

SuperBulbs' Recommendations for ENERGY STAR Program Requirements for Integral LED Lamps (DRAFT 1-16-09)

Prepared by the Staff of SuperBulbs™, Inc., February 26, 2009

General

Many of these specifications may be met at nominal line voltage of 120VAC and not at other line voltages; or may be met at lower than nominal, but not at 120VAC. Many of the Recommended Wordings below attempt to account for this.

Scope

We believe that it will be possible to build LED lamps without “an integrated LED driver”, using, for example, AC LEDs. These words should be removed from the scope to ensure coverage of this type of lamp.

Recommended wording:

These criteria apply to integral LED lamps, defined as a lamp with LEDs and an ANSI standardized base designed to connect to the branch circuit via an ANSI standardized lampholder/socket.

All Lamps, Lamp Requirements

Correlated Color Temperature (CCT)

The market currently has incandescent bulbs with CCT of 4100K (daylight white). It seems that lamps with this CCT ought to be allowed to qualify for Energy Star.

Recommended Wording:

<i>Nominal CCT (K)</i>	<i>CCT(K)</i>
2700	2725 \pm 145
3000	3045 \pm 175
3500	3465 \pm 245
4100	4065 \pm 355

Color Spatial Uniformity

The Color Spatial Uniformity requirement, being applicable to all bulbs in the specification, does not specifically call out the angle over which the requirement is applicable. It should be moved to the individual lamp type sections, and specified the same way Luminous Intensity Distribution is for each type.

Additionally, there is some lack of clarity about the meaning of the variation being 0.004. The wording should be clear that what is meant is that the variation shall be $(u'_{WAP} \pm 0.004, v'_{WAP} \pm 0.004)$.

We'd also like to express some concern about the meaning of the "150° zone". If this is intended to be $\pm 75^\circ$, then we think that this is to narrow a beam to replace an A lamp, and should be at least $\pm 120^\circ$.

Products shall have a uniform spatial color distribution within the 0° to 150° zone (axially symmetric) when operated at nominal line voltage of 120VAC. The variation of chromaticity in different directions (both cylindrically and azimuthally) shall be not more than $(u'_{WAP} \pm 0.004, v'_{WAP} \pm 0.004)$ from the weighted average point (WAP) on the CIE 1976 (u', v') diagram.

Color Maintenance

The Color Maintenance requirement should be reworded to follow the wording recommended for Color Spatial Uniformity, above.

Recommended wording:

The change of color over the lifetime of the product shall be not more than $(u'_{WAP} \pm 0.007, v'_{WAP} \pm 0.007)$ on the CIE 1976 (u', v') diagram.

Color Rendering Index (CRI)

There are various proposals being circulated for improvement in measurement of CRI, and so the particular version being used should be specified, presumably CIE 1995.

It is possible to have a high CRI without having good color rendition. While there is no accepted method of dealing with this, the area in which most present-day LEDs have problems is with strong red, R9. Specifying R9 to be also ≥ 80 would be a step in the right direction.

Recommended wording:

Products shall have a Color Rendering Index (CRI) ≥ 80 as measured by CIE 1995, when operated on nominal line voltage of 120VAC. Products shall also have R9 ≥ 80 as measured by CIE 1995 under the same conditions.

Dimming

We have seen a number of bulbs whose performance suggests that it may be difficult to specify desired performance. For example, some dimmable bulbs have jumps in brightness somewhere in the dimming range. Others reach 20% of initial brightness when starting out bright and decreasing brightness, but don't turn back on when starting to dim until more than 20% is reached. All of these behaviors should be prohibited.

It is also not clear how a 20% number is to be measured. While it could be construed as being 20% of full brightness, bulbs on dimmers at full brightness are not as bright as they are when not on a dimmer (this includes incandescents). 20% as measured in an integrating sphere corresponds to approximately 45% in perceived brightness. To clarify the testing and produce a reasonable user experience, we recommend that the test be specified at 20% of the dimmer slide or knob position (or the lowest setting in a discrete level dimmer).

Products shall meet the following requirements:

- Must be compatible with at least three (3) widely available residential dimmers.

- Must be continuously dimmable from the 100% setting of the dimmer to less than the 20% setting of the dimmer for continuous dimmers, or to the lowest setting on dimmers with discrete steps. Within this range, the product shall continuously produce light, and there shall be no visible flickering and no visible discrete jumps in brightness. Must also meet the same criteria when turned on at the 20% setting, or the lowest setting on dimmers with discrete steps, and increasing to the 100% setting.

Thermal Management

It is our opinion that this section is unnecessary. As long as the Warranty requirements are met, adherence to guidelines, certification programs and test procedures are irrelevant and should not be specified, for the LEDs the same as for other electronic components contained within the product. This section should be removed.

Minimum Operating Temperature

It's not clear that products need to start at low temperature, as opposed to merely operating there once on. Further, it should not be the power supply which is specified, but rather the lamp.

Recommended wording:

Product shall have a minimum starting and operating temperature of -20 °C or below when used in luminaires intended for outdoor applications at 120VAC.

Output Operating Frequency

We presume that what is being referred to is not the switching frequency of the power supply, but rather the possibility of asymmetry in light output between adjacent half-cycles of the power line.

Recommended wording:

Products shall not show visible differences in light output during adjacent half-cycles of the line voltage, nor at any lower frequency. This shall also be true on dimmers specified in “Dimming” and at all light levels specified therein.

Electromagnetic and Radio Frequency Interference

The entire bulb should pass EMI, not just the power supply. Additionally, dimmers are very EMI noisy devices, and it is common to certify compliance for devices only when they are operated on a non-dimming circuit. The specification, to be clear, should call out both radiated and conducted emissions.

Recommended wording:

Products designated by the manufacturer for residential applications must meet both the conducted and radiated requirements of FCC 47 CFR Part 18/Consumer Emission Limits when operated on a non-dimming circuit.

Noise

The current specification refers only to power supply noise. However, this product may have fans or other mechanical devices in it not directly affiliated with the power supply. The specification should be extended to cover the entire product.

Recommended wording:

Product shall have a noise level not to exceed 30dBA when operated at 120VAC.

Transient Protection

These products are two-wire systems, and thus “common-mode” doesn’t make sense: Common-mode refers to the two power wires with respect to a third wire, typically ground, which doesn’t exist for light bulbs.

Recommended wording:

Product shall comply with IEEE C.62.41-1991, Class A operation. The line transient shall consist of seven strikes of a 100KHz ring wave, 2.5KV level, after which the product shall continue to function normally.

Operating Voltage

Power supply engineers have found over the years that the AC line is a hostile environment for electronics, and special care needs to be taken with devices attached to the line. To start with, 120VAC is nominal voltage only; a bulb should certainly work over the $\pm 10\%$ range that all electronic devices do. Further, during brown-outs, line voltage may sit at reduced voltages for protracted periods; poorly designed power supplies sometimes fail in this environment.

Recommended wording:

Products shall be capable of normal operation on 120VAC circuits. The products shall not be damaged by continuous operation at any voltage in the range 0-132VAC.

Safety Ratings

Energy Star certified lamps should be safe. A section should be added on safety ratings.

Recommended wording:

Lamps shall meet applicable safety ratings for self-ballasted lamps.

Non-Standard Lamps

Minimum Luminous Efficacy

Since LEDs dim with age, presumably this measurement is to be taken shortly after production. Furthermore, LEDs lose efficacy as they warm, and this specification presumably is meant to be taken after the lamp has reached its steady-state temperature.

Recommended wording:

Lamp shall have a minimum luminous efficacy of 55 Lumens per Watt after reaching steady-state temperature at nominal line voltage of 120VAC, and after an initial burn-in of 100 hours.

Minimum Light Output

As in the section on Minimum Luminous Efficacy. It should be observed that lamps with power factor correction may have a light output that depends on line voltage.

Recommended wording:

Lamp shall have a minimum light output at nominal light voltage of 120VAC of 400 Lumens after reaching steady-state temperature, and after an initial burn-in of 100 hours.

Omnidirectional Lamp Requirements

Minimum Luminous Efficacy

Since LEDs dim with age, presumably this measurement is to be taken shortly after production. Furthermore, LEDs lose efficacy as they warm, and this specification presumably is meant to be taken after the lamp has reached its steady-state temperature.

Recommended wording:

Lamp shall have a minimum luminous efficacy of 55 Lumens per Watt after reaching steady-state temperature at nominal line voltage of 120VAC, and after an initial burn-in of 100 hours.

Minimum Light Output

Comments as in the section on Minimum Luminous Efficacy.

Recommended wording:

Lamp shall have a minimum light output at least corresponding to the target wattage of the lamp to be replaced, as shown below, at nominal line voltage of 120VAC after reaching steady-state temperature, and after an initial burn-in of 100 hours. Target wattages in between the given levels may be interpolated.

Luminous Intensity Distribution

For clarity, 10% should be $\pm 10\%$. Since there are two angular coordinates, this should be explicitly called out. We'd also like to express some concern about the meaning of the "150° zone". If this is intended to be $\pm 75^\circ$, then we think that this is to narrow a beam to replace an A lamp, and should be at least $\pm 120^\circ$.

Recommended wording:

Products shall have an even distribution of luminous intensity within the 0° to 150° zone (axially symmetrical). Luminous intensity in different directions (both cylindrically and azimuthally) shall not differ from the mean luminous intensity for the entire 0° to 150° zone by more than $\pm 10\%$.

Color Spatial Uniformity

This section should be moved here from All Lamps, Lamp Requirements section, as noted above.

Maximum Lamp Diameter

This should mirror the wording in Maximum Overall Length.

Recommended wording:

Not to exceed lamp diameter for target lamp as per ANSI C78.20-2003.

Testing Requirements

LED Lumen Maintenance

This requirement seems unnecessary, given the Lamp Lumen Maintenance requirement. We recommend it be deleted.