

December 19, 2009

Dear Energy Star Stakeholders:

DOE is pleased to announce publication of the ENERGY STAR® Program Requirements for SSL Luminaires, version 1.1. This revision provides performance criteria for SSL-dedicated luminaires for use in several new lighting applications. It does not change the performance requirements for the Category A applications included in version 1.0. DOE issued draft criteria for the proposed Category A additions on August 15, 2008, with stakeholder comments invited through September 15, 2008. A total of 173 comments were received from 159 individuals, nine manufacturers or manufacturers' associations, and four government or utility program sponsors. All comment letters received are posted online at http://www.energystar.gov/index.cfm?c=new_specs.ssl_luminaires.

This letter summarizes how version 1.1 differs from version 1.0; identifies several changes in the final criteria for the Category A additions relative to the August 15, 2008 draft; explains DOE's overall approach in setting efficacy and performance requirements for the Category A additions; and responds to stakeholder questions and comments, explaining DOE decisions on key issues.

HOW DOES VERSION 1.1 DIFFER FROM VERSION 1.0?

This revision provides performance criteria for several new lighting applications. It does not change the performance requirements for the Category A applications included in version 1.0, nor does it change the global requirements applying to all luminaires. The document has been updated in the following ways:

- 1) References to industry standards have been updated to reflect current status.
- 2) Category A has been divided into Residential Applications and Non-Residential Applications.
- 3) New Category A applications have been added. These include the following additions:
 - a. Residential: Ceiling-mounted luminaires with diffusers, Cove lighting, Surface-mounted luminaires with directional heads, and Outdoor pole/arm-mounted decorative luminaires. In addition, the Recessed downlight category was expanded to include Surface and pendant-mounted downlights.
 - b. Non-Residential: Wall wash luminaires, and Bollards. The same addition of Surface and pendant-mounted downlights was added to Recessed downlights for non-residential application.
- 4) Explanatory text boxes throughout the version 1.0 document were updated or deleted.
- 5) The Lumen Maintenance Qualification (pg 16 of the 1.1 document) was updated to explain the required 6,000 hour lumen maintenance minimum thresholds, based on the new LM-80-08 test procedure.

- 6) The section on Qualification Procedures (pg 18) has been updated to provide links to the ENERGY STAR Manufacturer's Guide for Qualifying SSL Luminaires, and to the Instructions for Partnering with ENERGY STAR.
- 7) The Definitions section (pg 20) has been updated to be consistent with ANSI/IES RP-16-05, Addendum a, "Nomenclature and Definitions for Illuminating Engineering".

KEY CHANGES FROM AUG 15 DRAFT TO FINAL CRITERIA FOR CATEGORY A ADDITIONS

Several applications included in the August 15, 2008 draft Category A additions document do not appear in the version 1.1 document. Stakeholder comments and DOE analysis indicate additional time is needed to finalize criteria for these applications to: a) ensure energy savings of ENERGY STAR qualified SSL luminaires relative to conventional lighting technologies; and b) to address the wide range of luminaire types and design considerations for these applications. These applications are the following:

- Outdoor pole/arm-mounted area and roadway luminaires
- Outdoor wall-mounted area luminaires ("wall packs")
- Circular or square parking garage luminaires
- Cove lighting – asymmetric distribution

DOE plans to issue revised draft criteria for these applications early in 2009, providing for a second stakeholder review and comment period before finalizing these criteria.

OVERALL APPROACH

Requirements for the original applications included in Category A (ENERGY STAR for SSL Luminaires, version 1.0, effective Sept 30, 2008) were established such that qualified SSL-dedicated luminaires would be at least as energy efficient as similar luminaires using compact fluorescent lamps, in terms of luminaire efficacy. Since the time these criteria were developed (they were published Sept 12, 2007) LED light output, efficacy, and other performance attributes have improved significantly, and new applications and products have appeared on the market. To keep pace with changing technology, and consistent with ENERGY STAR program objectives, minimum luminaire efficacy requirements for the Category A additions are higher than requirements for the original Category A applications. In general, DOE has applied the principles outlined below in setting these criteria.

1. Qualified SSL luminaires will offer significant energy savings over dominant incumbent lighting technology. While incandescent is still the dominant incumbent technology in residential applications, DOE has benchmarked luminaire efficacy performance to CFL performance, and then added an adjustment factor with the objective to be significantly more energy efficient than CFL-based luminaires. This is in recognition of the changing baseline in residential lighting: CFLs are now estimated by the National Electrical Manufacturers Association to be in 25% of residential lighting

sockets, a share that is likely to grow in response to current and pending local, federal, and international regulations affecting incandescent lamp performance and sales. Further, LED device efficacy continues to improve, and well-designed LED luminaires are capable of meeting higher efficacy requirements.

DOE established luminaire efficacy requirements for each Category A additional application such that qualified LED luminaires will be approximately 20% more efficacious than luminaires with the most commonly used incumbent technology for the application.

2. Minimum light output requirements are established to help ensure end-user satisfaction with early SSL products, while allowing for optimal luminaire design to meet application lighting needs most efficiently both in terms of wattage and system cost. Given the wide range of lighting applications and design needs, particularly in non-residential categories, DOE has considered the lowest power conventional lamp source appropriate for the application in setting minimum light output requirements for each application. For conventional light sources, luminous efficacy typically increases as wattage increases; low-wattage lamps are usually less efficacious than higher wattage lamps. In contrast, LEDs are able to maintain high luminous efficacy even at low wattages, providing a higher-efficacy alternative for lighting applications best served by small “lumen packages.”

3. Zonal lumen density requirements are established to help ensure energy savings from appropriate design to exploit the directional nature of LEDs and to ensure end-user satisfaction with qualified luminaires. These requirements are based on analysis of the photometric performance of high-quality conventionally-lamped luminaires for each application, and seek to match or improve upon these distributions.

RESPONSES TO STAKEHOLDER COMMENTS

Several key issues were identified by stakeholders. These are categorized below and a brief explanation of how DOE has responded to these issues is provided for each item.

1. Category names and definitions – clarification of the luminaire categories is needed; in some cases, there appears to be overlap between categories.

RESPONSE: DOE has made a clearer distinction between residential and non-residential applications, which addresses most of the confusion cited by stakeholders. Additionally, several of the category names have been revised to be less restrictive with regard to luminaire shape/form factor. For example, “Circular or square wall wash luminaires” has been changed to “Wall wash luminaires.”

2. Minimum light output requirements – several stakeholders were concerned that the minimum light output requirements for some applications were too high, and did not account for the possibility that lighting requirements could be met with lower light output.

RESPONSE: In several cases, minimum light output levels have been decreased in conjunction with better defining the luminaire category as intended for residential or non-residential settings. These cases include Cove lighting and Outdoor pole/arm-mounted decorative luminaires. In other cases, (for example, “Surface-mounted luminaires with directional heads”) the minimum light output requirement has been revised downward to allow for lower lumen package solutions. In setting these levels, DOE has considered the lowest wattage conventional lamp source appropriate for the application.

3. Color requirements – several stakeholders suggested allowing 4100K CCT sources for ceiling-mounted luminaires with diffusers and surface and pendant-mounted downlights.

RESPONSE: As part of the clarification and delineation of the application categories, these two lighting applications have been limited to residential application at this time. DOE has limited allowable CCTs for all interior residential applications (with the exception of Portable desk task lights) to 2700K, 3000K, and 3500K. This is to help ensure consumer satisfaction with residential lighting products, responding to lessons learned from CFL market development. Also, for all applications, allowable CCTs must be one of those identified on page 4 of the v. 1.0 document (the relevant portion of the table is reprinted below for reference); defined in ANSI Standard C78.377-2008. For some applications, a sub-set of these CCTs is allowed; this is noted specifically for those applications. If limited CCTs are not specifically listed for an application, it means that the CCT must be one of the eight CCTs defined by ANSI C78.377-2008.

| <u>ANSI C78.377-2008</u> | <u>Tolerance</u> |
|--------------------------|------------------|
| <u>Nominal CCT</u> | <u>CCT (K)</u> |
| 2700 K | 2725 ± 145 |
| 3000 K | 3045 ± 175 |
| 3500 K | 3465 ± 245 |
| 4000 K | 3985 ± 275 |
| 4500 K | 4503 ± 243 |
| 5000 K | 5028 ± 283 |
| 5700 K | 5665 ± 355 |
| 6500 K | 6530 ± 510 |

Color requirements (continued) – Several comments questioned the apparent lack of CRI requirements for the Category A additions.

RESPONSE: The CRI minimum requirement was established in the v 1.0 criteria document (page 4). This requirement remains unchanged with regard to the Category A additional applications. It is as follows: indoor luminaires shall have a minimum CRI of 75.

4. LM-80 – Stakeholders raised questions regarding the status of LM-80 and concerns about whether LM-80 would include an extrapolation methodology to predict lumen maintenance.

RESPONSE: On Sept 23, 2008 the IESNA formally adopted LM-80-08, “Approved Method for Measuring Lumen Maintenance of LED Light Sources.” LM-80-08 does not include a method for predicting lumen maintenance beyond the test period (at least 6,000 hours); therefore, DOE’s requirement for lumen maintenance does not require LED package manufacturers to apply a curve-fit to the data collected via LM-80-08. Rather, DOE established 6000 hour lumen maintenance thresholds of 91.8% (for residential indoor applications) and 94.1% (for non-residential and all outdoor applications). These points lie on exponential decay functions that cross a 70% lumen maintenance threshold at 25,000 and 35,000 hours, respectively.

DOE verifies qualifying luminaires meet this requirement through three steps:

- a) Review the LM-80 test for the LED package, array, or module; this shows actual lumen maintenance after 6,000 hours of operation at three distinct temperatures.
- b) Review temperature measured at the manufacturer-designated temperature measurement point (TMP) on the LED package, array, or module as installed in the luminaire; this measurement is taken concurrent with UL testing, with the luminaire installed *in situ* in the appropriate environment as defined in UL Standard 1598 (for hard-wired fixtures) or UL 193 (for portable fixtures).
- c) Using the measured TMP temperature, verify that the 6,000-hour lumen maintenance for that temperature (or the next higher temperature for which LM-80-08 data is available) is at least 91.8% or 94.1%, depending on the application requirement.

5. Minimum luminaire efficacy – Stakeholder comments regarding minimum luminaire efficacy included suggestions to a) lower required efficacy, b) relate required efficacy to CCT, c) instead require maintained or end-of-life efficacy, and d) use a different metric, such as watts per footcandle.

RESPONSE: a) DOE established minimum luminaire efficacy levels as described under Overall Approach above. In several cases, the requirement was lowered due to the delineation between residential and non-residential applications. For example, the August 15, 2008, draft criteria required 56 lm/W luminaire efficacy for cove lighting - asymmetric distribution, based on a linear fluorescent benchmark for commercial lighting applications. The revised document includes cove lighting among the residential applications; the luminaire efficacy requirement has been lowered to 45 lm/W to reflect the lower efficacy benchmark technology for residential settings.

b) DOE did not provide for different minimum luminaire efficacy levels depending on CCT. Requirements were set to ensure energy savings compared to incumbent technology, while meeting lighting quality expectations for end-users. On-going improvement in efficacy and performance of warm-white LEDs indicates required luminaire efficacy levels are achievable with well-designed luminaires.

c) DOE verifies initial luminaire efficacy through the LM-79-08 photometric test procedure. Further, lumen maintenance for the LED devices used is verified through the LM-80-08 test procedure, combined with *in situ* verification of the LED temperature once installed in the luminaire, concurrent with UL testing. DOE is not aware of any industry standard test procedure available to verify maintained or end-of-life luminaire

efficacy. Further, LED luminaires may be designed for different useful lifetimes and lumen maintenance levels, depending on the needs of the application, precluding a universal maintained luminaire efficacy requirement.

d) DOE adopted the luminaire efficacy metric as the basis for the ENERGY STAR for SSL program because it is accurate and independently verifiable. Watts per footcandle is an application-specific metric, depending on proximity to the illuminated surface, surface reflectances, and other factors that cannot be consistently or independently verified at the luminaire level.

DOE appreciates the level of stakeholder interest and detailed comments received on the Category A additions. These criteria will take effect February 1, 2009. Thank you for your continued support of the ENERGY STAR program.

Sincerely,

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U.S. Department of Energy