The guidance for reported values has also been updated to align with the Federal requirements.

A stakeholder has requested that EPA consider a lower efficacy tier across all product types for products with a color rendering index (CRI) of 90 or higher. The specific request was for a reduction of five lumens per watt for lower wattage products and an efficacy reduction of ten lumens per watt for higher wattage products. The stakeholder believes that lower efficacy levels for higher CRI lamps will help encourage the adoption of energy efficient lighting and increase the availability of ENERGY STAR certified products that are cost competitive. EPA believes color quality is important for the adoption of energy efficient lighting but that the existing levels in this specification adequately address color quality while balancing considerations such as product cost and energy savings. Further, reducing efficacy to accommodate lamps with higher color rendering is not supported by the lamp data in the current ENERGY STAR qualified products list or DOE's LED Lighting Facts[®] database which indicates LED lamps in the market can meet both the proposed efficacy requirements and a minimum CRI of 90. EPA invites stakeholders to comment on this subject.

9.2. Light Output (Exemption: MR and PAR lamps)

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	Reported initial light output (in lumens) value for each lamp model shall fall within the range of the referenced incandescent lamp per the table below. Additionally 8 or more units individually shall meet the requirement.	Measurement: IES LM-66-11 Measurement (solid-state): IES LM-79-08 Reference Documents: IES LM-54-12 Reference Document for all lamps covered by FTC: 16 CFR § 305.2.	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. For CFLs, initial luminous flux measurements shall be taken at the end of 100 hours of seasoning. A 3% tolerance may be applied to the initial luminous flux value of each unit (e.g. [initial luminous flux of a unit X 1.03]). No other tolerances shall be applied and the reported value for the sample shall be the average of the unit values and may be rounded to the nearest multiple of 5.														
	<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
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																
Directional (R, BR and ER)	<p>Reported 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:</p> <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 <p>For example - a lamp replacing a 25W incandescent shall produce ≥ 250 lumens.</p> <p>For all other directional lamps not included above, reported lamp light output (in lumens) shall be greater than or equal to the product of the claimed wattage equivalency and the light output multiplier in the table below.</p> <table border="1"> <thead> <tr> <th>Rated Wattage of the Referenced Incandescent Lamp (watts)</th> <th>Light Output Multiplier</th> </tr> </thead> <tbody> <tr><td>40 – 50 W</td><td>10.5</td></tr> <tr><td>51 – 66 W</td><td>11.0</td></tr> <tr><td>67 – 85 W</td><td>12.5</td></tr> <tr><td>86 – 115 W</td><td>14.0</td></tr> <tr><td>115 – 155 W</td><td>14.5</td></tr> <tr><td>156 - 205 W</td><td>15.0</td></tr> </tbody> </table>	Rated Wattage of the Referenced Incandescent Lamp (watts)	Light Output Multiplier	40 – 50 W	10.5	51 – 66 W	11.0	67 – 85 W	12.5	86 – 115 W	14.0	115 – 155 W	14.5	156 - 205 W	15.0		
Rated Wattage of the Referenced Incandescent Lamp (watts)	Light Output Multiplier																
40 – 50 W	10.5																
51 – 66 W	11.0																
67 – 85 W	12.5																
86 – 115 W	14.0																
115 – 155 W	14.5																
156 - 205 W	15.0																

Decorative	Reported lamp initial light output (in lumens) shall fall within the range of the referenced incandescent lamp per the table below.			
	Rated Wattage of the Referenced Incandescent Lamp (watts)	Light Output (Lumens)		
		Decorative	Globe (G) Shape	Covered A-Lamp
	10	70-89	--	--
	15	90-149	--	--
	25	150-299	250-349	250-449
	40	300-499	350-499	450-799
	60	500-699	500-574	800-1099
	75	--	575-649	1100-1599
	100	--	650-1099	1600-1999
150	--	1100-1300	2550-3000	
Includes all candelabra base (E12) lamps				

Note: In Drafts 2 and 3, EPA proposed light output requirements for directional (R, BR, and ER) lamps developed using the efficacy requirements in 10 CFR 430.32 Subpart C for Incandescent Reflector Lamps (IRLs) that took effect on July 14, 2012. Several stakeholders commented that the equivalency claim table presented for the light output requirements with regard to non-PAR directional lamps was confusing and proposed minimum light output levels that were very high in comparison to the initial lumen levels for traditional incandescent/halogen being replaced. In response to stakeholder concerns and after additional research and analysis, the Agency has proposed a multiplier table in order to benchmark the light output values for traditional reflector lamps.

Covered A-lamp CFLs were added to the decorative section after further analysis on the performance of these products. Covered A-lamp CFLs may be evaluated as omnidirectional lamps or decorative lamps due to their decorative cover which reduces efficacy; however the light output levels must be consistent with the omnidirectional levels for equivalency claims. The expanded table in the decorative section was added to make that distinction clear.

9.3. Elevated Temperature Light Output Ratio: All Directional Lamps (Exemption: Omnidirectional, decorative, and lamps labeled “not for use in enclosed or recessed fixtures” or equivalent)

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°C \pm 5°C) when tested in the same elevated temperature condition required by the Lumen Maintenance requirement. Calculation of the elevated temperature light output ratio shall be carried out with directly measured (unrounded) values.	Measurement: ENERGY STAR Elevated Temperature Light Output Ratio Test	Sample Size: One unit tested base-up. The reported value shall be the calculated ratio for the unit rounded to the nearest tenth.

Note: The exemption for lamps labeled “not for use in enclosed or recessed fixtures” or equivalent was added in Draft 4.

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

Lamp Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
ANSI Standard PAR and MR Shape Lamps	Lamp center beam intensity shall be greater than or equal to the 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/iledl/IntLampCenterBeamTool.zip)	Measurement (fluorescent): IES LM-66-11 Measurement (solid-state): IES LM-79-08 Reference Documents: IES LM-54-12	Sample Size: One new unit. The sample may be the same unit for testing color angular uniformity as applicable. The reported value shall be the measured candela value rounded to the nearest whole number.

Note: Center beam intensity benchmarking for line voltage MR lamps was removed from Draft 4 because until an ANSI MOL is published the products are not eligible for ENERGY STAR certification. EPA and DOE continue to explore approaches to benchmarking the performance of these products.

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. 90% of the luminous intensity measured values (candelas) shall vary by no more than 25% from the average of all measured values. All measured values (candelas) shall vary by no more than 50% from the average of all measured values. No less than 5% of total flux (zonal lumens) shall be emitted in the 135° to 180° zone. See Appendix A-1 for illustration.	Measurement (solid-state): IES LM-79-08	Sample Size: One unit. Lamp luminous intensity shall be measured about the lamp (polar) axis, in maximum increments of 22.5° from 0° to 180° about the polar axis. Within each vertical plane luminous intensity measurements shall be taken from 0° to 135° at 5° vertical angle increments (maximum).
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 110° to 180° zone. See Appendix A-2 for illustration.		Sample Size: One unit.

Note: EPA has adjusted the allowed uniformity variance of the luminous intensity values for omnidirectional lamps after confirming that the intensity distribution data of some incandescent lamps is not consistent with the existing 20% limit on average candela values for omnidirectional lamp performance in previous drafts and the Integral LED Lamps specification. This update is likely to increase the availability of omnidirectional ENERGY STAR certified lamps that meet consumers' expectation for omnidirectional performance.

In Draft 3, EPA 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. Prompted by stakeholder comments and after confirming the limitations on the location of the electrical components in energy efficient lamps with candelabra bases, the Agency adjusted the zone of interest for the 5% light output in Draft 4.

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	<p>Reported lamp model light color temperature shall correlate to one of the following nominal CCTs, additionally 9 out of 10 units shall fall within a 7-step MacAdam ellipse or ANSI quadrangle for the designated CCT, per the referenced ANSI document:</p> <ul style="list-style-type: none"> • 2700K • 3000K • 3500K • 4000/4100K • 5000K • 6500K 	<p>Measurement: IES LM-66-11</p> <p>Calculation: CIE 15.2004</p> <p>Reference Documents: ANSI C78.376-2001 Sections 2 and 4, and Table 2</p> <p>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>Measurements shall be taken at the end of 100 hours of seasoning according to IES LM-54-12.</p> <p>Reported CCT shall be the average of the unit measured values rounded to the nearest whole number.</p>
Solid-State		<p>Measurement: IES LM-79-08</p> <p>Calculation: CIE 15.2004</p> <p>Reference Document: ANSI C78.377-2011</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: All units shall fall within the defined 7-step ANSI quadrangle for the target correlated color temperature.</p> <p>Reported CCT shall be the average of the unit measured values rounded to the nearest whole number.</p>

Note: In Draft 2, the correlated color temperature requirements returned to the 7-step ellipses/quadrangles found in the existing specifications, but increased the passing requirement to 10 out of 10 units. In response to stakeholder feedback, requesting the allowance of one outlier in order to account for normal manufacturing production variances, EPA has redefined a passing test to require 9 out of 10 units. Since better and more consistent color of CFLs are consumer issues, EPA will continue to monitor the situation and determine at a later date when tightening of the requirement might be appropriate.

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) ≥ 80 . The average of units tested shall meet the requirements and no more than 3 units shall have $R_a < 77$. No unit shall have $R_a < 75$.	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. Reported R_a shall be the averages of the unit measured values rounded to the nearest whole number. Reported R_9 shall be the average of the unit measured values rounded to the nearest whole number.
Solid-State	Lamp shall have a color rendering index (R_a) ≥ 80 , and an $R_9 > 0$. The average of units tested shall meet the requirements and no more than 3 units shall have $R_a < 77$. No unit shall have $R_a < 75$.	Measurement: IES LM-79-08 Calculation: CIE 13.3-1995	

Note: In previous drafts, EPA proposed positive R_9 requirements for both CFL and LED lamps, aligning with the existing requirement for LED lamps and introducing a new requirement for CFLs. Over the course of the past three drafts, stakeholders consistently commented that in order to achieve a positive R_9 for compact fluorescent lamps, significant redesign with deep red phosphors, especially for warmer color temperatures, will be required. As a result, the lamp cost will increase and the lamp efficacy will decrease. Stakeholders also provided data demonstrating that a modest increase in R_9 is imperceptible to the human eye. In Draft 4, EPA has removed the requirement for a positive R_9 for CFLs, and will start collecting R_9 data for all lamps in order to monitor this color quality metric and adjust the requirement as needed.

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. Nine or more units shall meet the requirement.	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. Reported color maintenance shall be the calculated value for each unit rounded to the nearest significant digit.

**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	Sample Size: One unit. The sample may be the same unit for testing Center Beam Intensity, as applicable. Lamp shall be scanned on two planes separated by 90 degrees. Maximum vertical scanning resolution shall be 2° for beam angles less than 15° and 5° for beam angles 15° or greater. Complete luminous intensity distribution data shall be reported.

Note: In Draft 3, EPA introduced proposed scanning angles of 1° for beam angles less than 10° and 2° for beam angles 10° or greater, fine enough to accurately evaluate the variation in chromaticity across the beam forming source, and provide uniform guidance to increase the reliability of measurements from laboratory to laboratory. Stakeholders commented that the scanning resolution was too fine, and significantly increased the length of time to conduct the test. In an effort reduce testing burden and consistent with guidance provided in IES LM-79-08, EPA has increased the maximum scanning resolution to 2° for beam angles less than 15° and 5° for beam angles 15° or greater.

10. LUMEN MAINTENANCE AND RATED LIFE

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.

10.1. Lumen Maintenance: All Lamps

Lamp Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
<p>Compact Fluorescent</p>	<p>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> <p>Reported values shall meet the requirement for the designated life claim. All lamp samples shall be surviving at 1000-hours, and no more than 3 units may have lumen maintenance $<75\%$ at 40% of rated life.</p>	<p>Measurement (fluorescent not covered by DOE): ENERGY STAR Elevated Temperature Life Test IES LM-65-10</p> <p>Measurement (fluorescent covered by DOE): 10 CFR Part 430 Appendix W to Subpart B</p> <p>Reference Documents for all lamps not covered by DOE: 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>Prescribed test time is the total ON time and shall not include the OFF time during lamp cycling.</p> <p>All decorative lamps, omnidirectional lamps < 10 watts, all lamps labeled "not for use in recessed fixtures" on the lamp and lamp packaging and all omnidirectional lamps labeled "not for use in enclosed fixtures" on the lamp and lamp packaging, shall be in an ambient temperature condition $25^{\circ}\text{C} \pm 5^{\circ}\text{C}$.</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 $45^{\circ}\text{C} \pm 5^{\circ}\text{C}$.</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 $55^{\circ}\text{C} \pm 5^{\circ}\text{C}$.</p> <p>For CFLs not covered by DOE's regulatory program, initial lumen output measurements shall be taken at the end of 100 hours of seasoning according to IES LM-54-12. The reported value shall be the average of the unit values rounded to the nearest tenth of a percent.</p> <p>For CFLs covered by DOE's regulatory program (medium base CFLs without reflectors or 3-way capabilities), the value should be calculated according to the 10 CFR 429.35.</p>

<p>Solid-State</p>	<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 L_{70}) per the table(s) below. Lamp may earn optional early interim certification after 3,000 hours, with a rated life claim \leq 25,000 hours, per the provisions below.</p> <table border="1" data-bbox="337 401 760 716"> <thead> <tr> <th>Maximum Life Claim (hours to L_{70})</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 certification 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="4">Interim certification; 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> <td></td> </tr> </tbody> </table> <p>For Extended Lifetime Claims: For lamp life claims > 25,000 hours, lamp shall maintain \geq 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="337 911 656 1115"> <thead> <tr> <th>Maximum Life Claim (hours to L_{70})</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 Certification 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 1556 760 1707"> <thead> <tr> <th>Maximum Life Claim (hours to L_{70})</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 certification testing completed.	20,000	89.9%	25,000	91.8%	30,000	93.1%	Interim certification; 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 Certification 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 Certification: 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 Certification Passing Test: The average lumen maintenance of the \geq 9 surviving units shall meet the minimum requirement for the designated life claim.</p> <p>Early Interim Certification 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> <p>All decorative lamps, omnidirectional lamps < 10 watts, and lamps labeled "not for use in recessed fixtures" on the lamp and lamp packaging and all omnidirectional lamps labeled "not for use in enclosed fixtures" on the lamp and lamp packaging, shall be tested in accordance with the ENERGY STAR Ambient Temperature Life Test in an ambient temperature condition $25^{\circ}C \pm 5^{\circ}C$.</p> <p>All directional lamps \leq 20 watts, and all omnidirectional lamps \geq 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 $45^{\circ}C \pm 5^{\circ}C$.</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 $55^{\circ}C \pm 5^{\circ}C$.</p> <p>Testing for early interim and final certification 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>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 rounded to the nearest tenth of a percent if the difference between the averages is greater than 3%; if less than 3% difference, then the lumen maintenance shall be the average of all surviving units rounded to the nearest tenth percent. If units are tested in restricted position, the average of surviving unit measured values shall be reported rounded to the nearest tenth percent.</p>
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20,000	94.8%																																												
25,000	95.8%																																												

Note: EPA has updated the Supplemental Testing Guidance exempting omnidirectional lamps labeled “not for use in enclosed fixtures” and all lamps labeled “not for use in recessed luminaires” from lumen maintenance testing in an elevated temperature environment. The Agency reviewed the restrictive product markings required for lamp safety certification and believes they are intended to prevent consumers from installing lamps in incorrect luminaire types, thus minimizing the need for elevated temperature life testing for lamps with restrictive labeling.

The Supplemental Testing Guidance has been updated with a $\pm 5^{\circ}\text{C}$ tolerance on the operating temperature for the Ambient Temperature Life and Elevated Temperature Life Testing, and the Agency has revised the language for reported values, allowing the lumen maintenance value to be average of all surviving units if the difference between the averages in each orientation is less than 3%.

10.2. Rated Life: All Lamps

Lamp Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
Compact Fluorescent	<p>Lamp shall have a rated life $\geq 10,000$ hours.</p> <p>At 40% of rated life 90% of the tested units shall be operational.</p> <p>$\geq 50\%$ of the tested units shall be operational at rated life.</p>	<p>Measurement (fluorescent not covered by DOE): ENERGY STAR Elevated Temperature Life Test Method</p> <p>IES LM-65-10</p> <p>Measurement (fluorescent covered by DOE): CFR Title 10 Parts 429 and 430</p> <p>Reference Documents for all lamps not covered by DOE: IES LM-54-12</p>	<p>Sample: The same samples used for lumen maintenance testing.</p> <p>For CFLs covered by DOE's regulatory program (medium base CFLs without reflectors or 3-way capabilities), the reported value shall be in accordance with 10 CFR 429.35.</p> <p>For lamps not covered by DOE's regulatory program, the reported value shall be the rated life in hours.</p>
Solid-State	<p>Decorative lamps shall have a rated life $\geq 15,000$ hours. All other lamps shall have a rated life of $\geq 25,000$ hours.</p> <p>All tested units shall be operational at 3,000 hours.</p> <p>$\geq 90\%$ of the tested units shall be operational at 6,000 hours.</p>	See Lumen Maintenance Requirements Section.	

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	<p>Lamp, 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. At least 5 units shall survive the minimum number of cycles.</p> <p>CFLs with a start time of ≤ 100 milliseconds, shall survive cycling once per every two hours of rated life, at 5 minutes on, 5 minutes off.</p>	<p>Measurement (lamps not covered by DOE): IES LM-65-10 (clauses 4,5,6)</p> <p>Measurement (fluorescent covered by DOE): 10 CFR Part 430 Appendix W Subpart B</p>	<p>Sample Size: 6 units per model tested base-up. The samples shall be unique for this test.</p> <p>For dimmable or multi-power lamps, testing shall be conducted at the highest wattage setting listed for the model.</p> <p>The reported value shall be the number of units surviving the minimum number of cycles.</p>

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.	Reference: ANSI/UL 1993-2012 ANSI/UL 8750-2009	None.

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	Reported value for each lamp model shall have a power factor ≥ 0.5.	Measurement: ANSI C82.2-2002	<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>Tested units, including low voltage lamps, shall be operated at rated voltage.</p> <p>The reported value shall be the average measured values of units tested rounded to the nearest tenth.</p>
Solid-State	Reported value for each lamp model shall have a power factor ≥ 0.7.	Measurement: ANSI C82.77-2002 Sections 6 and 7	

11.3. Frequency: All Lamps

Lamp Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
Compact Fluorescent	Lamp light output shall have a frequency within 20 to 33kHz, or ≥ 40kHz.	None	<p>Sample Size: One unit per model.</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.</p> <p>Digitized photometric waveform data and an image of the relative photometric amplitude waveform and frequency shall be reported.</p> <p>For purposes of third-party certification documentation shall not be reviewed when products are certified or during verification testing.</p>
Solid-State	Lamp light output shall have an frequency ≥ 120Hz.		

11.4. Start Time: All Lamps

Lamp Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
All Lamps	Reported value of time for lamp to remain continuously illuminated shall be within one second of application of electrical power.	Measurement: ENERGY STAR Start Time Test	Sample Size: 3 units per model. The reported value shall be the average of measured unit values tested, rounded to the nearest milliseconds.

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	Reported value of time for lamp to achieve 80% stabilized light output shall be \leq 120 seconds.	Measurement: ENERGY STAR Run-Up Time Test 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. Measurements shall be taken at the end of 100 hours of seasoning according to IES LM-54-12. The reported value shall be the average measured values of units tested, rounded to the nearest second.
All Other Compact Fluorescent Lamps	Reported value of time for lamp to achieve 80% stabilized light output shall be \leq 60 seconds.		

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. All units shall be fully operational at the completion of testing.	Measurement: ANSI/IEEE C62.41.2-2002, Category A operation.	Sample Size: 5 units per model. The sample shall be unique for this test.

Note: For Power Factor, EPA has provided additional guidance for evaluating the power factor of low voltage lamps at the lamp's rated voltage. For Operating Frequency EPA has adjusted the name to "Frequency" to clarify the operating frequency is in reference to the lamp's light output and provided additional testing guidance.

EPA has continued to seek opportunities to reduce sample size and testing burden where appropriate. To that end, EPA has reduced the required sample size and removed lamp orientation for the Start Time test after confirming that start time values for the same lamp, whether CFL and LED, are independent of the lamp's test orientation and very consistent from sample to sample.

12. DIMMING PERFORMANCE: ALL LAMPS MARKETED AS DIMMABLE

If lamp is designed for phase cut dimming operation (alterations to the line voltage to the lamp), select 10 dimmers for testing. The 10 dimmers shall meet the following conditions:

1. From at least 2 different manufacturers
2. At least one dimmer must be specified as compatible use with energy efficient lighting (such as CFL or LED lamps)
3. At least one dimmer must be of one of the following types: Single (Forward) Phase Shift; Double Phase Shift, or Electronic Low Voltage/ Reverse Phase
4. At least one dimmer must have one of the following features: Microprocessor with Power Supply, Voltage Compensation, or Pre-set levels

If lamp is compatible with a non-phase cut control device (dimmer that does not alter the line voltage to the lamp), the controls must be listed on the packaging and be tested with the lamp against all dimming performance requirements. An asterisk next to "dimnable" on lamp packaging/online product listing marketing materials must be included and point to an "only compatible with ..." statement.

The tested minimum light level on dimmers or controls shall be the minimum light level claimed by the manufacturer (or 20% if no minimum is claimed), and the lamp shall meet flicker and audible noise requirements at this level.

For purposes of third-party certification, maximum lighting output, minimum lamp output, flicker and noise levels shall be reported by the partner to the certification body however documentation shall not be reviewed when products are certified or during verification testing.

Note: EPA recognizes that testing with 10 dimmer samples is labor intensive, and therefore requests comments from stakeholders on the number of dimmer samples required for testing to maintain an accurate representation of lamp performance with dimmers available on the market.

The requirement for dimmers from different manufacturers was reduced from three to two due to the limited number of residential dimmer manufacturers present in today's market.

Dimming performance testing for certification is not required to be performed by a third party laboratory, but the performance data must be submitted to the certification body. EPA is continuously monitoring progress that industry and others are making towards the measurement of dimming, flicker, and audible noise and may refine the methods and requirements in the future as research and additional data becomes available.

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 the maximum setting of a dimmer/control shall not exceed the lamp's rated light output by more than 10% or fall below the light output of the lamp by more than 20%. 80% of tested lamp/dimmer combinations must meet the requirement.	Measurement: ENERGY STAR Recommended Practice for evaluating Light Output on a Dimmer	Sample Size: 1 lamp per dimmer and 4 lamps per dimmer. See Section 8 of the Recommended Practice for Evaluating Light Output on a Dimmer for reporting information.

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 the maximum light output of the lamp on each tested dimmer/control. 80% of tested lamp/dimmer combinations must meet the requirement.	Measurement: ENERGY STAR Recommended Practice for evaluating Light Output on a Dimmer	Sample Size: 1 lamp per dimmer and 4 lamps per dimmer. See Section 8 of the Recommended Practice for Light Output on a Dimmer for reporting information.

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 light output waveform periodic frequency of ≥ 120 Hz and have a flicker index less than or equal to the values in the table below when evaluated at dimmer's maximum setting and dimmed conditions.	Measurement: ENERGY STAR Recommended Practice for evaluating Light Source Flicker	Sample Size: 1 lamp per dimmer and 4 lamps per dimmer See Section 8 of the Recommended Practice for Light Source Flicker for reporting information.			
	<table border="1"> <thead> <tr> <th>Light output waveform periodic frequency (in Hertz)</th> <th>Flicker Index</th> </tr> </thead> <tbody> <tr> <td>120 – 800</td> <td>(0.001 times the periodic frequency)</td> </tr> <tr> <td>Greater than 800</td> <td>Not applicable</td> </tr> </tbody> </table> <p>Lamps with undetermined frequencies shall have a percent flicker value $\leq 30\%$.</p> <p>80% of tested lamp/dimmer combinations must meet the requirement.</p>			Light output waveform periodic frequency (in Hertz)	Flicker Index	120 – 800
Light output waveform periodic frequency (in Hertz)	Flicker Index					
120 – 800	(0.001 times the periodic frequency)					
Greater than 800	Not applicable					

Note: EPA has adjusted acceptable flicker index range, introducing a frequency dependent equation to address concerns about pulse width modulated (PWM) circuits. Clarification was added for lamps that have a periodic frequency outside of the range of interest for the flicker index requirement. This specification limits the frequency range to 120Hz and above, and no requirement was set for frequencies above 800Hz because research shows that people don't notice 100% flicker at this point.

EPA acknowledges the flicker requirement may limit technologies or circuit topologies that can meet the requirements, and while the Agency is not trying to be exclusive, current research supports that the flicker requirement will begin to address unacceptable flicker, and may continue to refine the requirements as additional data becomes available.

12.4. Audible Noise:

Lamp Type	ENERGY STAR Requirements	Methods of Measurement and/or Reference Documents	Supplemental Testing Guidance
All Lamps Marketed as Dimmable	Lamp shall not emit noise above 24dBA at 1 meter. 80% of tested lamp/dimmer combinations must meet the requirement.	Measurement: ENERGY STAR Recommended Practice for evaluating Noise Reference: ISO 7574-4:1985, B.2.1 ANSI S12.55-2006/ISO3745:2003	Sample Size: 1 lamp per dimmer and 4 lamps per dimmer The loudest measurement of all lamp/dimmer combinations shall be reported as the sound level. Measurement shall be on a single lamp. See Section 8 of the Recommended Practice for evaluating Noise for reporting information.

13. LAMP TOXICS REDUCTION

13.1. Lamp Toxics Reduction: All Lamps

Lamp Type	ENERGY STAR Requirements	Method of Compliance
<p>All Lamps</p>	<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><u>Exemptions:</u></p> <ol style="list-style-type: none"> 1. Copper alloy containing up to 4% lead by weight 2. Lead in high melting temperature type solders (i.e. lead- based alloys containing 85% by weight or more lead) 3. Electrical and electronic components containing lead in a glass or ceramic other than dielectric ceramic in capacitors, e.g. piezoelectronic devices, or in a glass or ceramic matrix compound 4. Lead in dielectric ceramic in capacitors 5. Cadmium and its compounds in electrical contacts 6. Lead in white glasses used for optical applications 7. Lead in solders to complete a viable electrical connection between semiconductor die and carrier within integrated circuit flip chip packages 8. Cadmium in color-converting II-IV LEDs (< 10 µg Cd per mm² of light-emitting area) for use in solid state illumination or display systems. 	<p>For purposes of third-party certification, lamp toxics documentation shall not be reviewed when products are initially certified or during verification testing. Instead 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>

Note: In previous drafts, EPA proposed lamp toxics reduction requirements for mercury content based on analyses of what is technically feasible today for compact fluorescent lamps. Beyond the mercury requirements the relevant toxics reduction requirements were outlined in the specification draft and did not include any exemptions for higher levels of toxic substances. Manufacturing partners commented that current construction of some lamp types will have issues complying with the requirement if the exemptions from the EU RoHS directive or the exemptions outlined in the Luminaires specification are not applicable to ENERGY STAR certified lamps. In response the Agency completed a thorough review of applicable exemptions and has updated the toxics reduction requirement to include exemptions for lead and cadmium content in alignment with the EU RoHS directive.

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 and solid-state Lamps with GU24 base	Lamp shall comply with ANSI minimum overall length (min OAL), maximum overall length (MOL) and maximum lamp diameter values, where they exist.	Reference Documents: ANSI C78.20-2003 ANSI C78.21-2011 ANSI C78.23-1995 (R2003)	Sample Size: one unit For decorative lamps that do not have an ANSI maximum lamp space drawing, a maximum outside diameter tolerance of $\pm 15\%$ of the nominal diameter is used. GU24 based lamps may qualify as an allowable variation of a standard lamp, and shall meet the min OAL and MOL of the standard lamp.

Note: The Supplemental Testing Guidance has been revised to include solid-state lamps with GU-24 bases and to incorporate the language of a published frequently asked question (FAQ) providing guidance for evaluating the maximum outside diameter of decorative lamps.

15. LAMP LABELING, PACKAGING & WARRANTY REQUIREMENTS

15.1. Lamp Labeling: All Lamps

Lamp Type	ENERGY STAR Requirement
All Lamps	Each of the following shall be printed on the lamp: <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>

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

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.

Criteria	ENERGY STAR Requirement
	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.

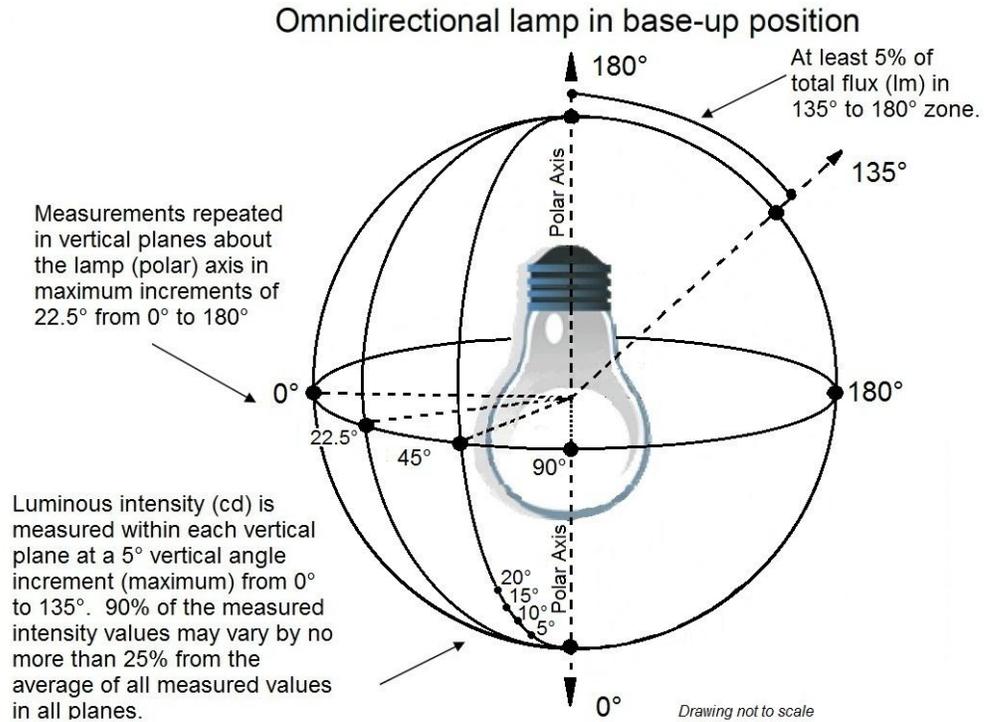
Note: EPA has maintained the packaging requirements from previous draft because no specific proposals were received to address stakeholder comments regarding printing on smaller packaging.

15.3. Warranty: All Lamps

Criteria	ENERGY STAR Requirement									
Warranty	<p>Per the table below lamps shall be backed by a minimum warranty corresponding to the lamp life rating and based on continuous operation over the corresponding number of hours per day.</p> <table border="1" style="margin-left: 20px;"> <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								

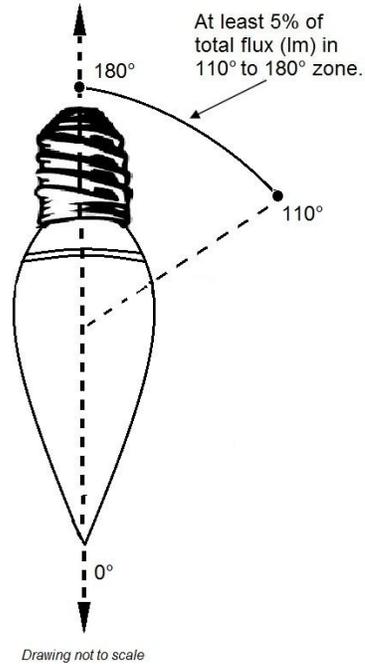
END OF SPECIFICATION

Appendix A-1: Luminous Intensity Distribution Diagram for Omnidirectional Lamp



Note: The Luminous Intensity Distribution Diagram for Omnidirectional lamps was updated to incorporate guidance on the proposed measurement points needed to determine compliance with the revised luminous intensity distribution requirements. See Section 9.5 - Luminous Intensity Distribution: ANSI Standard Omnidirectional and Decorative.

Appendix A-2: Luminous Intensity Distribution Diagram for Decorative Lamp



Note: Appendix A-2, the Luminous Intensity Distribution Diagram for Decorative lamps, was added to the specification to clarify the zone on interest in the revised luminous intensity distribution requirements. See Section 9.5 - Luminous Intensity Distribution: ANSI Standard Omnidirectional and Decorative.

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

Example Operating Hour Milestones for Rated Lifetime Lumen Maintenance			
Lifetime Rating	1 st (Early Interim) Certification Milestone ¹	2nd (Interim) Certification Milestone ²	Full Lifetime Certification
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