Comments from Lumination
"ENERGY STAR Program Requirements
for SSL Luminaires – Category "A" Additions

Surface and pendant-mounted downlights:

(1) CCT should not be limited to <3500K. 4100K also is utilized in this segment.
(2) Concerned with the "one size fits all" Luminaire efficacy given the range of CCTs. It is well known that a correlation exists between LED efficacy and CCT (and CRI). Should Luminaire efficacy be tied to CCT?
(3) CRI requirements are significant in the indoor residential space … Should a CRI metric be added?
(4) #1 becomes even more important if "pendant-mounted downlight" includes LFL replacement. Not enough definition provided to determine if this category includes LFL.

Outdoor pole/arm-mounted area and roadway luminaries

(1) Per the Zonal Luminous Intensity requirements of the Beam Uniformity metric: No test house, manufacturer or photometric analysis software package (e.g. Photometric Toolbox) is set up to perform this CD analysis today. This would require multiple involved steps to produce this data and would be a significant burden for the luminaire manufacturers.
(2) The Zonal Luminous Intensity specifications contained under the "Beam Uniformity" metric as proposed for Type III-V all assume an optimum 4:1 pole height to spacing ratio. This is not a standard throughout the industry and various applications (entryway to parking and roadway in particular) will deviate significantly from this specification.
(3) Beam Uniformity (Light distribution) as specified assumes an HID-type of profile. However, the DOE is unnecessarily penalizing the LED luminaire mfr, as other "flatter" profiles can offer even greater energy savings.

As an example, **Figure 1** provides a comparison of an LED-based Site Light solution that was optimized for "light usage", uniformity and minimum glare (LED1); whereas LED2 was designed to mimic the existing HID light output profile. Note that LED2 would meet the proposed Zonal Density specification (as identified by the colored "blocks"); whereas, LED1 would not.

Additionally, as per Point #2 above, **Figure 2** demonstrates the peak angle requirements for various Pole Height to Spacing ratios that are utilized in the industry. This is the basis for extending the "peak area" recommendation in Figure 4.

In **Figure 3**, a comparison of the power consumption, Lumen efficacy, minimum intensity and Max/Min ratio for the two lamps demonstrated in Figure 1 clearly shows the benefits of a "non-HID" type of profile. Although the total flux is ~20%

lower for LED1, the minimum maintained intensity is 1.77X that of LED2! And both solutions meet the proposed Energy Star criteria for luminous efficacy. In addition, glare reduction is significant in the LED1 design and has garnered very positive feedback in the marketplace.

Finally, **Figure 4** proposes a modified Zonal intensity profile recommendation based on the above results. Note that light output at *nadir* is reduced in order to place the light where it is more useful within the target area. An ideal light pattern for uniformity on the ground, batwing, would require ~25% of peak output at *nadir*. Note also that the peak area is extended to allow for multiple pole height-to-pole spacing ratios within the roadway application.

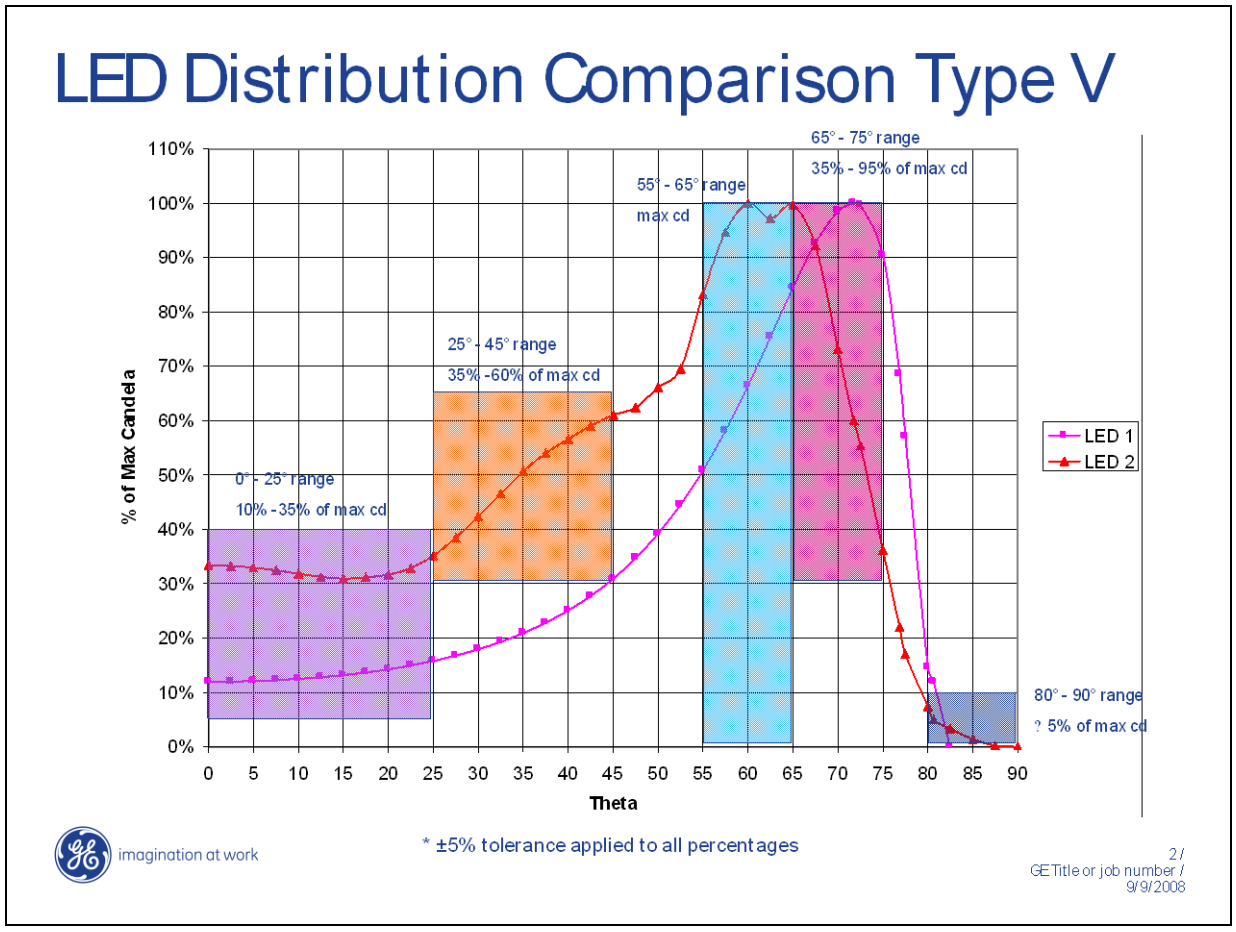


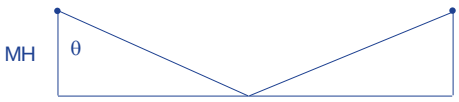
Figure 1

Pole Spacing to Mounting Height

PS:MH	Peak Theta
1	27
2	45
3	56
4	63
5	68
6	72
7	74
8	76
9	77
10	79
11	80
12	81

θ = Angle of Maximum Cd at ½ Pole Spacing

PS:MH = Pole Spacing to Mounting Height Ratio



Pole Spacing = X*Mounting Height

Typical Roadway Light PS:MH = 4-8:1

Typical Area Light PS:MH = 3-6:1

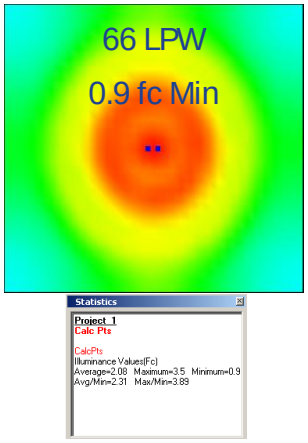
imagination at work

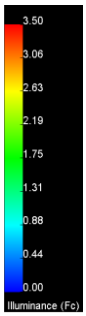
Figure 2

Application Comparison

LED 2 / 232W

15,300 Lumens





LED 1 / 205W

12,400 Lumens

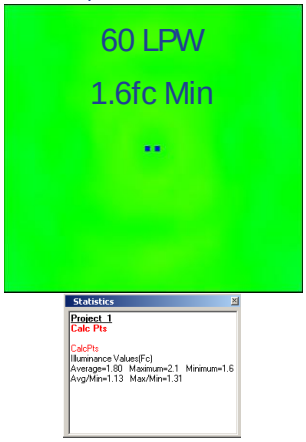


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Figure 3

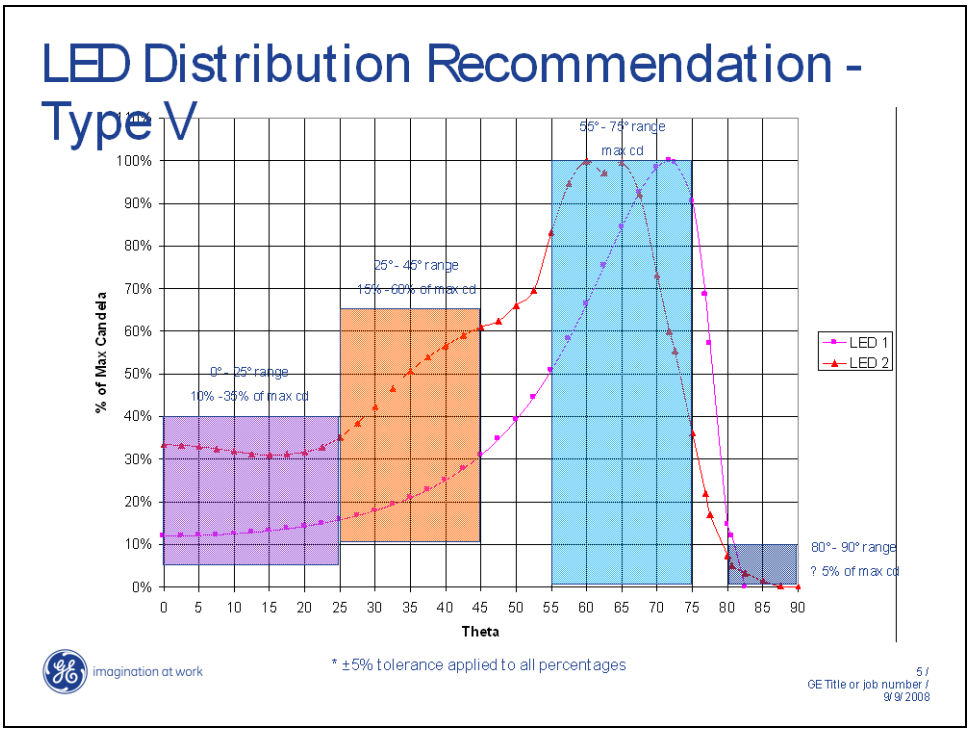

Figure 4

(4) The stated candela profiles listed in the "Beam Uniformity" metric imply that intensity in some directions is desirable and undesirable in others. In the context of IESNA's move to implement TM-15, there is a distinct and intentional effort to move away from prescribing a fixture's intensity profiles as being either good or bad and letting the application and solution options drive the judgement of how well any given photometric distribution performs in any given application. As an example, one could design a photometric distribution for an area light that is intended to simultaneously illuminate the store-front drive lane and the building façade. This distribution could violate the prescribed distribution (CD) limits, but be the most cost effective and energy efficient solution while best controlling trespass above the building façade. Why would DOE NOT want to list this as an Energy Star solution … best performance … least cost? The beam uniformity metric limits the inventiveness of solution providers. Similarly, roadway luminaires can serve multiple purposes in residential applications simultaneously providing street and sidewalk illumination. Again, the CD distributions that optimally solve this 'dual-application' problems may conflict with DOE's prescriptions while meeting system efficacy goals and delivering the least cost highest efficiency solution to the application

(5) It is assumed that "Minimum Luminaire Efficacy" refers to an initial light output, rather than a maintained output over the lifetime of the lamp. However, minimum maintained system efficacy is what really matters in any application space. DOE

should give consideration as to whether or not the maintained performance is what should be specified … though harder to measure.

(6) Why is there any minimum assigned to system luminous output? This presupposes that an application does not exist for less lumens than would be satisfied by this product class. What value is there in defining a lumen minimum?

Outdoor pole/arm-mounted decorative luminaries

(1) Applications exist which might require pole-mounted solutions for façade lighting needing more than 15% of the total luminous output. This application would not be allowed based on the < 90° light distribution spec.
(2) Why is there any minimum assigned to system luminous output? This presupposes that an application does not exist for less lumens that would be satisfied by this product class. What value is there in defining a lumen minimum?
(3) Reference Item 5 above per minimum maintained light output.

Outdoor wall-mounted area luminaries ("wall packs")

(1) Why is there any minimum assigned to system luminous output? This presupposes that an application does not exist for less lumens that would be satisfied by this product class. What value is there in defining a lumen minimum?

(2) As an example, a high efficiency solution for typical egress lighting in a 20' by 10' area at retail employee egress door requires 200 lumens at 100% systems efficiency to deliver 1 fc to the area. Accounting for thermal, electrical, optical, and depreciation losses, ~ 465 lumens minimum flux would be required to meet the photometric specification for the application. Allowing another factor for coefficient of utilization would place the flux at ~ 600 lumens. However, the proposed Energy Star specification is > 2X this value! This appears counter-productive to the DOE energy savings goals.

Cove lighting – Asymmetric distribution

(1) The stated criteria would seem to limit the available technology to LFL-based systems only. The lumens per foot criteria seems quite stringent for applications that might still desire asymmetrical beam patterns but prefer lower light levels, or perhaps greater color flexibility. For customers desiring mercury free options, it appears nothing would be available that would meet energy star. Customers may well be prepared to shift to non-LFL technologies from halogen, or HID systems that are providing asymmetrical lighting in vaulted ceilings, and still achieve significant energy reductions. This would provide greater choice and flexibility

and still meet the desired goal assuming that the LPW and LPF requirements are reduced.

(2) Addressing lower "ambient light" cove applications should be an Energy Star target. This is a significant application space with excellent opportunity for energy reduction with LED technology. It is usually desirable to have lower lumens per foot and lower color temperatures, which can only be accomplished with less efficient sources, or by dimming and/or filtering LFL, which can be cost prohibitive. The LED technology can provide significant efficiency benefits over xenon, halogen, neon, and ccfl which are heavily used in this application. For these reasons, we submit for DOE's consideration that the luminous efficacy specification for this application be reduced to 40 LPW.

Circular or square parking garage luminaries

(1) One size fits all Zonal Lumen Density requirement is inconsistent with varying applications in this space. As an example, a parking garage has several key application zones, general parking space, vehicular entrances, and pedestrian ingress/egress points within the parking space. The photometric properties of luminaires optimally illuminating these zones to the typical specifications differ in a least energy/least cost scenario. Pedestrian ingress/egress regions can use low lumen limited throw distributions to cover the zone of interest. In the vehicular entrances, high levels for daylight transition zones can most effectively be met with high lumen package units acting as limited throw down lighting to confine the lumens to the key transition area rather than broadcasting lumens over an unnecessarily large space. Again, stating distribution limits where not needed unnecessarily constrains the solution provider from optimizing against the application conditions to the limits of LED technology.

(2) Luminous efficacy requirement is inconsistent when compared to the Outdoor pole/arm-mounted area luminaire. The output distribution and total flux requirements are similar in nature, but the technology is inherently impacted by increases in ambient temperature. To achieve the same system efficacy as an outdoor fixture, a garage fixture will have to have inherently higher efficacy and better thermal management just to break even, making it harder to solve the technical problem. The real question is at what efficacy level does LED beat the incumbent for ROI that is attractive. What is the benchmark … HPS or MH? A higher system efficacy threshold implies that the incumbent is better indoor than outdoor, which is not the case for MH.

(3) A Zonal Lumen Density approach does not address the energy savings entitlement for this application. A better metric would be "Watts/Minimum Foot Candle". We recognize that this is a harder metric to analyze but is more meaningful to the application. Believe this to be amenable to the Area Luminaire as well. Any optimized solution will be attempting to solve the application problem at minimum power consumption and at minimum amortized system cost … i.e. maximum ROI. The application does not require a specific lumen density distribution, it requires a minimum maintained lighting performance (average or minimum levels and maximum uniformity metrics) versus the application spaces.

The most energy efficient solutions meet spec (required footcandles and uniformity) at a minimum power requirement. One can consider this from the standpoint of an application "entitlement". For example … 200 sqft at an average of 2 fc can theoretically be done with a total of 400 maintained lumens. With a maintained system efficacy of 40 LPW, the 'photometrically perfect' solution to this application can do the job for 10W (or 0.025 w/sf*fc). Anything more is a less than optimal solution. Therefore, DOE might want to focus on an LPD (Lighting Power Density) type metric scaled to the application's specific light level requirements with an allowance for reasonable assumptions about LED system's ability to deliver superior uniformity.

Bollards

(1) DOE description used in Bullet #3 of comment block is similar to the argument we have proposed for Outdoor pole/arm-mounted decorative luminaire for façade lighting, as an example.
(2) The Luminaire efficacy for this application is significantly lower than for other outdoor applications included in this specification. This is one instance where the efficiency requirement could be higher and is artificially low because it is tied to the existing technology rather than considering an optimized LED approach.
(3) Why is it necessary to have a minimum lumen output?
(4) Reference multiple comments above about zonal lumen or zonal candela distribution requirements … let the solution providers optimize to the application

Circular or square wall wash luminaires

(1) The asymmetrical profile requirement limits the geometrical and physical configuration for this application (ie does it assume only a wall-mounted structure?)
(2) CCT spec is limiting. Recommend matching to C78 specification.

Ceiling-mounted luminaires with diffusers

(1) Makes sense to drop the Cosine distribution requirement proposed in original draft.
(2) Recommend expanding CCT allowance for 4100K substitute.

Surface-Mounted Luminaires with Directional Head(s)

(1) Additional definition would be helpful, especially in terms of the configuration to be replaced (ie Track head, Retail spot, …)

General Comments:

(1) The overall approach utilized to determine spec limits in this document is to reference the typical light output distribution and luminous efficacies of the technology to be replaced. This gives no consideration to the benefits to be derived from the LED-based technology. A perfect example of this is the specification for the Outdoor pole/arm-mounted area light, in which an HID profile at a specific pole height-spacing ratio is assumed. Thus limiting the ability to optimize the solution based on the benefits to be gained by the LED technology.
(2) Providing additional descriptions/pictures etc would help to eliminate ambiguity based on applications specified in this document.
(3) The Zonal Lumen Density approach does not work well in all situations and a better metric, particularly for Area and Garage lighting may be "W/min ft-cd" or "Min ft-cd/W".
(4) There is perhaps a fine line between an energy spec document and one that dictates engineering design. Ultimately, the customer base is going to dictate what is allowable and what isn't. DOE should not attempt to make that decision for the customer, other than placing minimum energy consumption (i.e. efficiency) requirements on their behalf.
(5) The thrust of an Energy Star Spec should be to set a minimum "Maintained" Luminaire Efficacy in all application spaces. Energy Star listed products should also promote "good" lighting practices where it is obvious that fixture features are necessary to support "good" practice. An example of this might be sharp house-side cutoff properties for fixtures intended to serve in perimeter lighting applications to avoid light trespass on adjacent properties. However, much of what constitutes "good" practice is really driven by proper application of the available product solutions. DOE needs to ensure that the Energy Star Specs are not mandating product characteristics that arbitrarily constrain the solutions based on DOE's perspective on "good" practice since its hard to know everything about every application space.