



**Department of Energy**  
Washington, DC 20585

September 18, 2009

Dear ENERGY STAR Stakeholders:

Please find attached revised criteria for ENERGY STAR Integral LED Lamps. DOE published the first draft of these criteria January 16, 2009 and invited stakeholder comments through February 27, 2009. DOE received 26 comment letters during the first review and comment period. The second draft was published May 19, 2009, with stakeholder comments received through June 26, 2009. Comments on draft 2 were received from 13 organizations and individuals. The attached third draft criteria reflect significant input from industry and the energy efficiency community.

This letter summarizes stakeholder feedback received on the second draft document, explains DOE's approach to addressing several key issues identified for particular stakeholder engagement, and identifies specific changes to technical requirements made in response to stakeholder feedback and/or additional technical analysis and data gathering.

**KEY ISSUES**

The following issues presented challenges to integral LED lamps intended to replace traditional light sources, primarily due to limitations of the incumbent lighting infrastructure and industry standards, relative to rapidly evolving LED technology.

**1. Dimming**

In the second draft, DOE proposed allowing both dimmable and non-dimmable lamps to be eligible to earn the ENERGY STAR. Most stakeholders supported this approach in the near term, although several re-emphasized the importance of dimming to meeting consumer preferences.

Stakeholder feedback also reiterated the need for industry standards to address dimmer compatibility issues. DOE continues to engage with the NEMA Lighting Controls and Solid State Lighting Sections, and the ANSI 82.04 LED Drivers committee, having retained an industry expert specifically to work with these committees and accelerate the development of industry consensus standards addressing this topic. This process is expected to proceed over the remainder of 2009 and into 2010.

As proposed in draft 2, the revised criteria allow for both dimmable (including continuous, three-way and other step dimming) and non-dimmable integral LED lamps to

earn the ENERGY STAR. Manufacturers will be required to clearly label their lamps as dimmable or non-dimmable, maintain a webpage containing dimmer compatibility information for consumers, and include a cautionary label on product packaging indicating potential compatibility limitations on existing dimmers and providing the dimmer page URL for up-to-date information.

## **2. Non-Standard Lamps**

Stakeholder feedback on the Draft 2 requirements for non-standard lamps suggested differentiating by lamp power for luminous efficacy requirement. This was based on the argument that non-standard LED lamps could be effective replacements for low-wattage incandescent lamps for which CFL replacements are typically not available. DOE has responded in the revised draft by requiring efficacy of 50 lumens per watt for lamps less than 10 watts. The efficacy requirement for lamps of 10 watts or higher remains 55 lm/W. In addition, minimum lumens for non-standard lamps was lowered from 400 lumens to 200 lumens, again based on the argument that near-term LED non-standard lamps may be especially good replacements for lower output incandescent lamps; 200 lumens is approximately equivalent to a 25W incandescent lamp, so a lamp meeting these minimum output and efficacy requirements would draw only 4 watts.

## **3. Low-Voltage MR16s**

In Draft 2, DOE proposed the following additional requirements for LED MR16 lamps intended for use on low-voltage fixtures in Draft 2:

- Manufacturers must provide results of in-house testing of their LED MR16 lamps on commercially-available low-voltage transformers.
- Product packaging must identify known incompatibilities.
- Manufacturer must maintain a web page containing low-voltage transformer compatibility and appropriate use information, including description of possible problems and how to address them (“troubleshooting” advice).
- Product packaging must carry a cautionary label indicating the product may not be compatible with all low-voltage lighting fixtures and providing the web page URL for up-to-date information.

Stakeholder comments supported this approach and further asked for DOE to support standardization in this area. No additional changes have been made in Draft 3.

## **4. Reliability Testing**

Expected integral LED lamp life is related to lumen maintenance of the LEDs, as well as overall system reliability. In Draft 2, DOE outlined a series of steps to evaluate lumen maintenance and reliability, and sought additional stakeholder feedback and consensus on the general approach, which includes qualification based on the following sources of information:

- Lumen maintenance (LM-80) test results for the LED packages, arrays, or modules used in lamp.

- Verification of the LED device or module temperature (at manufacturer-designated temperature measurement point or TMP) in the lamp through pre-drilled holes with thermocouples attached.
- Additional long term and reliability testing at elevated temperatures simulating operation in enclosed or insulated fixtures.

Stakeholder feedback supported various levels of life and reliability testing. Several manufacturers thought reliability should be manufacturer-certified, supported by the warranty requirement. Others suggested test conditions and durations which DOE considered carefully in developing the testing requirements. DOE will require at least 6000 hours of lumen maintenance testing of the complete integral lamp under appropriate temperature conditions, in addition to a rapid cycle stress test.

Testing of the full integral lamp assembly is necessary to evaluate the performance of all components contained in the lamp. LM-80 testing of LED packages used in the integral lamps provides some information useful for life estimation, but LM-80 data alone is inadequate. Further, LM-80 data may not be available or applicable for integral LED lamps using multiple LED colors in combination with color mixing optics, reflectors, and/or controls to achieve white light. However, for those lamps using LED packages, modules, or arrays for which LM-80 data is available, DOE has provided an option for interim ENERGY STAR qualification after 3000 hours of lamp testing.

#### **ADDITIONAL CHANGES BETWEEN SECOND AND THIRD DRAFT**

- 1) Minimum Life Requirement -- The integral LED lamp criteria includes products with a wide range of light output (as low as 70 lumens), applications, form factors, and replacement targets (incandescent, halogen, CFL). One lifetime may not be appropriate for all; 25,000 hours may be more than needed for small decorative lamps to effectively replace incandescent, but not long enough for higher performance lamps replacing halogen or CFL.

The minimum life requirements have been revised to: 15,000 hours to 70% lumen maintenance ( $L_{70}$ ) for Decorative lamps (section 7B); 25,000 hours for all other lamp types. At least 6000 hours of lumen maintenance testing is required of all lamps. Longer  $L_{70}$  life may be claimed based on verified lumen maintenance levels after 6000 hours of lumen maintenance testing.

- 2) Omnidirectional Lamps – Luminous Intensity Distribution Requirements  
Draft 2 required the following: “Products shall have an even distribution of luminous intensity within the 0° to 135° zone (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%.”

Stakeholder comments questioned the requirement for uniformity throughout the 0° to 135° zone, pointing out that many incandescent A-type lamps do not meet this degree of uniformity, and that various distributions can meet general lighting

requirements. Others expressed concern that the requirements would allow for no light in the 135° to 180° zone, the area around the base of the lamp, which is needed for table lamps and other applications in which the lamp is positioned base down. Finally, reference was made to European guidelines (EC No. 244/2009) defining directional lamps as all lamps with at least 80% of luminous flux in the 0° to 60° zone and defining all other distributions as non-directional. DOE has responded by adopting the non-directional lamp definition, with an adjustment to help ensure some light in the 90° to 180° zone.

“Products shall have less than 80% of total flux in the 0° to 60° zone and at least 20% of total flux above 90° (lamp in base-up position, with 0° at the nadir). Distribution shall be vertically symmetrical as measured in three vertical planes at 0°, 45°, and 90°.”

- 3) CRI – Industry stakeholders cited the technical difficulty of meeting 80 CRI at high efficacy levels; several suggested CRIs in the 70s instead. In fact, NEMA proposed variable requirements reflecting the relationships among CRI, CCT, and luminous efficacy, including a higher (85) CRI category with lower efficacy requirements. DOE did not adopt this approach, due to the complexity it would add to the program and verification process, as well as product labeling and marketing. DOE has adjusted the minimum CRI requirement to 75 to provide for consistency with the ENERGY STAR SSL Luminaires requirements, and to acknowledge the current challenges for LEDs to meet higher CRI levels while maintaining high efficacy. Further, given the acknowledged limitations of the CRI metric particularly for LEDs, DOE seeks a balance between minimum performance to meet consumer needs and adherence to currently available technical metrics.

However, DOE has also added a requirement that color rendering be reported for deep red (the R<sub>9</sub> metric) in addition to the eight colors comprising the traditional CRI (R<sub>a</sub>). The R<sub>9</sub> value must be greater than 0, a level determined in consultation with NIST. (NOTE: Due to the exaggerated effect of R<sub>9</sub> in the color space used to calculate CRI, a value greater than 0 is sufficient to prevent poor rendering of deep red. For example, a tri-phosphor T8 lamp with CRI (R<sub>a</sub>) of 85 had an R<sub>9</sub> score of 2.)

- 4) Decorative lamps, minimum light output – Draft 2 required minimum light output for decorative lamps to be calculated as:

$$\text{Target incandescent lamp wattage} \times 7$$

Industry stakeholders voiced a preference for a table of minimum values by target wattage, similar to the other lamp categories. Acknowledging the relatively wide variation in low wattage baseline (incandescent) decorative lamps, DOE has adjusted the criteria to accommodate this suggestion, as follows:

Minimum Light Output Requirements for LED Decorative Lamps	
Nominal wattage of lamp to be	Minimum light output of LED

replaced (watts)	lamp (lumens)
10	70
15	90
25	150
40	300
60	500

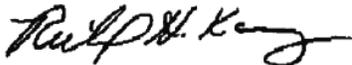
- 5) Document format – the 3<sup>rd</sup> draft has been revised to include testing and laboratory requirements in the criteria tables, similar to the format used in the ENERGY STAR CFL criteria. In addition, the Partner Commitments, Certification, Qualification, Private Labeling, Commercial Packaging, Quality Assurance, and Third Party Testing aspects of the CFL program have been added to the Integral LED Lamps criteria, with modifications as necessary.

## **SCHEDULE**

DOE is providing for a third stakeholder comment period, particularly on the life and reliability testing requirements detailed in this third draft. Please provide comments no later than October 16, 2009 to [ssl@energystar.gov](mailto:ssl@energystar.gov). DOE anticipates publication of the final criteria in early November, with an effective date for the Integral LED Lamp criteria 270 days later (approximately August 2010).

DOE appreciates the on-going level of stakeholder interest in the ENERGY STAR program, and in particular, your substantive input on the integral LED lamp criteria.

Sincerely,



Richard H. Karney, P.E.  
ENERGY STAR Program Manager  
U.S. Department of Energy