February 27, 2009

NGLIA and NEMA Comments on
Draft 1 of Proposed Energy Star Requirements for SSL Replacement Lamps

On behalf of the Next Generation Lighting Industry Alliance (NGLIA and the Solid State Lighting Section of the National Electrical Manufacturers Association (NEMA), thank you for the opportunity to provide comments on the first draft of proposed Energy Star requirements for solid-state lighting (SSL) replacement lamps, released on January 16, 2009. We appreciate the effort that the Department of Energy (DOE) has so far put into developing this proposal and the recognition that much additional work will be required before the Version 1.0 of the requirements can be finalized. We stand ready to assist.

At the outset, we offer the following comments in response to the questions posed in the cover letter that accompanied the proposed program requirements.

Cover Letter Questions

Dimming

Is it possible to define a common protocol for LED products that would ensure acceptable dimming performance on most currently installed residential dimming controls?

The effort needs to be focused on not only what performance parameters are important for dimming functions in general but also the unique or advanced dimming features that LED lamps may have. LED lamps should not be hindered by past technologies.

Is it necessary to transition to new "LED-compatible" dimmers as more LED products come to market?

Dimmers are very popular in many different applications and also can be done in many different ways (0-10V, DMX, DALI, etc.). The majority of the installed base of dimmers is specifically designed to be used with specific incumbent technologies like incandescent. The issue is that the design for the LED replacement lamps may be different and a lot of the dimmers installed will not be a viable option. This is the same thing that CFLs are currently experiencing. One of the largest compatibility issues with dimmers today is a minimum load requirement that a large percentage of dimmers currently have. If this minimum load requirement is not maintained the overall dimmer functionality will not work. For example, a specific LED lamp will work with the existing dimmer switches, but when the dimmer slide switch gets down to a specific level, say 50 percent, the LED bulb will simply shut off.

DOE will want to promote the LED technology but will not to do things like ask the LED manufactures to make lamps to a specific wattage level since that will defeat the purpose of using energy saving lamps. At a bare minimum the DOE should mandate that the labeling and instructions for the current LED products should state what type of dimmers can be used, including if there is none available. During this period industry needs to come together, through

NEMA or another appropriate body, and develop a dimmer specification that provides guidance for both the LED lamp and dimmer manufacturers.

How can DOE and the ENERGY STAR program best facilitate progress and improvement in the area of LED-dimmer compatibility?

The DOE needs to use organizations like NEMA, ANSI to help drive industry to come together and define standards for compatibility, just as has been done in other areas, such as ballasts. There is currently an effort by NEMA in this area.

Non-Standard Replacement Lamps

It needs to be clarified that Non-Standard Replacement Lamp means an LED lamp with (ANSI) standard base but having different form (shape of envelope).

Should luminous intensity distribution requirements be specified for non-standard lamps? Minimum luminous flux levels?

If these non-standard lamps are being marketed as non-standard replacement lamps (intended not to replace existing standard lamp functions), then specifying a minimum flux level is not needed. Although all lamps should have a defined beam spread angle or luminous intensity distribution, these luminous intensity distributions are desired or preferred for specific applications. Because the range of the applications is broad, the specification can't, and should not, to have a "generalized" luminance intensity distribution requirement.

If the non-standard lamps are being "marketed" as a replacement for an existing standard lamp type, the luminous distribution and minimum luminous flux levels should be defined. However, the existing lamps' luminous intensity distribution (with a given minimum luminous flux level) often is based on the limit of existing technologies (e.g., incandescent), and it is not desired or optimized per customers' or application need. Therefore, one should not simply require the LED lamps to be limited to having the same performance as the existing lamps. The detailed contents of specifications should be further prepared by the industry.

How can non-standard lamp performance be communicated to the buyer without creating false expectations? (For example even the statement of wattage equivalency -- "replaces 60-watt bulb" -- implies the lamp will look and perform like an A19 incandescent.)

If such an LED lamp is to replace a specific existing standard lamp, (e.g., 60 W A19 bulb), then the luminous flux and luminous intensity distribution should be comparable to that specific lamp.

How can DOE allow for non-standard lamp forms without creating a loophole through which products sold as replacement lamps can circumvent the requirements of standard lamp forms?

The solution is proper marking requirements.

MR-16 Replacements

DOE seeks industry and stakeholder input on how to avoid problems potentially caused by installation of LED MR16 replacement lamps in existing low voltage lighting systems and not meeting minimum load requirements.

There are two scenarios:

A) the LED MR16 lamps (AC or DC) have the same wattage of existing lamps (e.g., 10 W, and may be connected with 5 in series to a 50 W transformer), but they produce much higher lumen output, and they will meet the minimum load requirements. The lamps need to be properly labeled (e.g., marked with 10 W).

B) the LED MR16 lamps have much lower wattage and will not meet minimum (transformer) load requirements. Then again require proper labeling and instruction should be required. Furthermore, the use of an appropriate LED MR16 matching power supply (may contain control functions) can also be recommend in the instructions.

Reliability

What kinds of requirements should be considered to minimize the likelihood of premature failure of ENERGY STAR qualified integral LED lamps?

One requirement that is normally used in several other product areas is called burn-in. Burn-in is the seasoning of the electronics for a short period of time at an elevated temperature to “weed” out premature failures of lamps during the production phase. This can be done at certain APQP standards so that overall supply of lamps is not an issue. Normal burn-in procedures navigate to around 4 hours at some elevated temperature like 60 C. A final burn-in protocol should be facilitated by an organization like NEMA. In the past this type of activity has been used by other organizations to help with eliminating premature failures.

What duration of testing is adequate to verify long-term performance?

Due to the long life of LEDs per LM-80 the next step is to investigate the lifetime of the electronics used to drive the overall lamp. It will be very difficult and thus hamper adoption to impose very long test time for electronics especially since this type of electronics has been around for decades. Testing, such as accelerated life testing, can give confidence over a specific design depending on a few key factors, ambient temperature, number of samples, and confidence level. These types of tests have been used for many decades to determine the life of electronic ballasts or power supplies.

The parameters and models for these types of tests will have to be developed in the same manner that LM-80 was.

Overall, reliability is a very complicated measure especially for long-lasting products. The industry continues to study the feasible and proper metrics to evaluate LED lamp products. It is not appropriate to rush into some specifications without scientific data, objective analysis, and best practice to support.

Having addressed the questions in the cover letter, we now turn to comments on the proposed program requirements.

Proposed Program Requirements

Scope

Energy Star should consider lowering the threshold from the proposed 25 W replacement to as low as 10 W. Ten watt lamps can be replaced by 2 W LEDs.

All Lamps

CCT Ranges: Need to be extended.

In ANSI C78.377 all 8 CCT zones are applicable for indoor lighting applications. Some outdoor lighting applications could have even further extended CCTs. This DOE specification is for all replacement applications, indoor and outdoor. Therefore, there are no reasons that CCT should be only limited in the 3 CCT zones. Instead, to cover all applications, as well as customers' needs, all ANSI 8 CCT zones should be allowed. In reality for many commercial indoor lighting applications, higher CCT are desired.

The Luminaire Energy Star Requirements include a more complete table for CCT. DOE should add in the other CCTs as shown below:

2700 K	2725 +/- 145
3000 K	3045 +/- 175
3500 K	3465 +/- 245
4000 K	3895 +/- 275
4500 K	4503 +/- 243
5000 K	5028 +/- 283
5700 K	5665 +/- 355
6500 K	6530 +/- 510

We recommend use of the same ANSI bins as used in the Energy Star CFL and Energy Star for SSL Luminaires programs. Using different bins creates complexity

Color Spatial Uniformity criteria: Not appropriate

This specification should not be generalized for "bulb" type of replacement lamps (it may be applicable for directional lamps). If it is a bulb type replacement, very often it may be placed into a luminaire that contains secondary optics (cover lens, reflector, shade, etc.). The view angle of the luminaire instead of LED bulb is what users are experiencing. The color special variation of the LED bulb can significantly differ from the luminaire in which the LED bulb installed. Therefore such stringent color spatial uniformity (for LED bulbs) become meaningless.

The spatial uniformity specification may only be specified for directional lamps and should be equal to the width of one of the color quadrangles in ANSI C78.377.. If it is smaller than one ANSI bin it will make very difficult to design an LED lamp that would meet this requirement in the long term.

The overall engineering behind adding optics to an LED device is a very difficult and currently there is large amount of intellectual property (IP) being generated. This IP, combined with this type of specification, will limit the abilities of manufacturers to meet specifications without potentially violating some of the IP. The language in this specification is very vague and needs to be defined more clearly to ensure that everyone is measuring and validating to the same claims. Specific attention needs to be given on how someone would actually calculate the weighted average.

Color Maintenance criteria: There are no data to support that LED lamps can maintain the u'v' values with claimed life (e.g., 25,000 hours). Some of the existing test data show that 0.007 is too stringent and many products can't comply, and it may not be necessary. Therefore, suggested revision is to extend to a (to be agreed upon) value. For example, our proposal would be to require that the LED lamp's color does not shift out of the claimed ANSI color bin range within the specified lifetime.

CRI: If the intent of the specification is for all LED replacement lamp applications, indoor, outdoor, and decorative, there is no reason to have a unified CRI requirement.

The minimum value of 80 is required, and 85 is more appropriate for indoor applications if the industry intends to promote LED to consumers as a good light source and not repeat the story of CFLs. LEDs will be compared to CFLs (CRI 82), incandescent and halogen (CRI 100), and metal Halide (CRI 85 to 95), and LED is much more expensive than these light sources. If LEDs do not deliver the color quality to consumers, consumers may choose other less expensive but better color rendering light sources. This will only slow down the market penetration of LED technology. However, as noted later in these comments, CRI is closely linked to LPW, and so this CRI choice – while appropriate – will render some of the proposed LPW values unrealistic at this time.

Dimming: In real practice, for many replacement lamp applications, dimming is not required. To promote energy saving and fast commercialization, there is no reason to require that all LED lamps should be dimmable.

The proposal to require dimming capability is appropriate for this specification, only for the case when dimming function is required, but we note once again that it will be technically challenging. We also predict that the compliant products will be more expensive and have slightly lower efficacy than products without the dimming capability. We suggest that DOE incorporate a recommendation or warning about the use of this product on phase-cut dimmers. Some have found that some integral LED Lamps experience premature failure on these types of dimmers. We suggest that the DOE move to "LED compatible" dimmers as part of the specification.

To elaborate on that, requiring total compatibility with the wide variety of installed base dimmers will likely lead to a *delay* in the availability of Energy Saving LED Lamps that have the otherwise much valued "Energy Star" label. Though great progress will be made in 2009 and is expected in the years to come, requiring full compatibility will be a barrier for entry that is too high for Energy Star to become an effective way of promoting Energy Saving High Quality LED Lamps soon. Propose to either make the required dimmability more concrete (types of dimmers) and/or incentivize dimmer makers to tune all new dimmer products towards LED Lamps.

NEMA has a task force challenged with providing direction on this issue currently.

Warranty: Inherently the environment of lamps is less controlled than that of a luminaire, which immediately translates in a wider range of ambient temperatures in which the lamp operates. Add to this direct exposure to mains voltage characteristics (or in the case of low voltage halogen to 12 V transformer characteristics), and the result is an integrated LED lamp in a less well controlled environment than the luminaire. While LED lamp lifetimes are subject to specific environmental conditions, in actuality unintentional misuse of LED lamps is not 100% preventable. We would argue to make that explicit in the warranty statement rather than an all-out warranty.

Lumen Maintenance: There must be a common test procedure for accelerating and extrapolating life testing. IES LM-80 needs to be referenced.

It is not acceptable to use an exponential model across the board since latest research indicates that at least another 7 lumen maintenance behaviors are possible. (It is possible for an SSL lamp to have less than 80% lumen maintenance at 6,000 hrs and still meet the 70% lumen maintenance goal at 25000 hrs.) Instead, a classification approach (at 10% LM intervals) is proposed, in line with the existing IEC PAS in the European Union.

Lumen maintenance is not the only issue for LED packages. Other components inside of SSL replacement lamps also contribute to lumen reduction over time: driver output change, secondary optical elements (plastic lens and metal coating on the reflector) performance decay over time (25,000 hours), often over 30%. It is not appropriate at the time to only rely on LED package information to claim the entire lamp lumen maintenance.

Power Factor: We have learned from our CFL experience that power factor (PF) should not be an issue due to the low wattages involved. The smaller size of the electronics in Integral LED Lamps is a positive attribute for consumers, but increased PF requires increased size, and also increased price. The power factor for these designs should be defined at full load and nominal input voltage. The power factor should also be broken down based on wattage. For example <5 W would have no requirement, 5-25W a power factor of .6, and greater than 25W> .7. This is consistent with PF categories for other products.

However, a proposal is currently under consideration to modify ANSI C82.77 to include SSL products. Under the proposal, for input wattages below 25W the PF should be .55 and above 25W the PF > .9. If at all possible, Energy Star should reference the ANSI C82.77 standard.

Output Operating Frequency: DOE should ensure that DC operation is acceptable and that the ripple on the DC level is not an issue.

EMI and RF: We suggest that the reference should be to FCC regulations Part 15 rather than Part 18.

Noise: We suggest this parameter should be labeled "audible noise" so that it is not confused with other types of "noise" tests.

Operating Voltage: The overall range should be plus or minus 10% from the nominal value.

Packaging Requirements

All aspects of the packaging are specified correctly; however we strongly suggest that DOE work very closely with the Federal Trade Commission (FTC) to establish criteria that require lumen output on the package. There are currently many examples in the market of integral LED lamps that claim equivalency to certain incandescent or halogen wattages but do not mention lumen output at all. Light output is a basic parameter that should be included not only for transparency, but also to contribute to the educational message that a package can deliver.

Incompatibility with Controls and Application Exceptions: The proposal for the lamp package to clearly state any known incompatibility with photo controls, dimmers or timing devices appears to be inconsistent with the comment requiring dimming. If we are going to allow exceptions to dimmers and photo controls, then we cannot have a requirement for compatibility with all dimmers.

Non-Standard Lamps

In the non-standard-lamp case discussed above, the non-standard lamp does not have a minimum wattage requirement. Therefore there is no reason to set a minimum lumen requirement. In the current DOE draft, if a non-standard lamp must have 55 LPW efficacy and 400 lm, this is equivalent to a minimum of 7.27 W.

Intended Applications: Product submission materials must indicate lighting applications and fixture types for which the non-standard lamp is intended. If Energy Star has a section for Non-Standard Lamp types, then everyone is going to look at this section to gain Energy Star. The Replacement Lamp section will become meaningless if the Non-Standard Lamp is the requirement everyone qualifies against. Two solutions are possible:

1. Eliminate Non-Standard Lamp Section
2. Make Non-Standard Lamp Requirements more stringent than Replacement Lamps

Replacement Lamps

We agree with the use of ANSI C79.1-2002 as the reference for lamp shapes.

Omni Directional Lamp Requirements: We agree with the lamp types named, maximum lamp diameter, and MOL.

Where we disagree with the proposed specification is as follows:

- **Minimum luminous efficacy:** 55 LPW cannot be achieved for a lamp with CRI of 80. The value should be minimum 44 LPW. When a white LED moves from 75 CRI to 80 CRI, there is a decrease in efficacy of 20%. We could have suggested that the minimum CRI be changed to 75 and then agreed with the proposed LPW, but we believe that 80 CRI is the right target. If 85 CRI is ultimately chosen, the minimum LPW value should be changed to 40 LPW. One approach can be used is to have series of CRI with corresponding LPW values.

  Perhaps there is wisdom in creating cool white, neutral white and warm white thresholds respectively, due to factors in phosphored white LED performance differences. 55 lumens per watt is high for a warm white lamp but might be workable for a cool white. Separating them can give a lot of feasibility to encourage good products instead of a one-size fits all approach..

  Minimum light output: The minimum light output column does not match with the lumen output of the corresponding wattage found in today's incandescent lamps, which presumably these lamps would replace. For example, a 25W soft white incandescent A-line lamp produces 160 lumens, not 250 lumens. For the 25W, 250 lumens is too high, This needs to be around 210 to 220 lumens for Omni-Directional A, G, P, PS, S.
  A 40W SW produces 465 lumens, a 60W produces 850 lumens, and a 75W produces 1170 lumens. We do not understand why some of the recommended lumen values are higher and some lower than today's incandescent lumen values. . In addition, this requirement is inconsistent with non-standard lamp. In this case, current draft allows 250lm. With efficacy of 55W, it is equivalent to minimum 4.54W

- **Luminous intensity distribution:** We suggest an even distribution of luminous intensity within the 0 to 135 degree zone (axially symmetrical), the variance within the zone cannot exceed 20%.

Decorative Lamp Requirements: We agree with the lamp shapes and diameters. We do not agree with the following:

- **Minimum luminous efficacy:** The form factors for \decorative lamps are small. Small size is extremely important for decorative lamps. The 45 LPW target is too high for an 80 CRI lamp of this type and should be reduced by 20% to 35 LPW minimum, per the rationale previously discussed. Minimum luminous efficacy standard needs separate cool white and warm white as above method.

- **Minimum light output:** The statement needs to be replaced by a table similar to the following:

10W replacement	70 lumen minimum
15W replacement	90 lumen minimum
25W replacement	150 lumen minimum
40W replacement	300 lumen minimum
60W replacement	500 lumen minimum

In general, mathematical formulas cannot be used to define product specifications for the lighting industry. We must use simple tables that everyone can understand.

Directional Lamp Requirements: We agree with all aspects of the proposed specification, except:

- **Minimum luminous efficacy:** 45 LPW is a suitable target for larger directional lamps; however, it would be a nearly impossible challenge for LED lamps in Candelabra, S14, MR16, PAR16, and PAR20 configurations to achieve this efficacy. Smaller reflectors are simply not as efficacious as larger reflectors. We recommend that the minimum efficacy for these smaller diameters be set at 40 LPW.

- **Minimum center beam intensity:** This is a serious error that uses existing product performance limit to measure advanced LED lamp products. In the directional lamp application, high uniform luminous intensity distribution within a given beam spread angle very often is strongly desired. However due the existing bulb limit, such uniformity is not achieved. As the results, the center beam intensity is derived. For LED lamps, a sophisticated optical design can provide uniform light distribution to meet customers' desire. In this case, center beam intensity may not be high enough to meet the current DOE draft. On the other extreme, the special optical design can also produce very high center beam intensity but rest of the beam spread is very dim. The current DOE draft also creates such a loophole.

  This Center Beam Tool is currently too sensitive to changes in Beam Angle. With a tool like this, manufacturers can "game" the system to hit targets to just pass Energy Star. We suggest for this first release of Energy Star that DOE develop a simple table for only 25 degree nominal lamps. The 10 degree lamp targets will be too difficult to reach in the short term with LEDs. The 40 degree lamp targets may also be meaningless in the short-term. (Too big a beam spread to get equivalent products via MBCP). Therefore, we suggest that DOE only target a 25 degree beam spread for the first release of the Energy Star criteria. (Future releases can include 10 and 40 degree beam spreads as the LEDs become more efficient.)

  For the MR-16 table of equivalency, we suggest the following:

20W equivalent	550 MBCP (Max Beam Candle Power)
35W equivalent	1000 MBCP
50W equivalent	2500 MBCP

  For the R20s table of equivalency, we suggest the following:

40W	500 MBCP
50W	600 MBCP
60W	800 MBCP
75W	1000 MBCP

For PAR30s and PAR38 table of equivalency, we suggest the following:

35W	??? MBCP
45W	1750 MBCP
60W	3000 MBCP
90W	5000 MBCP

The low-voltage (12V) operated MR16 class of lamps work with halogen transformers of which there is a multitude and wide variety available in the market and installed. Insisting that any LED MR16 is compatible with the total installed base will delay the introduction of energy saving LED MR16 solutions. Compatibility with standard halogen transformers is a long standing topic of research and development, and while compatibility with a subset of transformers can be achieved for ONE lamp with a FIXED wire length, adding multiple lamps with or without varying wire lengths, makes the total solution a very high barrier for entry. Note that the combination of halogen transformer and dimmers makes this a multi-dimensional problem. We are strongly advising to make a more explicit need for compatibility (types of transformers, recommended number of lamps (1 in the professional channel, 3-5 in the consumer channel) as well as fixed wire length to make this not an impossible-to-meet requirement. At the same time, the incentive to develop a total solution will remain unchallenged.

- **Luminous intensity distribution:** The current Energy Star draft does not have any specification for the light level control beyond the beam spread angle (e.g., no requirement for flood lamp beyond 30 degree spread). In practice, it is desired that minimum or no light should be put into the angle beyond spread. However, the light beyond spread angle will be accounted for LPW and total lumens. Therefore a higher performance LED lamp with high light level within spread angle and zone light level beyond spread angle will be penalized with LPW and total lumen value. See previous comments on beam spread. Perhaps only 25 degree nominal beam spread (20-30 degree) would be appropriate. Other beam spreads are too difficult to reach with current LED technology. The appropriate measure should be “useful” LPW and “useful” lumens that only account for the light inside of the spread angle.

- **Spatial beam distribution**: Energy Star may also consider setting a spatial beam distribution requirement. For example, spatial beam distribution of 360 degrees in horizontal and 275 degrees in vertical.

- **Maximum overall length:** Special electronic transformers may be needed for LED MR-16 products. It is not possible to be backward compatible to all makes and models of transformers. Perhaps manufacturers need to be responsible for maintaining a compatibility list.

Testing Requirements

We encourage Energy Star to reconsider whether 6,000 hour testing at both the level of the package and the integrated lamp should be required.

Integral LED Lamp Lumen Maintenance and Reliability: The elevated temperature conditions must be specified since they are not currently part of LM-79. An elevated ambient temperature of 45 C is proposed, in line with an existing IEC PAS in the EU. In addition, a “regular” ambient temperature for the life test (e.g. 25 C) is needed since it would be typical of indoor applications, and it should be used as the reference for determining 6,000 hrs lumen maintenance rather than the elevated temperature, also in line with the EU PAS.

As noted above, it is not acceptable to use an exponential model across the board since the latest research indicates that at least another 7 lumen maintenance behaviors are possible. (It is possible for an SSL lamp to have less than 80% lumen maintenance at 6,000 hrs and still meet the 70% lumen maintenance goal at 25,000 hrs.) Instead, a classification approach (at 10% LM intervals) may ne appropriate, in line with the existing IEC PAS in the EU.

Our previous comment on developing a common life test that accelerates and extrapolates life is important to this specification.

Perhaps Energy Star should further consider adding a standard statistical method in assessment of omni-directional lamps’ B10 or B50 values, in-line with CFLs and Incandescent.

For more information regarding any of these comments, contact Craig Updyke at cra_updyke@nema.org or 703 841 3294.

END COMMENTS