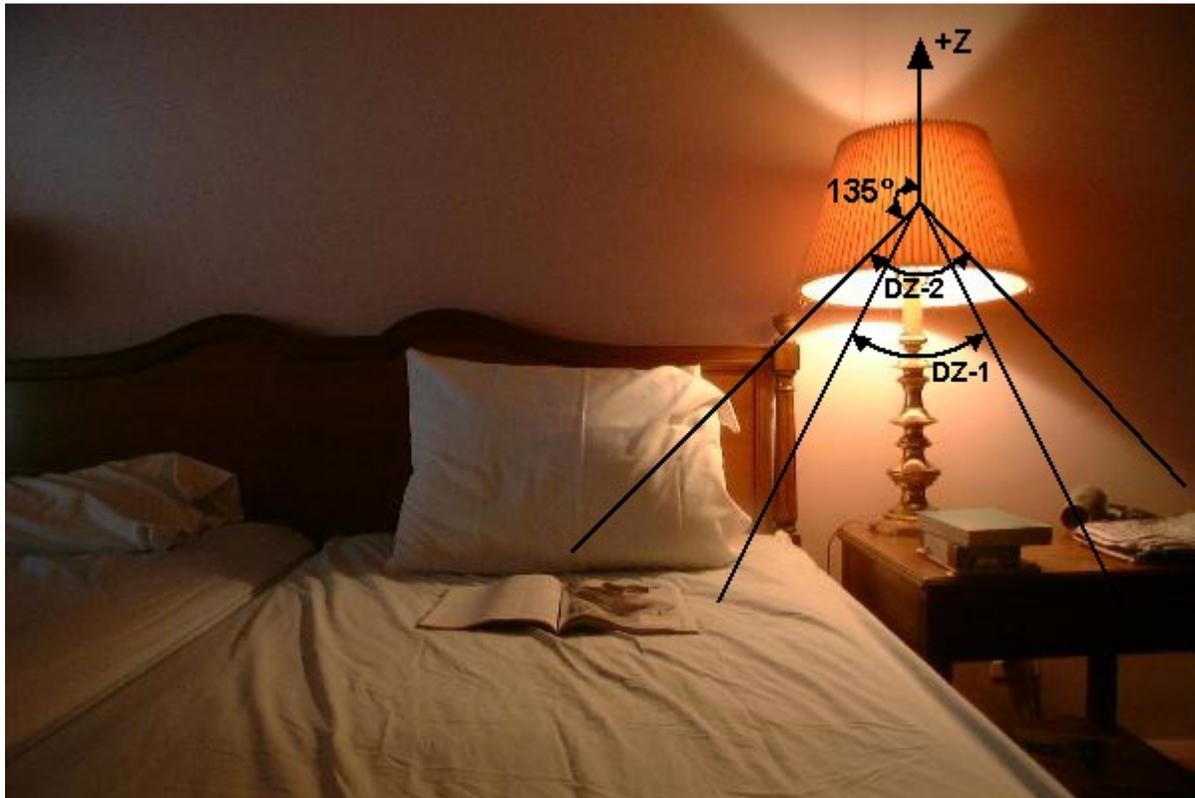


Comments on Energy Star Program Requirements for Integral Lamps Draft 2

The photo in FIG. 1 below shows a table lamp in typical use on a nightstand. The proposed amendment to the LED general service bulb **Energy Star** uniformity specification for “omnidirectional” lamps that is contained in Draft-2 allows for the direct light intensity in the in the polar angular range marked DZ-2 in FIG. 1 to be zero. According to the original proposed requirements published on Jan 16, 2009 direct light intensity in the polar angle range marked DZ-1 is permitted to be zero.

FIG. 1



The original proposed requirements stipulated uniformity of +/- 10% in a polar angle range 0-150°. Draft-2 has slackened the uniformity requirements by reducing the angular range over which uniformity is to be measured to 0-135° and increasing the tolerance to +/- 20%.

As is apparent both requirements permit bulbs that would leave large dimmer zones labeled DZ-1 and DZ-2 in the vicinity of the lamp. These zones would only be weakly illuminated by diffuse reflected light from the lamp shade.

PROPOSED CHANGE CONTRADICTS DEPARTMENT OF ENERGY'S OWN RESEARCH

The DOE office of Energy Efficiency and Renewable Energy itself funded research in the 1990's into the effect of differences in omnidirectional bulb light distributions on overall performance. The research was conducted by the Lighting Systems Research Group of the Buildings and Technology Program of the Energy and Environment Division of the Lawrence Berkley Lab. This research was reported in the paper E. Page et al. "A Comparative Candle Power Distribution Analysis for Compact Fluourescent Table Lamp Systems", 1995. Some of the conclusions of the paper are important to note in the present context.

In discussing the impact of table lamps and floor lamps on energy consumption the researchers state:

"A significant portion of these high use sockets are table or floor lamps"

In discussing consumer expectations regarding such lamps the paper states:

"Consumers are used to a bright halo of light emanating from the top aperature of the shade and bright illumination directly below the shade for high-definition tasks such as reading."

Most relevant to the ill-advised proposed slackening of the uniformity requirements for LED omnidirectional lamps that is contained in Draft-2, the researcher's state:

"A comparison of the A-lamp and the circline demonstrates the advantage of focusing output vertically."

"While the A-lamp yields the largest total lumen package of 1815 lumens, the circline has a much more intense output at the crucial nadir and zenith angles. In effect, fewer total lumens are required to produce sufficient illumination where it is actually needed: at nadir for task lighting and zenith for indirect lighting" {emphasis added}

The proposed lax uniformity specification does not require any light at all in the vicinity of nadir which is directly contrary to the conclusions of the paper.

Allowing lamps that are to be marketed as "omnidirectional" to have zero illumination over ¼ of the polar angle range (135°-180°) per Draft-2 would lead to consumer disappointment in LED products, and reduced faith in the Energy Star certification.

PROPOSED UNIFORMITY STANDARD

The Energy Star Program Requirements for omnidirectional Integral Lamps should be issued with a stipulation of +/- 10% over the entire 0-180°. This would restore the original +/- 10% tolerance which can certainly be achieved and extend the angular range so that the emission pattern will be truly

“omnidirectional”. It requires that light be provided to the nadir region as recommended by the DOE’s own research.

The advent of LED based light bulbs is an opportunity to improve upon the light distribution of the incandescent light bulbs. With a better light distribution the same effective illumination, e.g., in the crucial nadir region, can be obtained with less total lumens and less wattage (e.g., dimmed down, or lower power bulbs) thereby saving energy.

RISK TO ENERGY STAR CREDIBILITY WITH CONSUMERS, CONSUMER CONFUSION

The table lamp application is one in which any deficiencies in LED light bulbs will readily be noted by consumers because consumers have well defined expectations of the light produced by a table lamp. The expectations include a fan shaped patterned of light emitted from the top of the lamp shade AND a fan shaped pattern of light emitted from the bottom of the lamp distribution. If LEDs bulbs fail to produce a bright bottom fan shaped distribution it is to be expected that consumers would deem LED bulbs deficient and the credibility of the Energy Star certification would be diminished.

Because LEDs are quasi-point sources, their light distributions can drop off rapidly, for example within 10 degrees. Thus an omnidirectional LED lamp that fully conforms with the looser Draft-2 uniformity specification could be down to 80% of average at 135° and down to near 0% by 142°, leaving no direct illumination in the nadir region which directly contradicts the DOE’s own research described above.

Disappointing consumer experiences with LED bulbs that have the Energy Star imprimatur but provide no light in the crucial nadir region is likely to erode confidence in the Energy Star rating for LED bulbs.

TECHNICAL FEASIBILITY OF MEETING BETTER, MORE STRINGENT PROPOSED STANDARD

The more stringent uniformity requirement that I am suggesting: +/- 10% over the entire 0-180° can be met. For example, my own pending patent application PCT US2009/000244 provides an omnidirectional LED light bulb that is superior in both thermal and optical performance to existing (very early stage) A-type LED light bulbs and can meet this more stringement uniformity requirement. Several drawings of the LED light bulb are shown below. Figure 3 is a perspective of the omnidirectional LED bulb.

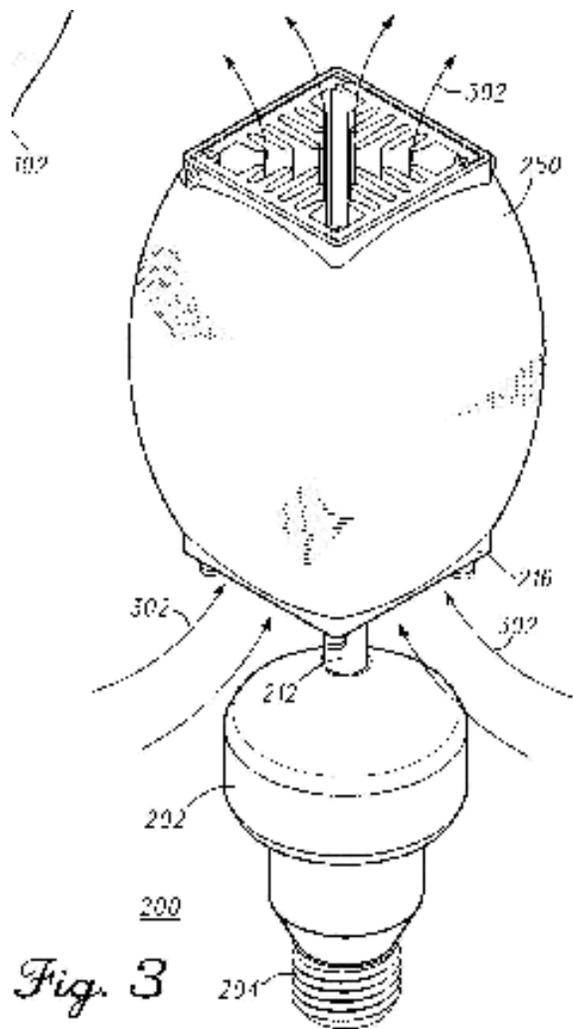
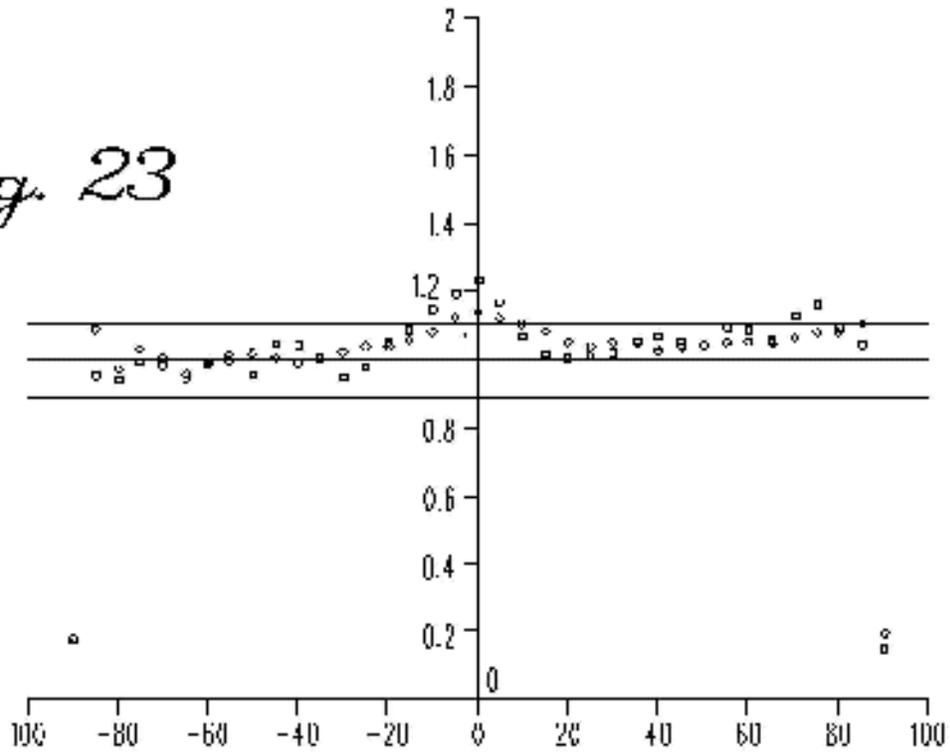


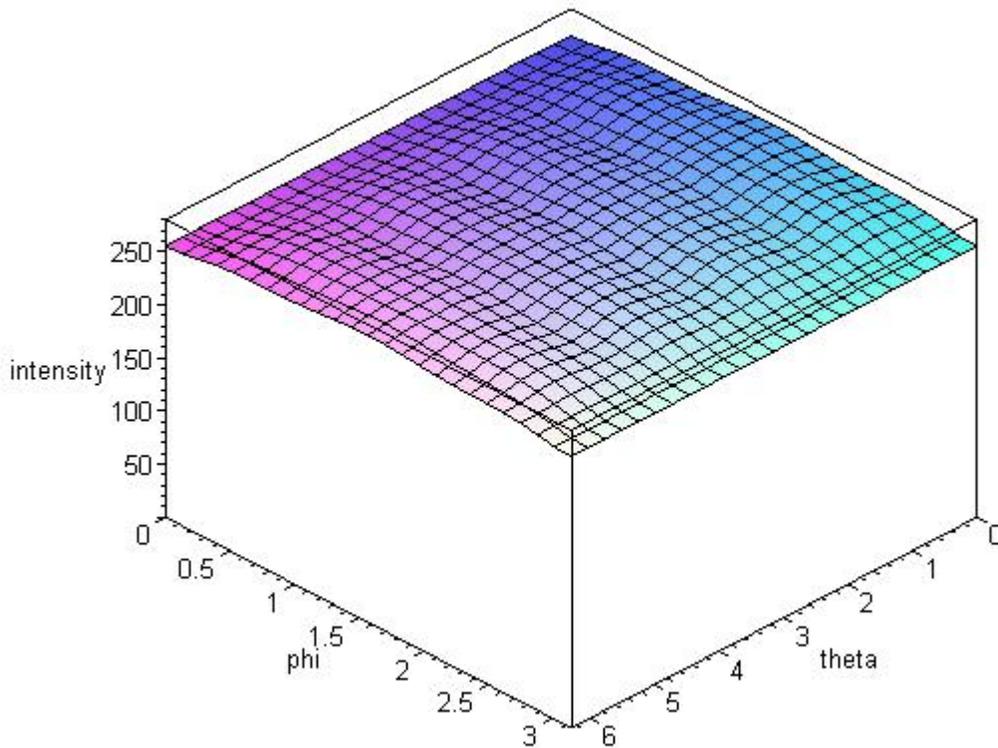
FIG. 13 is partial cross-sectional view through the top of the bulb which illustrates an arrangement of the outer bulb shape diffuser that allows all the light emitted by the LEDs 1244, 1242 to be diffused by the diffuser while allowing natural convection air flows to flow through and around the central heat sink. The overall thermal resistance of the bulb is much better than existing LED bulbs and can handle 10 watts of LED input power while maintaining the LEDs well within manufacture recommended temperature limits.

Fig. 23



By arranging the LEDs in the bulb facing in all four cardinal directions, each pair of LEDs facing in opposite directions (e.g., N & S) will nearly cover the complete sphere of solid angle, 4π steradian, around the bulb. The two pairs together (e.g., N & S and E & W) will cover the 4π steradian twice over. Light from different LEDs combines together generally smoothing out the small ripples in light intensity shown in FIG. 23. The bulb shaped diffusive cover (250, 1230, 1232 in FIGs. 3, 13) further smoothes the ripples in intensity. The resulting light distribution over 4π Steradian is quite uniform as shown in FIG. 4 below. The maximum intensity is 8% higher than the minimum so that the originally proposed (Draft-1) uniformity specification of $\pm 10\%$ relative to the mean can easily be met and the same standard can be met over the wider proposed 0-180° range.

FIG. 4.



REMARKS ON COMMENTS BY OTHER INTERESTED PARTIES

NGLIA and NEMA's Comment

NGLIA and NEMA were the parties that suggested changing the uniformity spec from +/- 10% in a polar angle range 0-150° to +/- 20% in a polar angle range 0-135° in their comments on the draft 1 (see page 8 of the NGLIA and NEMA comments dated February 27, 2009). NGLIA did not disclose in these comments that one of their constituent companies: Light Prescriptions Innovators (LPI), has at least one pending patent on an LED bulb optic that meets the more lax uniformity standard that NGLIA and NEMA proposed but does not meet the original Draft-1 uniformity standard. The pending patent application is U.S. Patent Pub. 2009/0067179 which is publically available at the USPTO web site. FIGs. 48c and 61 of that patent application show light distributions that would meet the looser NGLIA-NEMA proposed standard contained in Draft-2 but would not meet the originally proposed standard. In my opinion it was improper not to have disclosed the pending patent application when proposing to change the uniformity standard. NEMA's own policy is that patents must be disclosed in the context of standard setting activities that NEMA manages, see <http://nema.org/stds/Patent-Disclosure-Policy.cfm>.

It is noteworthy that NGLIA and NEMA did not present a rationale for loosening requirement. They couched their request for a lower uniformity requirement as a request for uniformity stating “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%.” It is also noted that the DOE acceded to the request without comment on the rationale in its letter discussing the draft modifications.

It should also be noted that while the optics disclosed in LPI patent, and similar optics shown by a Taiwanese company at LightFair 2009 can be the basis of LED based replacements for very low power decorative bulbs (non-uniformity issues aside), such optics are not useable in LED replacements for bulbs that have a significant impact on energy usage (60 to 100 watt incandescent bulbs). This is because the optic design requires all the LEDs to be positioned close together near the base of the bulb under the optic. In such an arrangement the highly localized heat generation associated with operating the LEDs at 8 to 15 watts (required to match a 60 to 100 watt incandescent) and lack of space in the ANSI dimensional envelope for bulbs (ANSI C78.20-2003) for a heat sink near the lamp base would result in unsafe temperatures that are also beyond the recommended limits for power LEDs. Thus such designs, while meeting the more lax uniformity standard design could not be used in light bulbs that have an impact on U.S. national energy usage of any significance. Low power decorative bulbs account for only a tiny fraction of electrical energy use. The standard which applies to omnidirectional LED bulbs that have a significant impact on U.S. energy consumption (i.e., A19 LED bulbs) should not be compromised at all, let alone to accommodate an interesting optical design that is only useful in decorative lamps, or that might require the ANSI dimensional envelope to be exceeded to accommodate a large heat sink.

LEDnovation’s Comment

LEDnovation shows an LED lightbulb on its homepage that would likely not meet even the lax Draft-2 uniformity specification as the light emission pattern is likely to be substantially confined to an upward facing hemisphere. LEDnovation argues that having a uniformity standard would lead to poor performance for omnidirectional light bulbs used in directional lighting applications. The fallacy of this argument is obvious. LED omnidirectional light bulbs should not be used in directional lighting applications. It would be far more energy efficient to use an LED bulb (e.g., PAR, MR) or integrated LED fixture that is specifically designed to be directional. Omnidirectional LED light bulbs are mainly to be used to support high energy usage legacy lighting applications, i.e., table lamps and floor lamps in the case of A-type lamps.

ECONOMIC IMPACT OF PROPOSED SLACKENED UNIFORMITY STANDARDS

While the primary motivating factor for the proposed loosening of the uniformity specification may be to respond to NGLIA’s request to loosen the specification, the main impact of the change that would be realized in one or two years will be to open the door many eager low cost, less technically

sophisticated foreign manufacturing firms who will not want or need to use LPI's patent pending optics in order to meet the more lax uniformity specification. U.S. firms would never have a chance. The market would be flooded with imported bulbs that have light distributions that contradict the Department of Energy's own research and further erode the U.S. trade deficit and overall economic condition.

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