



ENERGY STAR® Program Requirements for Integral LED Lamps DRAFT 1-16-09

Scope

These criteria apply to integral LED lamps¹, 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 intended to replace standard general service incandescent lamps of 25 watts or greater, decorative (candelabra style) lamps, and standard reflector lamps of 20 watts or greater, as well as non-standard lamps. These criteria are not applicable to LED lamps intended to replace linear fluorescent or high-intensity discharge (HID) lamps.

All Lamps

Lamp Requirements:	
Correlated Color Temperature (CCT)	Lamp must have one of the following designated CCTs (per ANSI C78.377-2008) and fall within the 7-step chromaticity quadrangles as defined in the Appendix.
	<u>Nominal CCT</u>
	2700 K
	3000 K
	3500 K
	<u>CCT (K)</u>
	2725 ± 145
	3045 ± 175
	3465 ± 245
Color Spatial Uniformity	The variation of chromaticity in different directions (i.e., with a change in viewing angle) shall be within 0.004 from the weighted average point on the CIE 1976 (u',v') diagram.
Color Maintenance	The change of chromaticity over the lifetime of the product shall be within 0.007 on the CIE 1976 (u',v') diagram.
Color Rendering Index (CRI)	Minimum CRI of 80.
Dimming	Must be dimmable. Specific requirements: TBD
NOTE:	DOE intends to require ENERGY STAR qualified SSL replacement lamps to be dimmable. Please see cover letter accompanying this draft for discussion of dimming questions for stakeholders.

¹ ANSI/IESNA RP-16-05, Addendum "a". IESNA. 2008.

Warranty	A warranty must be provided for lamps, covering repair or replacement for a minimum of three (3) years from the date of purchase. The written warranty must be included with the lamp packaging at the time of shipment.
Thermal Management	Lamp manufacturers shall adhere to LED package manufacturer guidelines, certification programs, and test procedures for thermal management.
Lumen Maintenance	Lamps shall deliver at least 70% of initial lumens for at least 25,000 hours.
Allowable Lamp Bases	Must be a lamp base listed in ANSI_ANSLG Standard C81.61-2007.
Power Factor	≥ 0.70
Minimum Operating Temperature	Power Supply shall have a minimum operating temperature of -20°C or below.
Output Operating Frequency	≥ 120 Hz Note: 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.
Electromagnetic and Radio Frequency Interference	Power supplies designated by the manufacturer for residential applications must meet FCC requirements for consumer use (FCC 47 CFR Part 18 Consumer Emission Limits).
Noise	Power supply shall have a Class A sound rating.
Transient Protection	Power supply shall comply with IEEE C.62.41-1991, 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.
Operating Voltage	Lamp shall be operable within a range of 110 to 130 volts, inclusive.

Packaging Requirements

Packaging Requirements	
Warranty	Product packaging must state "Warranty" or "Limited Warranty" and have a toll-free (e.g., "800") number, or mailing address, or web site address (<i>if applicable</i>) for consumer complaint resolution.
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	Lamp package <u>must clearly state</u> any known incompatibility with photo controls, dimmers or timing devices. In addition, packaging should state specific applications exceptions.
Product Equivalency Claims (for Replacement Lamps)	For replacement lamps, product packaging and marketing material must be consistent with ANSI standard lamp type indicated on ENERGY STAR product application. For example, an integral LED lamp approved by ENERGY STAR as a replacement for a 40W PAR30 halogen incandescent lamp may not claim equivalency to a higher wattage lamp or to a different lamp type.
Lighting Facts™ Label	Manufacturers must use the Lighting Facts label that is part of the DOE Quality Advocates program.

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. In addition to the requirements above, the following performance and information requirements apply to Non-standard Lamps.

Non-Standard Lamp Requirements	
Minimum Luminous Efficacy	55 lumens per watt (lm/W)
Minimum Light Output	400 lumens
Luminous Intensity Distribution	No specific distribution is required. Must submit goniophotometer report (based on LM-79-08 test procedure) showing luminous intensity distribution produced by the lamp.
Intended Applications	Product submission materials must indicate lighting applications and fixture types for which the non-standard lamp is intended.

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.

Minimum performance and dimensional criteria are provided below for omnidirectional, decorative, and directional lamp replacements.

Omnidirectional Lamp Requirements

Applicable lamp types	For LED lamps intended to replace the following ANSI standard lamp types (ANSI C79.1-2002): A, G, P, PS, S	
Minimum luminous efficacy	55 lumens per watt (lm/W)	
Minimum light output	Lamp shall have minimum light output (total luminous flux) at least corresponding to the target wattage of the lamp to be replaced, as shown below. Target wattages in between the given levels may be interpolated.	
	Nominal wattage of lamp to be replaced (watts)	Minimum light output of LED lamp (lumens)
	25	250
	40	450
	60	800
	75	1,100
Luminous intensity distribution	Products shall have an even distribution of luminous intensity within the 0° to 150° zone (axially symmetrical). Luminous intensity at any angle within this zone shall not differ from the mean luminous intensity for the entire 0° to 150° zone by more than 10%.	
Maximum lamp diameter	Equal to target lamp diameter.	
Maximum overall length (MOL)	Not to exceed MOL for target lamp as per ANSI C78.20-2003.	

Decorative Lamp Requirements

Applicable lamp types	For LED lamps intended to replace the following ANSI standard lamp types (ANSI C79.1-2002): B, BA, BT, C, CA, DC, F	
Minimum luminous efficacy	45 lumens per watt (lm/W)	
Minimum light output	Lamp shall have minimum light output (total luminous flux) equal to the target wattage of the lamp to be replaced multiplied by 10.	
Maximum lamp diameter	Equal to target lamp diameter.	

Directional Lamp Requirements

Applicable lamp types	<p>For LED lamps intended to replace the following ANSI standard lamp types (ANSI C79.1-2002):</p> <p>BR, ER, K, MR, PAR, R</p> <p>For MR and PAR lamps, the following lamp diameters are included at this time:</p> <p>MR16, PAR16, PAR20, PAR30S, PAR30L, PAR38</p>						
Minimum luminous efficacy	45 lumens per watt (lm/W)						
<p>Minimum center beam intensity² – PAR and MR16 lamps</p>	<p>Models based on statistical analysis of 432 PAR and 284 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 for PAR lamps is within two standard deviations of the center beam intensity predicted by the PAR model. For MR16s the required minimum is within one standard deviation.</p> <table border="1"> <thead> <tr> <th>Lamp family</th> <th>Functions</th> </tr> </thead> <tbody> <tr> <td>PAR</td> <td> http://www.drintl.com/temp/ESIntLampCenterBeamTool.xls Please enter the following information into the online tool: <ol style="list-style-type: none"> 1. PAR diameter in eighths of an inch (i.e., 16, 20, 30, 38) 2. Target lamp nominal wattage 3. Target lamp beam angle in degrees </td> </tr> <tr> <td>MR16</td> <td> http://www.drintl.com/temp/ESIntLampCenterBeamTool.xls Please enter the following information into the online tool: <ol style="list-style-type: none"> 1. Target lamp nominal wattage 2. Target lamp beam angle in degrees </td> </tr> </tbody> </table>	Lamp family	Functions	PAR	http://www.drintl.com/temp/ESIntLampCenterBeamTool.xls Please enter the following information into the online tool: <ol style="list-style-type: none"> 1. PAR diameter in eighths of an inch (i.e., 16, 20, 30, 38) 2. Target lamp nominal wattage 3. Target lamp beam angle in degrees 	MR16	http://www.drintl.com/temp/ESIntLampCenterBeamTool.xls Please enter the following information into the online tool: <ol style="list-style-type: none"> 1. Target lamp nominal wattage 2. Target lamp beam angle in degrees
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NOTE:	<p>Minimum beam requirements for directional lamps are designed to ensure integral LED replacement lamps will perform similarly to the incandescent or halogen lamps they are intended to replace (i.e., the target lamp). For commercially available halogen PAR and MR16 lamps, a statistically robust relationship exists among lamp wattage, beam angle, and center beam intensity. Mathematical functions for each lamp type (PAR and MR16) are provided to indicate the minimum center beam intensity required for LED replacement lamps, based on target lamp wattage and beam angle.</p>						

² ANSI C78.379-2006, Revision of ANSI C78.379-1994 plus C78.379a-1997. American National Standard for electric lamps – Classification of the Beam Patterns of Reflector Lamps. Section 3.2, Definitions, page 6.

Minimum light output – BR, ER, K, and R lamps	Lamp shall have minimum light output (total luminous flux) equal to the target wattage of the lamp to be replaced multiplied by 10.
Luminous intensity distribution – BR, ER, K, and R lamps	BR, ER, K, and R lamps are required to state the beam distribution in terms of Spot, Narrow Flood, or Flood, defined as follows: Spot: 10°-20° beam angle Narrow flood: 20°-30° beam angle Flood: >30° beam angle
Maximum lamp diameter	Equal to target lamp diameter.
Maximum overall length (MOL)	BR, ER, PAR, R lamps: Not to exceed MOL for target lamp as per ANSI C78.21-2003.
NOTE:	MR16 lamps are used in low voltage and line voltage applications. Direct replacement of halogen MR16s in existing low voltage systems using electronic transformers can result in failure to meet minimum load requirements. DOE seeks stakeholder input on how to address this issue. Please see the cover letter for additional information.

Testing Requirements

Testing Requirements	
Light Output	Photometric measurement using LM-79-08 test procedures.
LED Lumen Maintenance	Minimum 6,000 hour data for the LED package(s)/array(s)/module(s) used in the integral LED lamp.
Integral LED Lamp Lumen Maintenance and Reliability	Minimum 6,000 hours with at least 10 samples tested under elevated temperature conditions. Average lumen maintenance of the 10 samples tested must be greater than 91.8% after 6,000 hours of operation, and no more than 3 individual samples can have a lumen output less than [87%].
NOTE:	DOE intends to require lumen maintenance and reliability testing for integral LED lamps as part of the ENERGY STAR qualification and ongoing quality assurance processes. DOE seeks stakeholder input on how to verify long term lumen maintenance and reliability of integral LED lamps. Please see the cover letter for additional discussion of this issue.