

***ENERGY STAR Program Requirements for Solid State Lighting Luminaires
Proposed Category “A” Additions – Outdoor Area and Parking Garage***

Fitted Target Efficacy (FTE) Comments.

Summary of Concerns:

1. Shape of target area
 - a. Rectangular is not necessarily ideal for area lighting, and light below the 1/30th maximum illuminance is still useful to the application.
 - b. Penalized for not filling in corners of target area on house side
2. Size of illuminated area is not considered. A metric is needed to make sure luminaire is lighting a sufficient area for energy effectiveness
3. Penalty for scalability. Having separate standards for “High Output” and “Low Output” luminaires penalizes products that maintain distribution while scaling lumen output.
4. Asymmetry of luminaires about the y-axis is penalized, where some luminaires are intentionally providing this distribution.

Further Clarification of Concerns:

- 1a.** With regard to “Step 8” in the FTE algorithm: “Delete/remove calculation points that are less than 1/30 the maximum point.”

This logic is assuming that you are aiming for the 15:1 average-to-maximum illuminance uniformity, and two luminaires are contributing to the extents of the luminaire’s throw. In area lighting, the interaction of the luminaires is different than in roadway lighting. Typically there is a two-dimensional array of luminaires, and in the 0°, 90°, 180° and 270° vertical planes are two luminaires adding together at the edge of their reach to create the minimum illuminance between the two. As you look toward the corners of the distribution (45°, 135°, 225°, and 315° vertical planes), there are 4 fixtures contributing to the illuminance at those points.

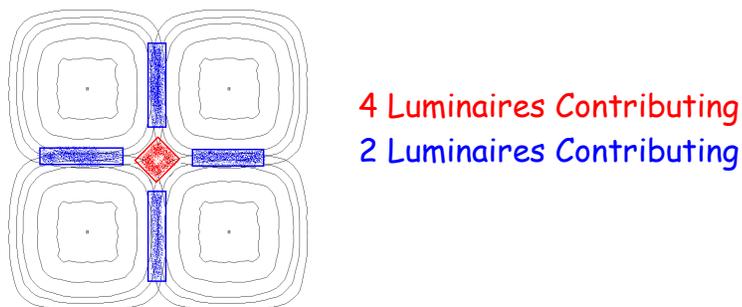


Figure 1: Overlap of illuminance for the interior of an area lighting application.

This being the case, the FTE calculator is not counting light that is positively affecting the application, even though it is below 1/30th the maximum illuminance point (the corner point only needs to be 1/60th the maximum illuminance to be useful). If you are looking at the 1/30th illuminance contour plot, then an octagonal shape is a more useful target than a rectangle.

Also, the lumens that fall below the 1/30th maximum illuminance level are still useful. Outdoor lighting applications come down to tenths even hundredths of footcandles when comparing luminaires, and the light filling the rectangle outside the uniform pool should still be counted. When the 1/30th isofootcandle line is near the border then the light below that level is outside the target, even though it is still useful to the application.

Lastly, this method encourages very sharp cutoffs eliminating benefits of lighting just outside the target zone. Under this proposed method, fixtures which produce light outside the defined "fitted target area" are penalized, yet maintaining minimal light levels outside of immediate task zones is beneficial for critical safety concerns including facial recognition, and identification of objects approaching the target area.

- 1b** Another concern is having a rectangle extending from the maximum and minimum X and Y value on the illuminance plane. Specifically with house-side light on type II, III, and IV luminaires, there tends to be higher amounts of back light near the pole. It then recedes closer to the curb line as X gets larger. If this is the case, you are docked for the lack of light between where your peak back light ends and to where your main throw extends. In other words, it encourages more back light to fill in the rectangle.

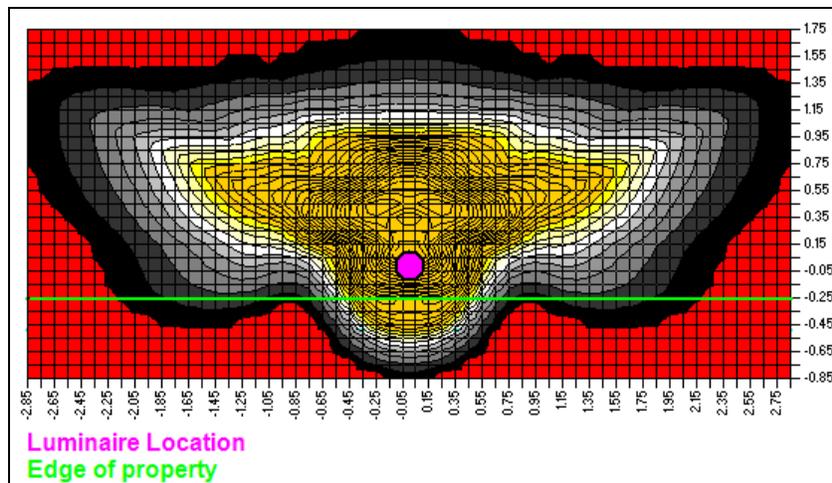


Figure 2: Illuminance plane for a Type II distribution.

In Figure 2, the red area is the target rectangle as defined by the FTE algorithm. The black to yellow shading show illuminance values above the 1/30th maximum

illuminance level. The magenta dot indicates the location of the luminaire. If this fixture were located on a roadway, or the perimeter of a parking area, then the green line indicates where the edge of the lot/roadway to be lighted could be located. In the case of the FTE method, this luminaire's rating is depreciated by the percentage of the red area below the green line. Assuming that not all applications require sharp, straight house side cutoff, it would make more sense to keep the lower Y value of the rectangle near the green line, and not count the lumens falling behind it. Trying to find a consistent way to locate the lower bound of the rectangle near the green line is not as straight forward, unless it is located at a fixed MH behind the luminaire, or at the curb line. This is another example where a rectangular target is neither ideal.

2. The size of the illuminated area is never considered. The method assumes that a rectangular shaped illuminance pattern is the goal, but says nothing about the size of that pattern. There is potential for over lighting an area with fixtures that dumps light at low angles, but have rectangular distributions. An application would need more of these fixtures, and have higher light levels than one that has higher angle flux, and similar wattage. Poor performing luminaires will be able to qualify for Energy Star, yet would require more luminaires and hence higher levels of power consumption to accomplish the desired light levels. There should be consideration for the size of the lighted area such as watts/area.

In some applications, where there are high levels required, the narrower distributions are indeed appropriate; however, this tool dramatically simplifies the application. To comply, manufacturers would be forced to optimize distributions for the qualification tool rather than for the intended application. This would in turn require more energy to make up for the deficiencies in real applications. There are an infinite number of applications, each with its own optimized distribution. For example, choice of equipment should be based on the application. Hydroform reflectors are generally regarded as inferior to faceted sheet reflectors because the maximums are generally greater, vertical throws are lessened, and the efficiencies are lower, but for applications requiring high averages, the hydroform reflectors out perform the faceted optics because the narrower distributions more appropriate. Where criteria revolved around minimums, the faceted optics would win. A simplified qualification tool will restrict the choices of the lighting designer and thereby the progress across the entire industry.

3. The reasoning for having separate FTE standards for "high output" and "low output" luminaires does not make sense. There are LED luminaires that scale up and down their light output without changing the efficacy or distribution. In this case the low output will pass while the high output will fail. This may open up the temptation to use two lower wattage luminaires on a pole because they are Energy Star rated instead of using the single head higher output fixture that does not qualify. Also there will be a segment of fixtures that will operate at or near the threshold (9500 lumens) lumen level, and the difference between qualifying

and not qualifying will be a matter of a few lumens, and it seems counterproductive to discourage development of luminaires exceeding 9500 lumens.

Luminaire	Luminaire Output	Input Watts	Photometric LPW	Uniform Pool Area	% Target Rectangle Covered	FTE Adjusted Lumens	FTE LPW	FTE Required
Type 3 - Low Output	5135	82.60	62.16	17.87	75.2%	3592	43	37
Type 3 - High Output	10269	165.20	62.16	17.87	75.2%	7183	43	48

Figure 3: Low output and high output variations of the same optic/luminaire.

Given an optical system with the same energy efficiency and optical efficiency, the “high output” version fails the minimum required FTE, while the “low output” version passes.

- With regard to “Step 13” in the FTE algorithm: “If the rectangle exhibits asymmetry about the y-axis, redraw the rectangle using the x-coordinate of greatest magnitude.”

Some fixtures, mostly for roadway lighting, use an asymmetric pattern on purpose, and will be punished *greatly* for having the majority of the lumens on one side of the y-axis.

Plot #	Filename	Luminaire Output	Input Watts	Photometric LPW	Uniform Pool		Uniform Pool Area	% Target Rectangle Covered	FTE Adjusted Lumens	FTE LPW	FTE Required
					Avg / Min	Max / Min					
1	Asymmetric Throw (current FTE target rectangle)	6247	120.00	52.06	5.42	29.95	14.96	45.8%	2522	21	37
2	Asymmetric Throw (suggested FTE target rectangle)	6247	120.00	52.06	5.42	29.95	14.96	74.0%	4078	34	37

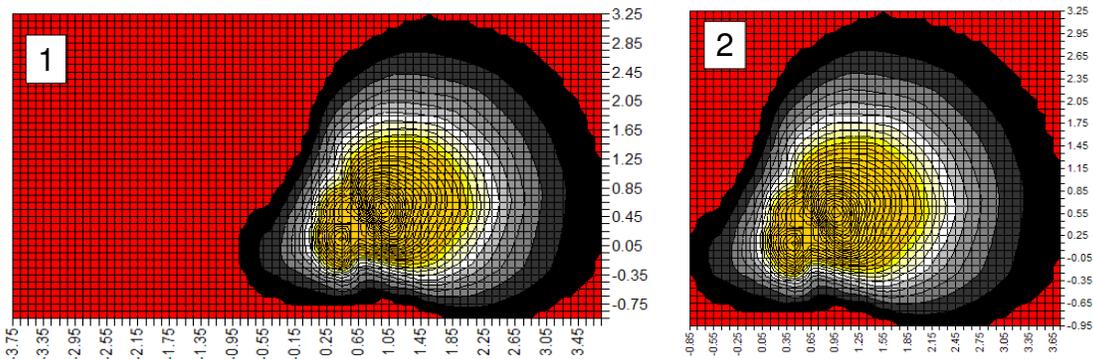


Figure 4: Asymmetric roadway luminaire analyzed with current FTE target rectangle, and an asymmetric rectangle.

The first plot shows how an asymmetric throw will be considered with the current FTE method. The second shows the illuminance plane where the maximum and minimum x-values are used to define the target rectangle. The swing in FTE is 13 lm/W, and while still not qualifying, it is a big difference, and could determine whether a product passes or fails.

Recommendations:

1. Shapes other than rectangles need to be considered for the fitted target area. This is especially true for asymmetric distributions. Penalizing asymmetric distribution could actually encourage light trespass for example. With the diversity of product applications, there should not be one standard target area shape that all outdoor lighting must conform to.
2. For roadway distributions, contributions behind the pole need to be treated differently than for area lighting. Also, consideration must be given regarding the application as to whether or not house side lighting is beneficial or not. Lastly, a non-straight edge cut off on the front of the distribution can be beneficial as well for street lighting.
3. Recognition of the potential safety and security benefits of low light levels extending beyond the 1/30th illuminance line.
4. For area lighting applications in particular, consideration must be given to the complementary contributions of multiple fixtures on a given pole and indeed an array of similarly mounted luminaires.
5. Unlike many traditional sources efficiency of LED luminaires is not dependant upon the total lumen package; therefore, combine the “high” and “low” output categories as segregation encourages the development of low output resulting in additional fixtures and resultant energy consumption to achieve recommended IESNA light levels in many applications.
6. There should be more consideration to the coverage area and watts used; however there are applications where you want higher light levels and the luminaire will need to cover less area with more light. It may be difficult to set a minimum, but the current method encourages light dumping under the pole.