



# ENERGY STAR® Program Requirements for Integral LED Lamps

## Partner Commitments

Following are the terms of the ENERGY STAR Partnership Agreement as it pertains to the manufacture and labeling of ENERGY STAR qualified products. The ENERGY STAR Partner must adhere to the following partner commitments:

### Qualifying Products

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1. Comply with current ENERGY STAR Eligibility Criteria, which define performance requirements and test procedures for integral LED lamps. A list of eligible products and their corresponding Eligibility Criteria can be found at [www.energystar.gov/specifications](http://www.energystar.gov/specifications).
2. **Prior to associating the ENERGY STAR name or mark with any product**, obtain written certification of ENERGY STAR qualification from a Certification Body recognized by EPA for integral LED lamps. As part of this certification process, products must be tested in a laboratory recognized by EPA to perform integral LED lamp testing. A list of EPA-recognized laboratories and Certification Bodies can be found at [www.energystar.gov/testingandverification](http://www.energystar.gov/testingandverification).

### Using the ENERGY STAR Name and Marks

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3. Comply with current ENERGY STAR Identity Guidelines, which define how the ENERGY STAR name and marks may be used. Partner is responsible for adhering to these guidelines and ensuring that its authorized representatives, such as advertising agencies, dealers, and distributors, are also in compliance. The ENERGY STAR Identity Guidelines are available at [www.energystar.gov/logouse](http://www.energystar.gov/logouse).
4. Use the ENERGY STAR name and marks only in association with qualified products. Partner may not refer to itself as an ENERGY STAR Partner unless at least one product is qualified and offered for sale in the U.S. and/or ENERGY STAR partner countries.
5. Provide clear and consistent labeling of ENERGY STAR qualified integral LED lamps.
  - 5.1. The ENERGY STAR mark must be clearly displayed on the front or primary display panel of the product packaging, in product literature (i.e., user manuals, spec sheets, etc.) and on the manufacturer's Internet site where information about ENERGY STAR qualified models is displayed.

### Verifying Ongoing Product Qualification

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6. Participate in third-party verification testing through a Certification Body recognized by EPA for integral LED lamps, providing full cooperation and timely responses. EPA/DOE may also, at its discretion, conduct tests on products that are referred to as ENERGY STAR qualified. These products may be obtained on the open market, or voluntarily supplied by Partner at the government's request.
7. Notify ENERGY STAR integral LED lamp Certification Body recognized by EPA for integral LED lamps, within 30 days, if the designated suppliers of any qualified private labeled integral LED lamps change to a new supplier.

### Providing Information to EPA

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8. Provide unit shipment data or other market indicators to EPA annually to assist with creation of ENERGY STAR market penetration estimates, as follows:

- 8.1. Partner must submit the total number of ENERGY STAR qualified integral LED lamps shipped in the calendar year or an equivalent measurement as agreed to in advance by EPA and Partner. Partner shall exclude shipments to organizations that rebrand and resell the shipments (unaffiliated private labelers).
- 8.2. Partner must provide unit shipment data segmented by meaningful product characteristics (e.g., type, capacity, presence of additional functions) as prescribed by EPA.
- 8.3. Partner must submit unit shipment data for each calendar year to EPA or an EPA-authorized third party, preferably in electronic format, no later than March 1 of the following year.

Submitted unit shipment data will be used by EPA only for program evaluation purposes and will be closely controlled. If requested under the Freedom of Information Act (FOIA), EPA will argue that the data is exempt. Any information used will be masked by EPA so as to protect the confidentiality of the Partner.

9. Report to EPA any attempts by recognized laboratories or Certification Bodies (CBs) to influence testing or certification results or to engage in discriminatory practices.
10. Notify EPA of a change in the designated responsible party or contacts within 30 days using the My ENERGY STAR Account tool (MESA) available at [www.energystar.gov/mesa](http://www.energystar.gov/mesa).

### **Performance for Special Distinction**

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In order to receive additional recognition and/or support from EPA for its efforts within the Partnership, the ENERGY STAR Partner may consider the following voluntary measures, and should keep EPA informed on the progress of these efforts:

- Provide quarterly, written updates to EPA as to the efforts undertaken by Partner to increase availability of ENERGY STAR qualified products, and to promote awareness of ENERGY STAR and its message.
- Consider energy efficiency improvements in company facilities and pursue benchmarking buildings through the ENERGY STAR Buildings program.
- Purchase ENERGY STAR qualified products. Revise the company purchasing or procurement specifications to include ENERGY STAR. Provide procurement officials' contact information to EPA for periodic updates and coordination. Circulate general ENERGY STAR qualified product information to employees for use when purchasing products for their homes.
- Feature the ENERGY STAR mark(s) on Partner website and other promotional materials. If information concerning ENERGY STAR is provided on the Partner website as specified by the ENERGY STAR Web Linking Policy (available in the Partner Resources section of the ENERGY STAR website), EPA may provide links where appropriate to the Partner website.
- Ensure the power management feature is enabled on all ENERGY STAR qualified displays and computers in use in company facilities, particularly upon installation and after service is performed.
- Provide general information about the ENERGY STAR program to employees whose jobs are relevant to the development, marketing, sales, and service of current ENERGY STAR qualified products.
- Provide a simple plan to EPA outlining specific measures Partner plans to undertake beyond the program requirements listed above. By doing so, EPA may be able to coordinate, and communicate Partner's activities, provide an EPA representative, or include news about the event in the ENERGY STAR newsletter, on the ENERGY STAR website, etc. The plan may be as simple as providing a list of planned activities or milestones of which Partner would like EPA to be aware. For example, activities may include: (1) increasing the availability of ENERGY STAR qualified products by converting the entire product line within two years to meet ENERGY STAR guidelines; (2) demonstrating the economic and environmental benefits of energy efficiency through special in-store displays twice a year; (3) providing information to users (via the website and user's manual) about energy-saving features and operating characteristics of ENERGY STAR qualified products; and (4) building awareness of the ENERGY STAR Partnership and brand identity by collaborating with EPA on one print advertorial and one live press event.

- Join EPA's SmartWay Transport Partnership to improve the environmental performance of the company's shipping operations. The SmartWay Transport Partnership works with freight carriers, shippers, and other stakeholders in the goods movement industry to reduce fuel consumption, greenhouse gases, and air pollution. For more information on SmartWay, visit [www.epa.gov/smartway](http://www.epa.gov/smartway).
- Join EPA's Green Power Partnership. EPA's Green Power Partnership encourages organizations to buy green power as a way to reduce the environmental impacts associated with traditional fossil fuel-based electricity use. The partnership includes a diverse set of organizations including Fortune 500 companies, small and medium businesses, government institutions as well as a growing number of colleges and universities. For more information on Green Power, visit [www.epa.gov/greenpower](http://www.epa.gov/greenpower).



## ENERGY STAR® Program Requirements for Integral LED Lamps

### Eligibility Criteria - Version 1.4

The May 13, 2011 revision of this product specification modifies the certification requirements to align with ENERGY STAR's Third-Party Certification requirements, which went into effect on January 1, 2011. This revision deletes all references to self-certification, verification testing, and specific laboratory requirements. This revision also incorporates new, additional, product labeling requirements for non-standard lamps, and incorporates technical clarifications issued by EPA on August 25, 2011. The technical clarifications regarding the CFL V.4.0 Elevated Temperature test have been added to Appendix E. The technical clarifications regarding product variations, equivalency claims and Lighting Facts labels have been added to Appendix F.

Below are the product criteria for ENERGY STAR Integral LED Lamps - Version 1.4. A product must meet all of the criteria in order to be certified as ENERGY STAR.

**1) SCOPE:** These criteria apply to integral LED lamps<sup>1</sup>, defined as a lamp with LEDs, an integrated LED driver, and an ANSI standardized base designed to connect to the branch circuit via an ANSI standardized lampholder/socket. These criteria include integral LED lamps of non-standard form, and those intended to replace standard general service incandescent lamps, decorative (candelabra style) lamps, and reflector lamps. Other types of replacement lamps may be added in the future as improvements to LED technology make LED use in other replacement lamp types viable.

## 2) DEFINITIONS

- A. **A2LA:** American Association for Laboratory Accreditation.
- B. **ANSI:** American National Standards Institute.
- C. **ASTM:** American Society for Testing of Materials.
- D. **CIE:** Commission Internationale de l'Eclairage (translated International Commission on Illumination).
- E. **Color rendition:** The effect the spectral characteristic of the light emitted by the LED has on the color appearance of the objects illuminated by it is called color rendition. The color rendering index (CRI) is defined in terms of a comparison of the spectral tri-stimulus values of the objects under test illumination and standard illumination according to the recommendations of CIE Publication No.13.3-1995.
- F. **Correlated Color Temperature (CCT):** The actual color of the light from the LED is called the color temperature and is defined in terms of the spectral tri-stimulus values (color coordinates) according to the recommendations of IES LM-16-93. For color coordinates near the blackbody loci, the correlated color temperature, measured in kelvin (K), is used.
- G. **CSA:** Canadian Standards Association.
- H. **DOE:** U.S. Department of Energy.
- I. **Duv:** the closest distance from the Planckian locus on the ( $u'$ ,  $2/3 v'$ ) diagram, with + sign for above and - sign for below the Planckian locus.
- J. **EPA:** U.S. Environmental Protection Agency.
- K. **ETLT:** elevated temperature life test.
- L. **Integral 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). (IES RP-16-10)
- M. **IEC:** International Electrotechnical Commission.
- N. **IES:** Illuminating Engineering Society of North America.
- O. **ISTMT:** *in situ* temperature measurement test.
- P. **LED driver:** A device comprised of a power source and LED control circuitry designed to operate a LED package (component), or an LED array (module) or an LED lamp. (RP-16-10)
- Q. **LED lumen maintenance (L<sub>70</sub>):** The length of time declared by the manufacturer at which 70% lumen maintenance of any large sample of LEDs is reached.
- R. **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. (RP-16-10)
- S. **LED package:** An assembly of one or more LED dies that includes wire bond or other type of electrical connections, possibly

<sup>1</sup> IES RP-16-10

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.(RP-16-10)

- T. **Lumen maintenance**: The luminous flux at a given time in the life of the LED and expressed as a percentage of the initial luminous flux.
- U. **MacAdam color ellipse**: An elliptical region of chromaticity coordinates that is defined using a centroid, a tilt angle relative to a horizontal axis, and a defined level of variance. Such a region defines what chromaticity coordinates can be acceptably associated with a target Correlated Color Temperature.
- V. **Manufacturer designated Temperature Measurement Point (TMP)**: The temperature measurement point designated by the manufacturer correlating to photometric, life or warranty values.
- W. **MOL**: Maximum overall length.
- X. **Minimum operating temperature**: The minimum temperature at which the power supply will reliably operate.
- Y. **MRA**: Mutual Recognition Arrangement.
- Z. **NEMA**: National Electrical Manufacturers Association.
- AA. **NRTL**: Nationally Recognized Testing Laboratory.
- BB. **NVLAP**: National Voluntary Laboratory Accreditation Program.
- CC. **OSHA**: Occupational Safety and Health Administration.
- DD. **Power factor**: The active power divided by the apparent power (i.e., product of the rms input voltage and rms input current of a driver).
- EE. **TMP**: temperature measurement point.
- FF. **UL**: Underwriters Laboratories.

**3) REFERENCE STANDARDS AND PROCEDURES:** ENERGY STAR integral LED lamps shall comply with the relevant clauses of the following standards, unless the requirements of the ENERGY STAR Integral LED Lamp criteria are more restrictive:

ANSI/IEEE C62.41-1991	<i>IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits</i>
ANSI C78.20-2003	<i>American National Standard for Electric Lamps – A, G, PS, and Similar Shapes with E26 Medium Screw Bases</i>
ANSI C78.21-2003	<i>American National Standard for Electric Lamps – PAR and R Shapes</i>
ANSI C78.24-2001	<i>American National Standard for Electric Lamps – Two-inch (51 mm) Integral-reflector Lamps with Front Covers and GU5.3 or GX 5.3 Bases</i>
ANSI/NEMA/ANSLG C78.377-2008	<i>Specifications for the Chromaticity of Solid State Lighting Products</i>
ANSI C78.5-2003	<i>Specifications for the Performance of Self-ballasted Compact Fluorescent Lamps</i>
ANSI C79.1-2002	<i>American National Standard for Electric Lamps – Nomenclature for Glass Bulbs Intended for Use with Electric Lamps</i>
ANSI/ANSLG C81.61-2009	<i>American National Standard for Electric Lamp Bases</i>
ANSI/UL 1993-2009	<i>Standard for Self-Ballasted Lamps and Lamp Adapters</i>
ANSI/UL 8750-2009	<i>Light Emitting Diode (LED) Equipment for Use in Lighting Products</i>
CIE Publication No. 13.3-1995	<i>Method of Measuring and Specifying Color Rendering of Light Sources</i>
CIE Publication No. 18.2-1983	<i>The Basis of Physical Photometry</i>
FCC CFR Title 47 Part 2	<i>General Rules and Regulations</i>
FCC CFR Title 47 Part 15	<i>Radio Frequency Devices</i>
FCC CFR Title 47 Part 18	<i>Industrial, Scientific and Medical Equipment</i>
IES LM-16-93	<i>Practical Guide to Colorimetry of Light Sources</i>
IES LM-28-89	<i>Guide for the Selection, Care, and Use of Electrical Instruments in the Photometric Laboratory</i>
IES LM-65-01	<i>Life Testing of Compact Fluorescent Lamps</i>
IES LM-79-08	<i>Electrical and Photometric Measurement of Solid State Lighting Products</i>
IES LM-80-08	<i>Approved Method for Measuring Lumen Maintenance of LED Light Sources</i>
IES RP-16-10	<i>Nomenclature and Definitions for Illuminating Engineering</i>

Performance Characteristics	Test Procedure
Lumen Output and Efficacy	IES LM-79-08 Electrical and Photometric Measurement of Solid State Lighting Products
Lumen Maintenance and Life	IES LM-79-08 at T=0 hrs and T=6,000 hrs or other target time; OR IES LM-80-08, Approved Method for Measuring Lumen Maintenance of LED Light Sources + IES LM-79-08 at T=0 hrs, T=3000 hrs, and T=6,000 hrs or other target time
Color Rendering Index	CIE Publication 13.3 – 1995
Transient Protection	ANSI/IEEE C62.41-1991, Category A, 7 strikes
Electromagnetic Interference	FCC CFR Title 47 Part 2 (General Rules and Regulations) Part 15 (Radio Frequency Devices), and Part 18 (Industrial, Scientific and Medical Equipment)

#### 4) REQUIREMENTS FOR ALL LAMPS

Criteria Item	ENERGY STAR Requirements	Reference Standard/Test Procedure	Sample Size/Specific Requirements		
Correlated Color Temperature (CCT) and Duv	Lamp must have one of the following designated CCTs (per ANSI/NEMA/ANSLG C78.377-2008) consistent with the 7-step chromaticity quadrangles and Duv tolerances listed below (see Appendix A for more information).	IES LM-79-08  ANSI/NEMA/ANSLG C78.377-2008	10 units per model - 5 base-up - 5 base-down At least 9 of the 10 samples must meet the specification		
	Nominal CCT			Target CCT (K) and tolerance	Target Duv and tolerance
	2700 K			2725 ± 145	0.000 ± 0.006
	3000 K			3045 ± 175	0.000 ± 0.006
	3500 K			3465 ± 245	0.000 ± 0.006
4000 K	3985 ± 275	0.001 ± 0.006			
Color Maintenance	The change of chromaticity over the minimum lumen maintenance test period (6000 hours) shall be within 0.007 on the CIE 1976 (u',v') diagram.	IES LM-79-08 ANSI/NEMA/ANSLG C78.377-2008	10 units per model - 5 base-up - 5 base-down 9 of 10 lamps must meet specification		
Color Rendering Index (CRI)	Minimum CRI (R <sub>a</sub> ) of 80. In addition, the R <sub>9</sub> value must be greater than 0.	IES LM-79-08 ANSI/NEMA/ANSLG C78.377-2008 CIE 13.3-1995	10 units per model - 5 base-up - 5 base-down Average of 10 samples must meet specification; none lower than 77		
Dimming	Lamps may be dimmable or non-dimmable. Product packaging must clearly indicate whether the lamp is dimmable or not dimmable. Manufacturers qualifying dimmable products must maintain a Web page providing dimmer compatibility information Minimum efficacy, light output, CCT, CRI, and power factor of dimmable lamps will be confirmed with the lamp operated at full power.	n/a	n/a		
NOTE: DOE is working with NEMA to develop a dimming standard for LED lamps and luminaires.					

Criteria Item	ENERGY STAR Requirements	Reference Standard/Test Procedure	Sample Size/Specific Requirements
Warranty	A warranty must be provided for lamps, covering material repair or replacement for a minimum of three (3) years from the date of purchase.		
Allowable Lamp Bases	Must be a lamp base listed by ANSI.	ANSI/ANSLG C81.61-2009	n/a
Power Factor	For lamp power $\leq 5W$ and for low voltage lamps, no minimum power factor is required For lamp power $> 5W$ , power factor must be $\geq 0.70$  <b>Note:</b> Power factor must be measured at rated voltage.	ANSI C82.77-2002  IES LM-79-08	10 units per model - 5 base-up - 5 base-down Average of 10 samples $\geq 0.70$
Minimum Operating Temperature	Integral lamp shall have a minimum operating temperature of $-20^{\circ}C$ or below.	n/a	n/a
LED Operating Frequency	$\geq 120 \text{ Hz}^2$ <b>Note:</b> This performance characteristic addresses problems with visible flicker due to low frequency operation and applies to steady-state as well as dimmed operation. Dimming operation shall meet the requirement at all light output levels.	n/a	1 unit per model  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.
Electro-magnetic and Radio Frequency Interference	Integral LED lamps must meet the appropriate FCC requirements for consumer use (FCC 47 CFR Part 15).	n/a	n/a
Audible Noise	Integral lamp shall have a Class A sound rating.	n/a	n/a
Transient Protection	Power supply shall comply with ANSI/IEEE C62.41-1991, Class A operation. The line transient shall consist of seven strikes of a 100 kHz ring wave, 2.5 kV level, for both common mode and differential mode.	ANSI/IEEE C62.41-1991	5 units per model
Operating Voltage	Lamp shall operate at rated nominal voltage of 120, 240 or 277 VAC, or at 12 or 24 VAC or VDC.	n/a	n/a
Safety Requirements	Integral LED lamps must meet the requirements of ANSI/UL 1993 – 2009	n/a	n/a

<sup>2</sup> This performance criterion is under further review.

## 5) PACKAGING REQUIREMENTS

Warranty	Product packaging must state “Warranty” or “Limited Warranty” terms and provide a toll-free (e.g., "800") number, or mailing address, or Web site address ( <i>if applicable</i> ) for consumer complaint resolution. The written warranty must be included with the lamp packaging.
Product Packaging Language	In English, or English with additional languages. For products that will be sold in Canada, packaging must include both English and French.
Incompatibility with Controls and Application Exceptions	<p>Lamp package must clearly state any known incompatibility with photo controls, occupancy sensors, or timing devices. In addition, packaging should state specific application exceptions, such as totally enclosed fixtures, insulated air-tight (ICAT) recessed downlights, damp locations, and any other application restrictions.</p> <p>This includes installations which would result in a lamp's noncompliance with the ENERGY STAR specification performance requirements. If a qualified lamp operating on AC or DC does not comply with requirements, this shall be considered an application exception which shall be detailed by the manufacturer. Therefore, on the lamp packaging (not on enclosed materials, not on a referenced website), language similar to the following should be included:</p> <p>"Not intended for AC operation."          "Not intended for operation on AC transformers."          "Not for use with AC transformers."</p> <p>"DC" may be substituted for "AC", as applicable.</p>
Dimmable lamps	Lamp package and product information sheet must include a caution label indicating the lamp may not be compatible with all dimmers and identifying the Web address (URL) to find up-to-date dimmer compatibility information.
LED MR-16 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.
Non-Standard Lamps	<p>Lamp package must state “Non-Standard Lamp” on any panel except the bottom panel. Lamp package and package inserts of product shall indicate lighting applications and fixture types for which the non-standard lamp is intended. See Appendix C for icons to be employed on product packaging to communicate appropriate applications. Icon image files are available at :</p> <p><a href="http://www.energystar.gov/index.cfm?fuseaction=products_for_partners.show_ILEDL">www.energystar.gov/index.cfm?fuseaction=products_for_partners.show_ILEDL</a></p> <p>Partners shall use both the recessed and table fixture icons on the package of each certified non-standard lamp, and shall select a minimum of two additional icons to display. The applications for which the lamp is appropriate shall be circled using the provided circle image, and those applications for which the lamp's luminous intensity</p>



	<p>distribution would fail to meet the requirements of a given task shall be marked with the provided “X” image. As an example, the packaging of a non-standard lamp which does not illuminate the surface below when installed base-down in a table or floor fixture would be required to indicate an “X” through the table fixture icon.</p> <p>These icons shall be printed no smaller in width than 3/8”. The icons shall not be located on the bottom of product packaging. The icons shall also be employed on all associated product literature, both in print and electronic form. Non-standard lamps shall not make any equivalency claims to standard incandescent shape or wattage on product packaging, or on the labeling of the lamp itself.</p>
Product Equivalency Claims (for Replacement Lamps)	Product packaging, supporting documents, and marketing material may only reference the ANSI standard lamp shape indicated on ENERGY STAR product application. Lamp packaging and supporting materials may not make performance comparisons that reference other types of lamps or lamp wattages other than that referenced in the ENERGY STAR application materials.
Product Equivalency Claims (for Non-Standard Lamps)	Product packaging, supporting documents and marketing materials may not reference any ANSI standard lamp shape or any other types of lamps, and may not claim performance equivalence to any other type of lamp on the market (e.g. incandescent wattage equivalency).
Lighting Facts Label	Beginning on January 1, 2012 the Federal Trade Commission’s new Lighting Facts label <sup>3</sup> will be required by law on packaging of medium screw base general service lamps. Manufacturers shall use the DOE Lighting Facts label for products not covered by the FTC ruling. Manufacturers can participate in DOE’s Lighting Facts program by uploading product data at <a href="http://www.lightingfacts.com">www.lightingfacts.com</a>
Model Number	Packaging must include model number. The model number of an LED lamp submitted for qualification must be different from any earlier, non-qualified versions of the product already introduced into the market. Partners wishing to maintain model numbers of LED lamps already in the market and submitted for qualification may do so by providing with their qualification submittal proof that no material or performance changes have been made to the model between original market introduction and submittal for ENERGY STAR qualification.

<sup>3</sup> [www.ftc.gov](http://www.ftc.gov)

**6) Non-Standard Lamps – for LED lamps of non-standard lamp type or form**

Lamps in this category may not state equivalency to existing standard electric lamps in terms of wattage or type/shape of lamp on the lamp itself, or lamp packaging, promotional materials, or cut sheets, either in print or electronic form. In addition to the requirements above, the following performance and information requirements apply to Non-standard Lamps. These criteria are not applicable to LED lamps intended to replace linear fluorescent or high-intensity discharge (HID) lamps.

Criteria Item	ENERGY STAR Requirements	Reference Standard/Test Procedure	Sample Size/Specific Requirements
Minimum Luminous Efficacy		IES LM-79-08	10 units per model - 5 base-up - 5 base-down 9 of 10 lamps must meet specification
- LED lamp power <10W	50 lm/W		
- LED lamp power ≥10W	55 lm/W		
Minimum Light Output	200 lumens	IES LM-79-08	10 units per model - 5 base-up - 5 base-down 9 of 10 lamps must meet specification
Luminous Intensity Distribution	No specific distribution is required. Must submit goniophotometry report showing luminous intensity distribution produced by the lamp.	IES LM-79-08, Section 10	1 unit per model
Lumen Maintenance	≥ 70% lumen maintenance (L <sub>70</sub> ) at 25,000 hours of operation	IES LM-79-08 Elevated Temperature Test per ENERGY STAR CFL version 4.0 and technical clarifications in Appendix E IES LM-80-08 (for early initial qualification option)	10 units per model - 5 base-up - 5 base-down - LED lamp power <10W must operate at 25°C between measurements. - LED lamp power ≥10W must operate at 45°C between measurements. -Average of 10 samples must be ≥ 91.8% at 6000 hours
Rapid-Cycle Stress Test	Cycle times: 2 minutes on, 2 minutes off. Lamp cycled once for every two hours of L <sub>70</sub> life	ANSI C78.5-2003 IES LM-65-01 (clauses 2,3,5, 6)	10 units per model - 5 base-up - 5 base-down 9 of 10 lamps must meet required number of cycles

**7) Replacement Lamps – for lamps intended to replace existing standard electric lamps (per ANSI C79.1-2002)**

All lamps stating equivalency to a standard lamp wattage or type in product packaging, literature, or other materials must provide the following information about the lamp to be replaced (i.e., the target lamp):

- 1) Target lamp type, using standard lamp designations defined in ANSI C79.1-2002. For example, A, R, MR, PAR, etc.
- 2) Target lamp diameter in eighths of an inch. For example, A19, MR16, PAR38, etc.
- 3) Target lamp nominal wattage.
- 4) For directional lamp types, target lamp beam angle in degrees.

These criteria are not applicable to LED lamps intended to replace linear fluorescent or high-intensity discharge (HID) lamps. Minimum performance and dimensional criteria are provided below for omnidirectional, decorative, and directional lamp replacements.

**7A) Omnidirectional Lamps**

Applicable lamp types: A, BT, P, PS, S, T (per ANSI C79.1-2002)

Criteria Item	ENERGY STAR Requirements	Reference Standard/Test Procedure	Sample Size/Specific Requirements
Minimum Luminous Efficacy		IES LM-79-08	10 units per model - 5 base-up - 5 base-down 9 of 10 lamps must meet specification
- LED lamp power <10W	50 lm/W		
- LED lamp power ≥10W	55 lm/W		
Minimum Light Output	Lamp shall have minimum light output (initial total luminous flux) at least corresponding to the target wattage of the lamp to be replaced, as shown below. Target wattages between the given levels may be interpolated.	IES LM-79-08	10 units per model - 5 base-up - 5 base-down 9 of 10 lamps must meet specification
	Nominal wattage of lamp to be replaced (watts)	Minimum initial light output of LED lamp (lumens)	
	25	200	
	35	325	
	40	450	
	60	800	
	75	1,100	
	100	1,600	
	125	2,000	
	150	2,600	
Luminous Intensity Distribution	Products shall have an even distribution of luminous intensity (candelas) within the 0° to 135° zone (vertically axially symmetrical). Luminous intensity at any angle within this zone shall not differ from the mean luminous intensity for the entire 0° to 135° zone by more than 20%. At least 5% of total flux (lumens) must be emitted in the 135°-180° zone. Distribution shall be vertically	IES LM-79-08, Section 10	1 unit per model

Criteria Item	ENERGY STAR Requirements	Reference Standard/Test Procedure	Sample Size/Specific Requirements
	symmetrical as measured in three vertical planes at 0°, 45°, and 90°. See Appendix B for illustration.		
Maximum lamp diameter	Not to exceed target lamp diameter	ANSI C78.20-2003 ANSI C78.23-1995	1 unit per model
Maximum overall length (MOL)	Not to exceed MOL for target lamp	ANSI C78.20-2003 ANSI C78.23-1995	1 unit per model
Lumen Maintenance	≥ 70% lumen maintenance (L <sub>70</sub> ) at 25,000 hours of operation	IES LM-79-08 Elevated Temperature Test per ENERGY STAR CFL version 4.0 and technical clarifications in Appendix E IES LM-80-08 (for early initial qualification option)	10 units per model - 5 base-up - 5 base-down - LED lamp power <10W must operate at 25°C between measurements. - LED lamp power ≥10W must operate at 45°C between measurements. -Average of 10 samples must be ≥ 91.8% at 6000 hours
Rapid-Cycle Stress Test	Cycle times must be 2 minutes on, 2 minutes off. Lamp will be cycled once for every two hours of L <sub>70</sub> life.	ANSI C78.5-2003 IES LM-65-01 (clauses 2,3,5, 6)	10 units per model - 5 base-up - 5 base-down 9 of 10 lamps must meet required number of cycles

## 7B) Decorative Lamps

Applicable lamp types: B, BA, C, CA, DC, F, G (per ANSI C79.1-2002)

Criteria Item	ENERGY STAR Requirements	Reference Standard/Test Procedure	Sample Size/Specific Requirements
Minimum Luminous Efficacy	40 lm/W	IES LM-79-08	10 units per model - 5 base-up - 5 base-down 9 of 10 lamps must meet specification
Minimum Light Output	Lamp shall have minimum light output (total luminous flux) at least corresponding to the standard incandescent target wattage of the lamp to be replaced, as shown below. Target wattages between the given levels may be interpolated.	IES LM-79-08	10 units per model - 5 base-up - 5 base-down 9 of 10 lamps must meet specification
	Nominal wattage of the standard incandescent lamp to be replaced (watts)	Minimum light output of LED lamp (lumens)	

Criteria Item	ENERGY STAR Requirements	Reference Standard/Test Procedure	Sample Size/Specific Requirements
	10	70	
	15	90	
	25	150	
	40	300	
	60	500	
Maximum lamp diameter	Not to exceed target lamp diameter	ANSI C78.23-1995 ANSI C78.20-2003	1 unit per model
Lumen Maintenance	$\geq 70\%$ lumen maintenance ( $L_{70}$ ) at 15,000 hours of operation	IES LM-79-08, IES LM-80-08 (for early initial qualification option)	10 units per model - 5 base-up - 5 base-down -Must operate at 25°C between measurements. -Average of 10 samples must be $\geq 86.7\%$ at 6000 hours
Rapid-Cycle Stress Test	Cycle times must be 2 minutes on, 2 minutes off. Lamp will be cycled once for every two hours of $L_{70}$ life.	ANSI C78.5-2003 IES LM-65-01 (clauses 2,3,5, 6)	10 units per model - 5 base-up - 5 base-down 9 of 10 lamps must meet required number of cycles

### 7C) Directional Lamps

Applicable lamp types BR, ER, K, MR, PAR, R (per ANSI C79.1-2002)

For MR and PAR lamps, the following lamp diameters are included at this time: MR16, PAR16, PAR20, PAR30S (short neck), PAR30L (long neck), PAR38

Criteria Item	ENERGY STAR Requirements	Reference Standard/Test Procedure	Sample Size/Specific Requirements
Definition	Directional lamp means a lamp having at least 80% light output within a solid angle of $\pi$ sr (corresponding to a cone with angle of 120°)	EC No 244/2009; IES LM-79-08, Section 10	1 unit per model
Minimum luminous efficacy		IES LM-79-08	10 units per model - 5 base-up - 5 base-down 9 of 10 lamps must meet specification
- Lamp diameter $\leq 20/8$ inch	40 lm/W		
- Lamp diameter $> 20/8$ inch	45 lm/W		
Color Spatial Uniformity	The variation of chromaticity within the beam angle shall be within 0.006 from the weighted average point on the CIE 1976 ( $u', v'$ ) diagram.	IES LM-79-08 ANSI C78.379-2006, section 5	1 unit per model - Angular chromaticity measurements shall be made at the center and edge of the beam. The measurements shall be made in at least two vertical planes 90° apart. Results shall be averaged from the different vertical planes.

Criteria Item	ENERGY STAR Requirements	Reference Standard/Test Procedure	Sample Size/Specific Requirements
Maximum lamp diameter	Not to exceed target lamp diameter	ANSI C78.21-2003  ANSI C78.24-2001	1 unit per model
Maximum overall length (MOL)	Not to exceed MOL for target lamp	ANSI C78.21-2003  ANSI C78.24-2001	1 unit per model
Minimum light output – <b>BR, ER, K, and R lamps</b>	Lamp shall have minimum light output (total luminous flux) equal to the target wattage of the standard incandescent lamp to be replaced multiplied by 10.	IES LM-79-08	10 units per model - 5 base-up - 5 base-down 9 of 10 lamps must meet specification
Minimum center beam intensity <sup>4</sup> – <b>PAR and MR16 lamps</b>		IES LM-79-08, Section 10	1 unit per model
- PAR lamps	Link to online tool at: <a href="http://www.energystar.gov/ia/products/lighting/iledl/IntLampCenterBeamTool.zip">http://www.energystar.gov/ia/products/lighting/iledl/IntLampCenterBeamTool.zip</a> Enter the following information into the online tool: PAR diameter in eighths of an inch (i.e., 16, 20, 30, 38) Target lamp nominal wattage Target lamp beam angle in degrees (Note: maximum allowable beam angle = 65°.)		
- MR16 lamps	Link to online tool at: <a href="http://www.energystar.gov/ia/products/lighting/iledl/IntLampCenterBeamTool.zip">http://www.energystar.gov/ia/products/lighting/iledl/IntLampCenterBeamTool.zip</a> Enter the following information into the online tool: Target lamp nominal wattage Target lamp beam angle in degrees (Note: maximum allowable beam angle = 50°.)		
Lumen Maintenance	≥ 70% lumen maintenance (L <sub>70</sub> ) at 25,000 hours of operation	IES LM-79-08 Elevated Temperature Test per ENERGY STAR CFL version 4.0 and technical clarifications in Appendix E  IES LM-80-08 (for early initial qualification option)	10 units per model - 5 base-up - 5 base-down - LED lamp power <10W must operate at 25°C between measurements. - LED lamp power ≥10W must operate at 45°C between measurements. -Average of 10 samples must be ≥ 91.8% at 6000 hours
Rapid-Cycle Stress Test	Cycle times must be 2 minutes on, 2 minutes off. Lamp will be cycled once	ANSI C78.5-2003	10 units per model - 5 base-up

<sup>4</sup> Models based on statistical analysis of 432 PAR and 122 MR16 lamps produced by NEMA manufacturers are used to set minimum center beam intensity requirements. For a given target lamp wattage and target beam angle, mathematical functions for each lamp type yield the minimum required center beam intensity in candelas (cd). The minimum requirement is within two standard deviations of the center beam intensity predicted by the model.

Criteria Item	ENERGY STAR Requirements	Reference Standard/Test Procedure	Sample Size/Specific Requirements
	for every two hours of L <sub>70</sub> life.	IES LM-65-01 (clauses 2,3,5, 6)	- 5 base-down 9 of 10 lamps must meet required number of cycles

### 8) LUMEN MAINTENANCE TESTING AND LIFE CLAIMS

Minimum life requirement: 15,000 hours to 70% lumen maintenance (L<sub>70</sub>) for Decorative lamps (section 7B); 25,000 hours for all other lamp types. At least 6,000 hours of lumen maintenance testing of the full integral lamp is required of all lamp types. Lumen maintenance cannot be claimed on the basis of component testing alone. Life claims associated with early initial qualification are limited to the minimum life requirement values stated above, though longer L<sub>70</sub> life may be claimed based on verified lumen maintenance levels after 6,000 hours of lumen maintenance testing, as follows:

	Minimum lumen maintenance at end of 6000 hours (% of initial lumens; -3% tolerance)	Maximum L <sub>70</sub> Life Claim (hours)	ENERGY STAR Approval Available After 6000-hour test
Minimum for Decorative	86.7%	15,000	<b>Full approval</b> (no additional lumen maintenance testing required)
Optional for Decorative	89.9%	20,000	
Minimum for Non-standard, Omnidirectional, and Directional Optional for Decorative	91.8%	25,000	
Optional for All Lamp Types	93.1%	30,000	<b>Initial approval</b> , pending completion of total required test period (see Table 2 below)
	94.1%	35,000	
	94.8%	40,000	
	95.4%	45,000	
	95.8%	50,000	

Longer life claims are allowed, based on longer required test periods and associated lumen maintenance thresholds, as shown in Table 2.

Minimum cumulative test period (hours)	Minimum lumen maintenance at end of test period (% of initial lumens; -3% tolerance)	Maximum L <sub>70</sub> Life Claim (hours)
7,500	91.2%	30,000
8,750	91.5%	35,000
10,000	91.5%	40,000
11,250	91.5%	45,000
12,500	91.8%	50,000

Lumen maintenance operation is conducted at specific ambient temperatures shown in Table 3 below, for each lamp category. Periodic photometric tests are conducted at room temperature (25°C).

Lamp category	Lamp subcategory	Minimum ambient temperature
Non-standard lamps Omnidirectional lamps Directional lamps	LED lamp power <10W	25°C
	LED lamp power ≥10W	45°C
Decorative lamps	All	25°C

**8A) OPTION FOR EARLY INITIAL QUALIFICATION WITH IES LM-80-08 AND IN SITU TEMPERATURE MEASUREMENT TEST**

This option is available for integral LED lamps using single color or phosphor-converted LED package(s)/array(s)/module(s) for which IES LM-80-08 test data is available. This initial qualification may be based on IES LM-80-08 data along with results of an *in situ* temperature measurement test (ISTMT)<sup>5</sup> that indicate the temperature of the LED package(s)/array(s)/module(s) when operated in the integral LED lamp. LED temperature is measured at the manufacturer-designated temperature measurement point (TMP). If the IES LM-80-08 data consistent with the ISTMT meets threshold requirements corresponding to the target L<sub>70</sub> lifetime, the integral LED lamp is eligible for provisional approval after 3000 hours of integral lamp testing. Continued qualification depends on successful completion of the full test period. Life claims for early initial qualification are limited to the minimum life requirements, though longer life claims are allowed based on longer required test periods and associated lumen maintenance thresholds shown in Tables 1 & 2.

**Table 4. Requirements for Interim Qualification with IES LM-80-08 and TMP Verification**

<b>Lumen Maintenance Test</b>	<b>Reference Standard / Test Procedure</b>	<b>Sample Size</b>	<b>Passing Threshold</b>
IES LM-80-08 data for LEDs used in the integral lamp	IES LM-80-08	LED packages: 25 LED modules: 10	At least 91.8% lumen maintenance at 6000 hours at Ts ≥ TMP of LED inside integral lamp and at drive current ≥ LED drive current inside integral lamp
TMP verification of LEDs inside integral lamp + declared drive current	<i>In situ</i> Temperature Measurement Test (ISTMT), ENERGY STAR SSL v 1.1	1 unit per model	A test report must be submitted by an OSHA NRTL laboratory.
Operate lamps continuously for 3000 hours at 45°C (5 base up, 5 base down) NOTE: Decorative lamps and all lamps <10W test at 25°C	Elevated Temperature Life Test (ETLT), ENERGY STAR CFL v 4.0 and Technical Clarifications in Appendix E; IES LM-79-08	10 units per model - 5 base-up - 5 base-down	Early Initial qualification: average lumen maintenance of 10 lamps ≥95.8%. NOTE: ≥ 93.1% for decorative lamps.

**9) CERTIFICATION:** In the Integral LED Lamps V.1.4, this section was removed to align this specification with EPA’s Third-Party Certification requirements.

**10) QUALIFICATION FOR INTEGRAL LED LAMP PRODUCTS:** Any LED Lamp can be qualified on the basis of 6,000 hours of data. In order to make lifetime claims above ENERGY STAR minimum requirements, PARTNERS shall follow the requirements in section C.

**A. EARLY INITIAL QUALIFICATION WITH IES LM-80-08 AND 3,000 HOURS OF LAMP LUMEN MAINTENANCE DATA**

A product photo will be required for certification to assist in identifying the current version of the certified product. A product shall meet all the requirements of the specification, in addition to specific requirements listed in section 8A, a PARTNER shall submit:

- 3,000 hour lumen maintenance data for the integral LED lamp

**Packaging Review:** All PARTNERS who are qualifying an integral LED lamp shall submit electronic or hard copy labeling and packaging samples for the specific integral LED lamp model. Packaging shall meet all of the requirements that are

<sup>5</sup> See Appendix D for additional information on the *In situ* Temperature Measurement Test.



identified under the Lifetime Performance and Packaging Requirements. Failure to meet the packaging requirements will delay the qualification process and the integral LED lamp model in question will not be qualified until all packaging requirements are met. The specific qualified model shall be distributed within this approved product packaging.

Products that meet the above requirements will be eligible for initial qualification for ENERGY STAR. PARTNERS may begin to market the integral LED lamp model as ENERGY STAR qualified by using the certification mark on the product packaging, and identifying the product as qualified within marketing materials, and the company's Web site.

## **B. FULL QUALIFICATION:**

When a product is initially qualified, partners will be provided with a due date for the **final average rated life time** test report to complete their ENERGY STAR Integral LED Lamp qualification process and fulfill the full qualification requirements. This due date will be based on the date the average rated lifetime test began and the rated lifetime of the integral LED lamp. Failure to submit this final test report within 60 days of completion of the test will result in an immediate disqualification of the model. After the final test report review, if a product does not meet the recorded average rated lifetime, then the disqualification process will be put into effect (see Section 15).

Once a model has reached full qualification, it must be re-qualified every **36 months** to ensure ongoing design or manufacturing changes maintain overall performance against the program requirements. See Section 16 for more information on the **ENERGY STAR INTEGRAL LED LAMP RE-QUALIFICATION PROCEDURE**.

## **C. UPGRADING THE LIFE CLAIM OF A PREVIOUSLY-QUALIFIED PRODUCT**

Once a product has been qualified under the procedures above, ENERGY STAR PARTNERS may increase the claimed lifetime of a product only by demonstrating full compliance with the ENERGY STAR criteria at the new lifetime.

If PARTNER plans to initially qualify a product at 6000 hours, and later upgrade the lifetime, the Rapid-Cycle Stress Test duration shall be extended to support the final product lifetime.

**11) PRIVATE LABELING PRODUCTS:** In the Integral LED Lamps V.1.4, this section was removed to align this specification with EPA's Third-Party certification requirements.

**12) COMMERCIAL PACKAGING OF PRODUCTS:** ENERGY STAR certified integral LED lamp products that will be bulk packaged for retail or commercial sales must submit a package proof for the container that the qualified products will be shipped in and that clearly displays all of the required criteria to fulfill the packaging requirements for ENERGY STAR.

**13) QUALITY ASSURANCE:** Original Equipment Manufacturers (OEM) PARTNERS are required to maintain documentation that describes the measures they are taking to assure their ENERGY STAR qualified integral LED lamp and those products they sell to private labelers meet program and criteria requirements.

**A. Manufacturing Quality Control Documentation:** any of the following industry quality control processes:

- Adherence to the International Standards Organization (ISO) 9000 family of international quality management standards and guidelines, used as the basis for establishing quality management systems.
- Employment of the Six Sigma methodology to measure and improve a company's operational performance, practices and systems; or an equally recognized industry process.
- Other quality control systems or formats that are accepted industry standards.

**B. Color Consistency:** The following quality requirements must be met during the production runs of each lamp model:

1. The lamp manufacturer is required to maintain color control such that a minimum of 90 percent of the ongoing production (as represented by samples tested from each production shift for the same color and when typically evaluated over 12 month period) will fall within the ANSI/NEMA/ANSI C78.377-2008 chromaticity quadrangle associated with the designated (manufacturer declared) target color.
2. For the purposes of meeting color control, the lamp manufacturer must maintain testing equipment calibrated to international practices and standards and must compile the ongoing color control data in a manner so that it can be easily reviewed upon EPA request.
3. At a minimum, the manufacturer's color quality control program must maintain the following information for a 3-

year period:

- a. Test dates and sample size (minimum of two lamps per production shift)
- b. Test results (x,y) for each sample lamp measured
- c. Test results (all x,y data) for sample lamps plotted graphically against the designated chromaticity quadrangle and available for review at least on a quarterly basis (See Appendix A)
- d. Records to substantiate that 90 percent of the (x,y) data points fall within the applicable chromaticity quadrangle. Manufacturers are encouraged to exceed this target.

**14) THIRD-PARTY VERIFICATION PROGRAM:** In the Integral LED Lamps V.1.4, this section was removed. Verification testing for LED lamps will be conducted by certification bodies once the new Lamps specification is effective.

**15) DISQUALIFICATION PROCESS:** PARTNERS shall refer to EPA's stakeholder letter dated July 20, 2010, available at [www.energystar.gov/lightingDQ](http://www.energystar.gov/lightingDQ), for the product disqualification procedures and corrective action requirements.

**16) ENERGY STAR INTEGRAL LED LAMP RE-QUALIFICATION PROCEDURE:** In the Integral LED Lamps V.1.4, this section was removed. Re-qualification requirements will be addressed during the new Lamps specification development process.

**17) RETIREMENT/DISCONTINUATION OF PRODUCTS:** Products should be identified to CB as "retired/discontinued" when they are no longer available.

**18) EFFECTIVE DATE:** The effective date for the ENERGY STAR Program Requirements and Criteria for Integral LED Lamps – Version 1.4 will be August 31, 2010.

**19) FUTURE CRITERIA REVISIONS:** ENERGY STAR reserves the right to change the criteria should technological and/or market changes affect its usefulness to consumers, industry, or the environment.

## Appendix A: Chromaticity Specification and Tolerance Quadrangles

This chromaticity specification below was developed by ANSI to be as consistent as possible with existing fluorescent lamp standards, and to reflect the current (and near future) state of SSL technology and color binning capabilities. Each of the eight quadrangles as defined below overlap the six current the ANSI 7-step MacAdam ellipses (consistent with the current ENERGY STAR lighting criteria), and thus have the same nominal CCT as ENERGY STAR fluorescent lamps. Two additional CCTs (4500 and 5700K) are included to encompass the additional CCTs available in SSL. Each quadrangle is defined by the range of CCT and the distance from the Planckian locus on the chromaticity diagram. Refer to ANSI/NEMA/ANSLG C78.377-2008 for the details of these definitions. Figure 1 shows the plot of these chromaticity quadrangles and the table below shows (x,y) coordinates of the center points and the corners of each quadrangle.

	2700 K		3000 K		3500 K		4000 K		4500 K		5000 K		5700 K		6500 K	
	x	y	x	y	x	y	x	y	x	y	x	y	x	y	x	y
Center point	0.4578	0.4101	0.4338	0.4030	0.4073	0.3917	0.3818	0.3797	0.3611	0.3658	0.3447	0.3553	0.3287	0.3417	0.3123	0.3282
Tolerance quadrangle	0.4813	0.4319	0.4562	0.4260	0.4299	0.4165	0.4006	0.4044	0.3736	0.3874	0.3551	0.3760	0.3376	0.3616	0.3205	0.3481
	0.4562	0.4260	0.4299	0.4165	0.3996	0.4015	0.3736	0.3874	0.3548	0.3736	0.3376	0.3616	0.3207	0.3462	0.3028	0.3304
	0.4373	0.3893	0.4147	0.3814	0.3889	0.3690	0.3670	0.3578	0.3512	0.3465	0.3366	0.3369	0.3222	0.3243	0.3068	0.3113
	0.4593	0.3944	0.4373	0.3893	0.4147	0.3814	0.3898	0.3716	0.3670	0.3578	0.3515	0.3487	0.3366	0.3369	0.3221	0.3261

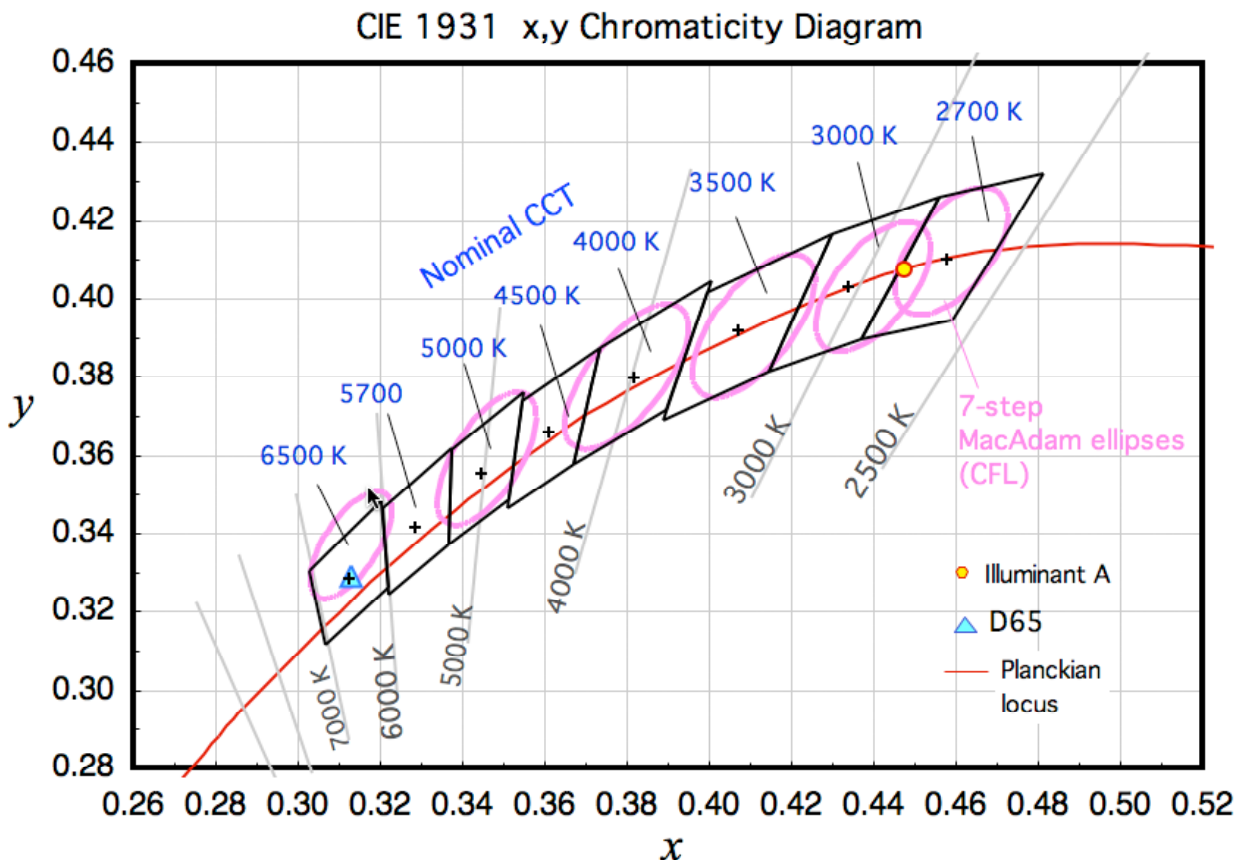
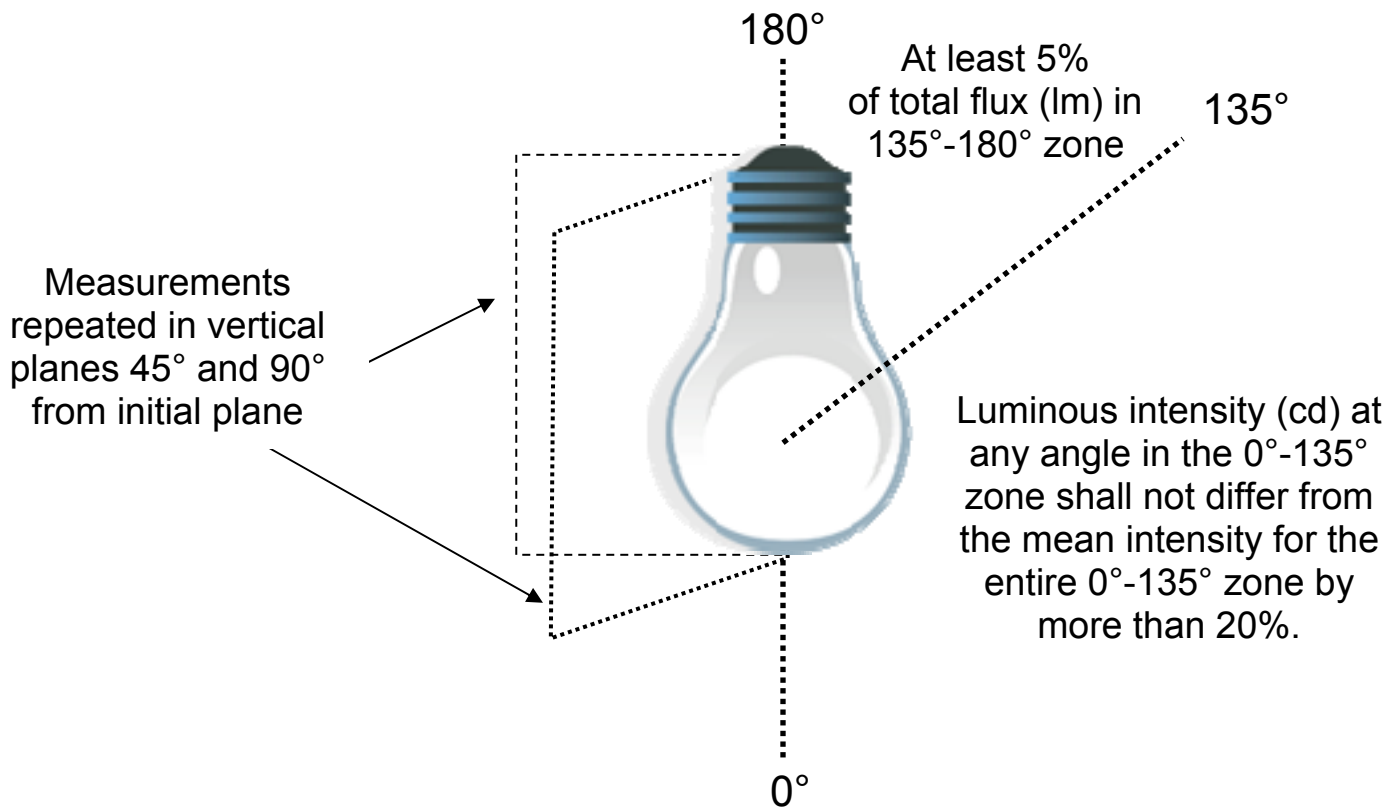


Figure 1. CIE 1931 Chromaticity Diagram Showing the Eight Nominal CCT Quadrangles

Appendix B: Diagram of Omnidirectional Lamp Zones

Omnidirectional lamp in base-up position

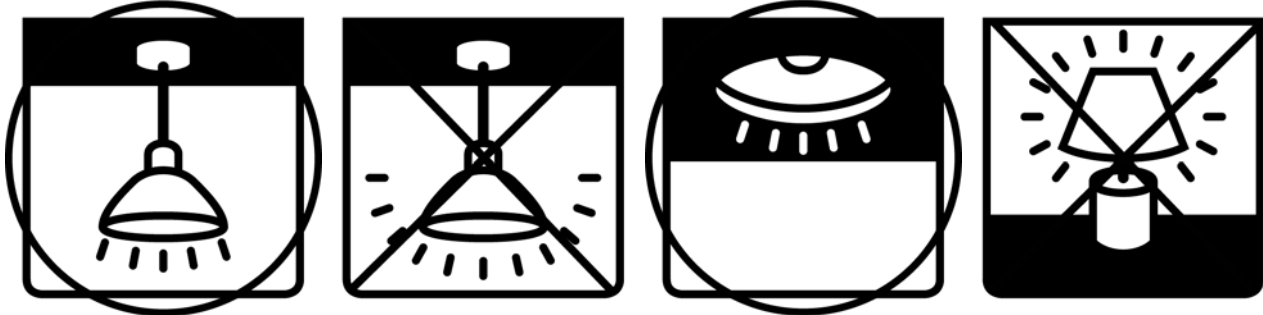


## Appendix C: Application Icons for Non-Standard Lamps

Partners shall use both the recessed and table fixture icons on the packaging of each qualified non-standard lamp, and shall select a minimum of two additional icons to display among the icons posted at [www.energystar.gov/index.cfm?fuseaction=products\\_for\\_partners.showLEDL](http://www.energystar.gov/index.cfm?fuseaction=products_for_partners.showLEDL)

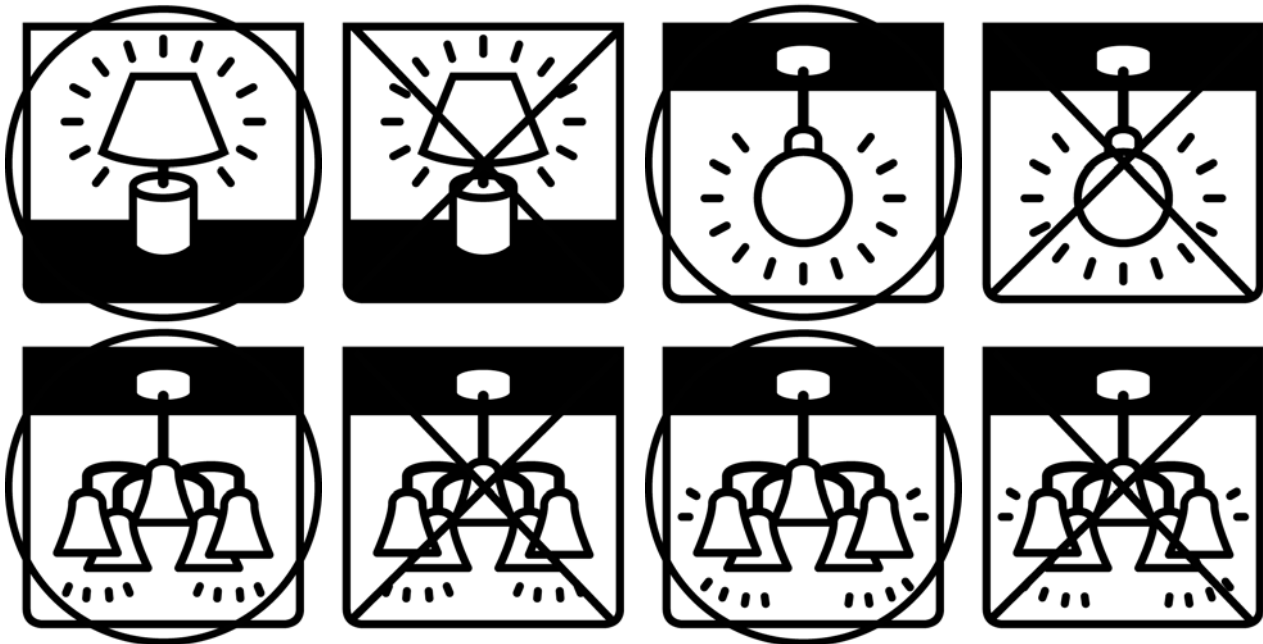
The applications for which the lamp is appropriate shall be circled with an "O", and those applications for which the lamp's luminous intensity distribution would fail to meet the requirements of a given task shall be marked with an "X".

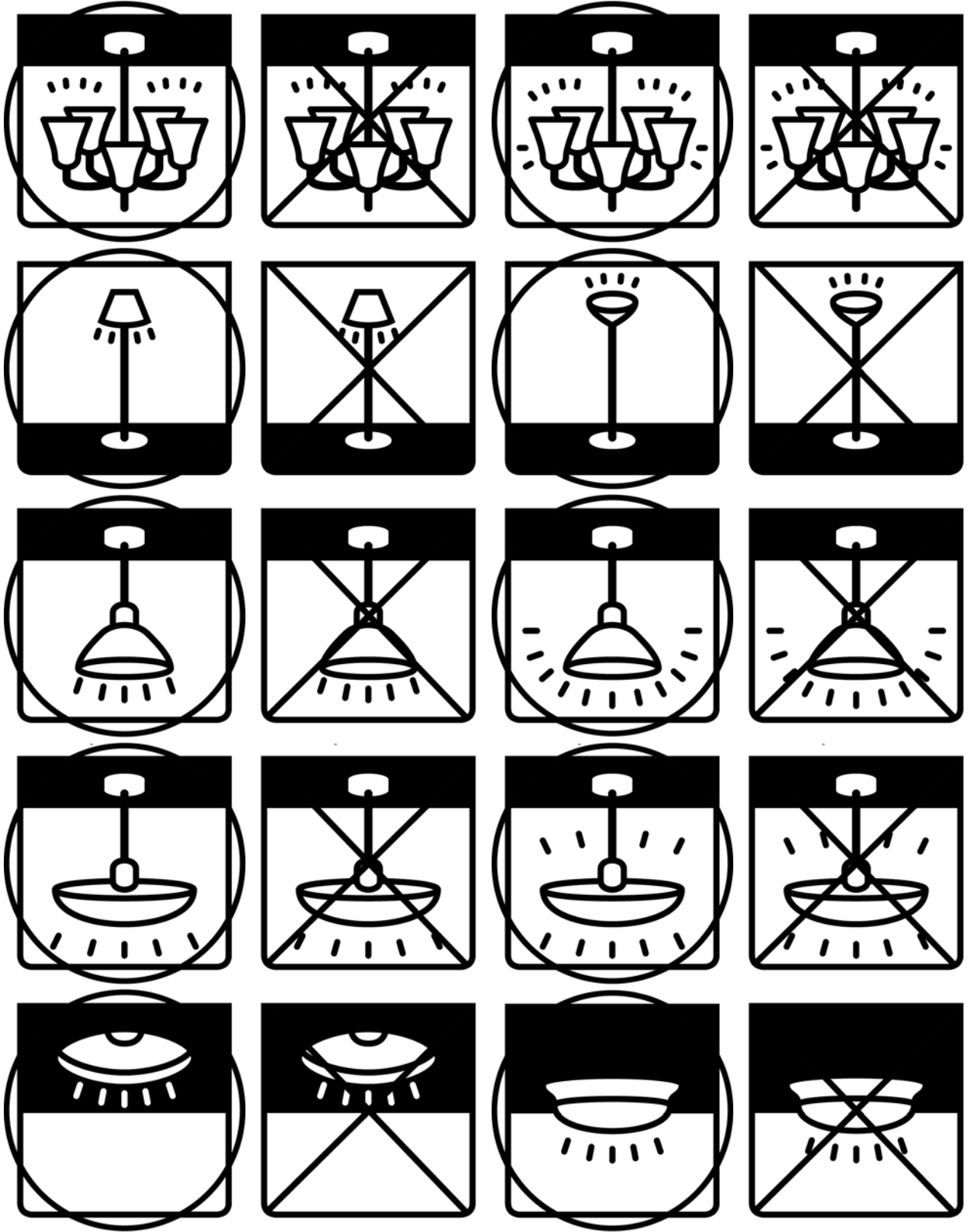
In the example below, the packaging of a non-standard lamp which does not illuminate the surface below when installed in a table or floor fixture, and would not illuminate the glass of a decorative pendant fixture, would be required to indicate an "X" through the table fixture and decorative pendant fixture icons.

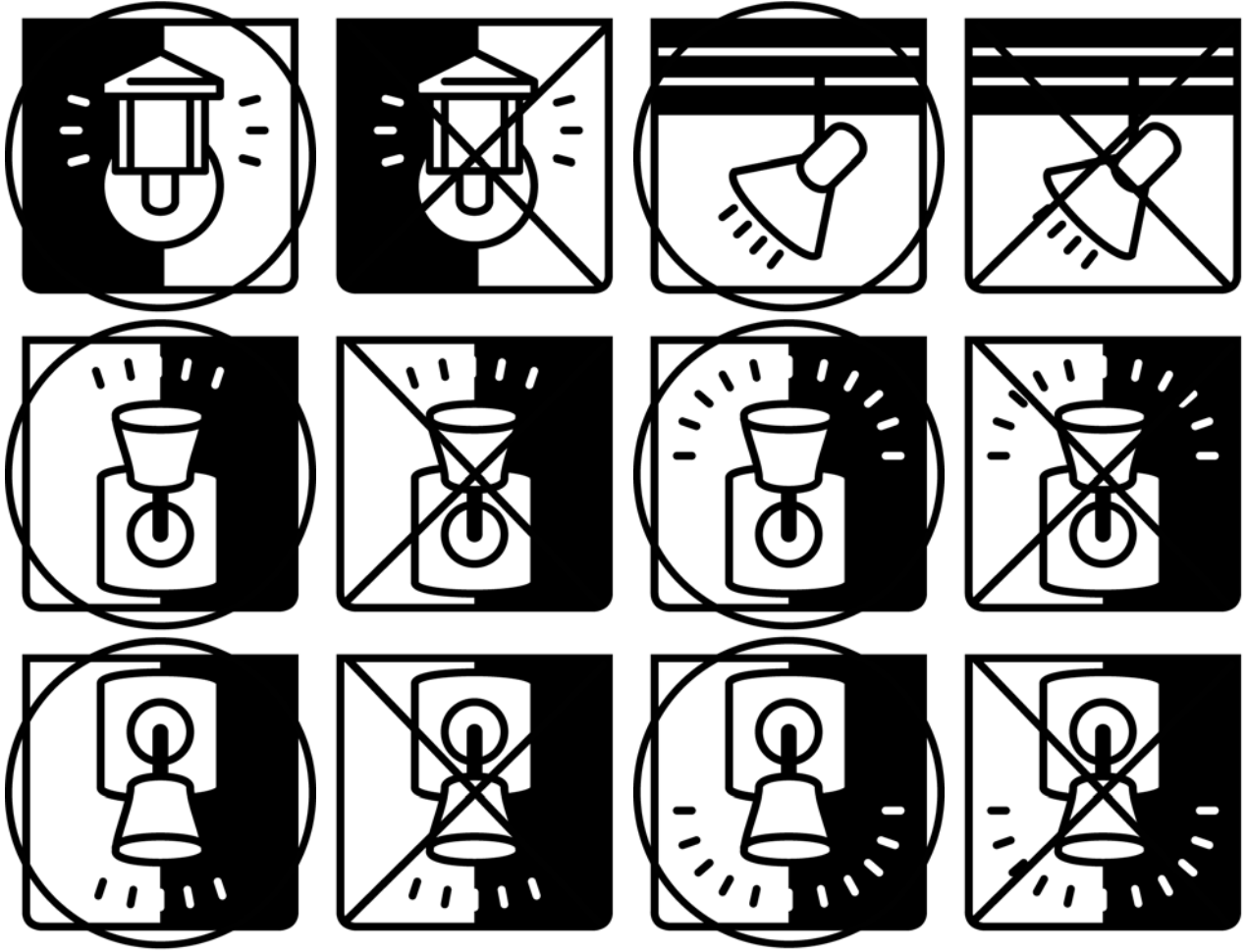


The icons, not inclusive of the circles or X's, shall be printed no smaller in width than 3/8". The icons shall not be located on the bottom of product packaging. The icons shall also be employed on all associated product literature, either in print or electronic form.

The following icons are available in TIFF format for free download without royalties at [www.energystar.gov/index.cfm?fuseaction=products\\_for\\_partners.showLEDL](http://www.energystar.gov/index.cfm?fuseaction=products_for_partners.showLEDL)







## Appendix D: *In situ* Temperature Measurement Test (ISTMT)

NOTE: the ISTMT is required only for products using the option for early initial qualification with IES LM-80-08 test data and ISTMT described in Section 8A.

IES LM-80-08 defines lumen maintenance testing for LED packages, arrays, and modules. Because LEDs are incorporated into integral lamps with heat sinks, optical elements, power supplies, etc. and then operated in a variety of ambient environments, IES LM-80-08 by itself is not a predictor of integral lamp lumen maintenance. To relate the results of the IES LM-80-08 test to the integral lamp, EPA requires verification of LED temperature in environments that simulate real-world applications (*in situ*) with tests that measure the temperature of the highest temperature LED in the integral lamp at steady-state thermal equilibrium. The procedure is called the *In situ Temperature Measurement Test (ISTMT)* which follows ANSI/UL 1993 – 2009 *Standard for Self-Ballasted Lamps and Lamp Adapters*. It includes the addition a thermocouple attached to the LED package, array, or module used in the integral lamp.

### **Temperature Measurement Point (TMP)**

LED package, array, or module manufacturers designate specific locations on their products which act as surrogate points for measuring junction temperature ( $T_j$ ). EPA generically designates these locations as the temperature measurement points (TMPs) for the purposes of measurement in testing.

Knowledge of the thermal pathway between the LED die junction and a designated external measurement point on the package, array, or module allows manufacturers to accurately estimate junction temperature. The surrogate temperatures and their measurement locations vary from manufacturer to manufacturer. Some manufacturers use temperatures measured at the solder joint ( $T_s$ ) at the board attachment site; some use the package case temperature ( $T_c$ ); and others use the board temperature ( $T_b$ ) on the module. Collectively, these locations serve the same function, i.e., to correlate an external temperature to the junction temperature, which is critical for determining LED lumen maintenance. For purposes of this document, the measurement locations for  $T_s$ ,  $T_c$ , and  $T_b$  are TMPs.

### **Conditions for Use**

To be eligible for the optional early initial qualification with IES LM-80-08 and ISTMT, **ALL** conditions below must be met. If **ANY** of the conditions is not met, the early initial qualification option may not be used.

1. The LED package(s), array(s), or module(s) used in the integral lamp have been tested according to IES LM-80-08.
2. The LED package/array/module manufacturer prescribes/indicates a temperature measurement point (TMP) on the package, array, or module. The LED package, array, or module TMP is accessible to allow temporary attachment of a thermocouple for measurement of *in situ* operating temperature. Access via a temporary hole in the lamp (no larger than 0.375" diameter), tightly resealed during testing with putty or other flexible sealant, is allowable. The size and location of the access port shall be documented in the submittal for the purposes of repeatability.

The ISTMT follows ANSI/UL 1993 – 2009 with the addition of a thermocouple attached to the highest temperature LED package or module in the integral lamp (i.e., at TMP).

### **Guidance for Thermocouple Attachment**

- Manufacturers shall select and designate the highest temperature LED package, array, or module in the integral lamp. In most cases the individual LED in the middle of symmetric arrays should be hottest. A well-designed thermal management solution will minimize the temperature gradient across packages.
  - For square/rectangular/circular arrays the individual LED closest to the center.
  - For other configurations it is recommended manufacturers sample several LEDs to find the highest temperature device within the integral lamp.
- Temperature probes shall be in contact with the TMP and permanently adhered. Permanent adhesion consists of high temperature solder, conductive adhesives (e.g., accelerator/UV activated or epoxy), or melting the tip into plastic or other approved product recommended by the temperature probe manufacturer. Tape alone is not acceptable for providing good thermal contact at the thermocouple/TMP interface.
- The thermocouple tolerance shall conform to ASTM E230 Table 1 "Special Limits" ( $\leq 1.1^\circ\text{C}$  or 0.4%, whichever is greater).



## Appendix E: Elevated Temperature Testing for Integral LED Lamps

### Lumen Maintenance Testing for Lamps 10W or Greater<sup>6</sup>

Lamps that draw 10W<sup>7</sup> or more must be subjected to elevated temperature testing for lumen maintenance. For this criterion, the integral LED lamp specification references the “ENERGY STAR CFL Elevated Temperature Test” detailed in Appendix B of the ENERGY STAR CFL V4.0 specification. The elevated temperature test procedures, identified in Appendix B of the CFL specification as “Option A” and “Option B” and created to meet the needs of the CFL program, were developed to simulate the environment of a reflector CFL in an airtight recessed downlight installed within an insulated ceiling (non-reflector compact fluorescent lamps and non-integrated compact fluorescent lamps were excluded from these test procedures). As such, certain elements of the original referenced test procedures must be modified or disregarded to account for differences in technology and the specific requirements outlined in the integral LED lamp specification. Below are clarifications related to the elevated temperature test procedures:

#### Testing Apparatus

“Option A” requires reflector lamps to be seasoned in the Halo® model H7UICAT incandescent downlight housing.

“Option B” requires an Elevated Temperature Testing Apparatus employing a flat section of perforated substrate with ceramic lampholders arranged in a rectangular array and radiant baffles at 55°C ± 5°C to both season and measure light output during testing.

#### Testing Apparatus: LED Lamps Clarification

For the purposes of elevated temperature testing for LED lamps, a fixture or apparatus is not required. The lamps may be burned in open air in the base-up and base-down positions so long as the required ambient temperature of 45°C is maintained. The spacing between lampholders shall remain the same as specified in Option B where the lampholders must be positioned between 8 and 12 inches on center. Whether testing is performed in an open chamber or a specially designed apparatus, testing should be performed according to the following steps:

1. Measure 5 lamps base-up, and 5 lamps base-down according to IES LM-79-08 at T=0.
2. Keeping the orientation of each sample consistent with the orientation of testing in step 1, age the lamps for 6,000 hours at an ambient temperature of 45°C.
3. After 6,000 hrs of aging, re-test the 10 samples in their original orientation according to IES LM-79-08.
4. Compare the step 1 measurements of each sample to the step 3 measurements of each sample.

Additional clarifications about specific aspects of the referenced “Option A” and “Option B” test procedures are detailed below.

#### Operating Cycles

Options A & B state: “Operation of the lamps shall be consistent with the provisions set forth in IES LM-65 Section 6.1; three hours ON and 20 minutes OFF.”

#### Operating Cycles: LED Lamps Clarification

Continuous operation is permitted instead of cycling, because unlike fluorescent products, cycling does not significantly impact the lumen maintenance of LEDs. The cycling used for fluorescent products aims to capture failure mechanisms found in fluorescent technology. EPA will accept tests that have already been performed with the cycling detailed in Options A & B.

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<sup>6</sup> Excludes Decorative Lamps

<sup>7</sup> Lamps with nominal wattage claims below 10 watts cannot have any one sample tested over 9.9 watts

### **Ambient Conditions**

Options A & B state: “The ambient temperature shall be maintained at 25°C + 10°C. The perimeter of the apparatus shall be kept clear of obstacles so that airflow is not inhibited from entering the apparatus during the purge portion of the test cycle.”

Option B states: “The operating temperature within the apparatus (represented as the average of at least four measurement locations specified in Section 8.4...) shall be maintained at 55°C ± 5°C during the on cycle. The operating temperature within the apparatus shall be achieved within 45 minutes upon on-cycle initiation (additional incandescent lamps may be added as heat sources to achieve this).”

### **Ambient Conditions: LED Lamps Clarification**

For lamps consuming 10 watts or more, the required minimum ambient temperature during aging is 45°C as detailed in the specification on pages 9, 11, 14, 15, and 16. This temperature is 10°C lower because LED lamps consume less power and generate less heat than a CFL reflector.

### **Elevated Temperature Housing/Apparatus**

Option A states: “Testing shall be conducted using the Halo® model H7UICAT incandescent downlight housing. No substitutions shall be allowed. No trim shall be used. Luminaires shall be oriented such that the lamp operates vertical base-up during the life test. The luminaires may be arranged in a horizontal plane or stacked vertically. If stacked vertically, a minimum spacing of 24” must be maintained between the bottoms of each row.”

Option B states: “The interior of the Elevated Temperature Testing Apparatus shall be on a flat section of perforated substrate with ceramic lampholders arranged in a rectangular array. The perforated substrate shall have holes of a minimum diameter of 1/4” spaced at a maximum spacing of 1” on center. The spacing between lampholders shall be no less than 8” on center and no greater than 12” on center. Radiant baffles shall be installed at the mid-point between all lampholders and along the perimeter of the lampholder array. The radiant baffles shall be constructed of an opaque, rigid material and shall be a minimum of 10” in height...”

### **Elevated Temperature Housing/Apparatus: LED Lamps clarification**

The Integral LED Lamps specification requires 10 samples per model, 5 oriented base-up and 5 base-down.

In Option B, baffles were originally required for CFL testing to enable photometric readings within the Elevated Temperature Testing Apparatus. Baffles are not required for LED lamp testing because the lamps are removed from the apparatus to be tested according to IES LM-79. Additionally, this apparatus was designed for all ten samples to be tested base-up, while the LED lamps specification requires 5 samples base-down and 5 base-up. Therefore, this apparatus would need to be modified to reorient the sockets for LED lamps.

EPA will accept lumen maintenance testing performed according to ENERGY STAR CFL V.4.0 elevated temperature test with all lamps operated base-up. However, lamps that have been determined to meet all other ENERGY STAR criteria and were only tested in the base-up position, must list on the packaging that the results are based on base-up operation only.

### **Center Beam Intensity Benchmark Tool**

Please be advised that early versions of this tool contained an error; the correct version of the center beam intensity benchmark tool should have “Log CBCP Two-sigma Lower Bound” for both PAR and MR lamps. Partners are strongly encouraged to dispense with any saved earlier versions of the calculator, which would include “Log CBCP One-sigma Lower Bound” in spreadsheet cell H37. If you have only accessed the calculator online you may need to clear your browser cache and temporary files to ensure you view the most recent version. The target lamp data entered into the benchmark tool must be from an existing incandescent or halogen lamp currently sold in the market. Manufacturer must provide proof of this target lamp to their Certification Body.

## Appendix F: Product Variations, Equivalency Claims, Lighting Facts Labels

### Product Variations

Any variation in lamp design that impacts the performance of the lamp is considered a new, separate product and therefore must be tested in accordance with all requirements detailed in the specification. EPA will permit the use of long term lumen maintenance data and rapid cycle data across multiple model numbers which vary only in paint color and/or beam angle. Variations in paint shall be limited to color/pigmentation only; lumen maintenance data may not be applied across multiple models which employ variations in the type of paint employed. To apply lumen maintenance and rapid-cycle data across multiple models which vary only in paint color/pigmentation, EPA will require submission of in-situ temperature measurements of each of the models in question (refer to specification for in-situ temperature measurement details).

The use of long term lumen maintenance and rapid cycle data across multiple models which vary only in beam angle will be permitted so long as the variation between models is limited to the dimensions of the secondary optics (e.g. lens thickness, refractor patterns), and so long as these changes do not have a measureable negative effect (not more than + 1.1°C) on original in-situ temperature measurements. Variations in secondary optic material will not be permitted. To apply lumen maintenance and rapid cycle data across multiple models which vary only in beam angle, EPA will require the following to be submitted:

- in-situ temperature measurements of each of the models in question (refer to specification for in-situ temperature measurement details)
- a signed statement on the partner company's letterhead stating that there are no material variations between the models in question except for the dimensions of the secondary optics

### Variations in Lamp Base

Lamps with the same bill of materials but alternate lamp bases may share test data if *in situ* testing demonstrates that the alternate lamp base has no measureable negative effect at the TMP. The *In Situ* Temperature Measurement Test detailed in Appendix D shall be used to establish that the variation in lamp base does not increase the temperature at the TMP more than + 1.1°C.

### Equivalency Claims

The Integral LED Lamp specification does not set tolerances for performance requirements, and does not allow for the rounding of values. However, for product packaging, equivalency claims to replace incandescent and halogen products will be evaluated based on reported test values, with one exception; directional LED lamps that are intended to replace incandescent and halogen lamps which themselves may leverage tolerances detailed in ANSI C78.379-2006 sections 4.1 and 4.3. These same tolerances may be considered in the evaluation of LED lamp packaging claims for ENERGY STAR qualification. For the U.S. Department of Energy (DOE) Lighting Facts™ label, partners may use tolerances outlined by the DOE Lighting Facts program and report rounded performance values on packaging.

### Lighting Facts Labels

Manufacturers of medium screw-base lamps shall choose which label to place on their packaging: the DOE or FTC label until the January 1, 2012 effective date, when only the FTC label will be permitted on packaging of medium screw base lamps. While manufacturers may elect to use the DOE label on packaging of LED lamps until the effective date of the FTC-mandated label for medium screw-base lamps, EPA strongly encourages the use of the FTC label on medium screw-base lamps from the start to minimize confusion in the marketplace. The DOE Lighting Facts label may still be used on materials other than product packaging, such as cut sheets, promotional literature, and web sites after the FTC effective date.

ENERGY STAR qualified LED lamps with base types other than medium screw-base are not affected by the FTC requirement, and must still use the DOE Lighting Facts label on packaging. The Lighting Facts label must be generated through [www.lightingfacts.com](http://www.lightingfacts.com) prior to applying for ENERGY STAR qualification. Specific questions about Lighting Facts should be directed to [info@lightingfacts.com](mailto:info@lightingfacts.com).