

March 4, 2014

LED Lumen Maintenance and Light Loss Factors

All lighting systems decline in lumen output over time, due to reductions in lamp emissions and changing surface properties. This decline is typically accounted for by applying a light loss factor (LLF) during the design process. An LLF is a multiplier that's used to predict maintained illuminance based on the initial properties of a lighting system.

A [new article](#) published in *Leukos: The Journal of the Illuminating Engineering Society of North America* (IES) discusses complications related to the lamp lumen depreciation (LLD) light loss factor and LEDs. Entitled "Lumen Maintenance and Light Loss Factors: Consequences of Current Design Practices for LEDs," the article compares the performance of some conventional and LED products, and examines alternatives to the currently recommended approach for determining LLD factors for LED products. It was written by Michael Royer of Pacific Northwest National Laboratory, a member of the U.S. Department of Energy (DOE) solid-state lighting team.

Light loss factors are used to help lighting systems meet quantitative design criteria throughout the life of the installation, but they also have other consequences, such as influencing first cost and energy use. Because of the unique operating characteristics of LEDs and lack of a comprehensive lifetime rating – as well as the problematic relationship between SSL lifetime and lumen maintenance – determining an appropriate LLD factor for LED products is difficult.

For LED-based lighting systems, the IES recommends using an LLD of no greater than 0.70 when the quantity of the light is an important design consideration. This approach deviates from the practice of using the ratio of mean to initial lumen output – which is typically used with conventional sources – and may misrepresent actual performance, increase energy use, and inhibit comparisons between products.

With all of the effort that's put into improving luminous efficacy in the name of energy efficiency, the effect of LLFs on energy use may deserve more attention, with more care given to using an LLD that best represents expected performance

for a given installation. For example, a change in LLD from 0.70 (resulting in an initial light level at 143 percent of the target) to 0.80 (initial light level at 125 percent of the target) can reduce energy consumption by roughly 13 percent over the life of the system.

For LED lamps and luminaires, the rated lifetime provided by manufacturers is typically based on only the lumen maintenance of the LED package, which has become the de-facto method for providing rated lifetime for LED products. Although the lumen maintenance lifetime of LED architectural lighting products is almost always based on L_{70} (the time it takes for the lumen output to fall to 70 percent of what it was originally), this is not helpful for calculating an LLD factor. As an alternative, it may be more appropriate to instead use a known end point (e.g., the building being renovated in 15 years) in establishing the end of life used for lighting calculations. This would allow specifiers to more easily distinguish between products with different lumen depreciation characteristics and design systems that are more energy-efficient over their lifetime.

Instead of giving lumen maintenance in terms of L_{70} , it may be more useful for manufacturers to report the lumen maintenance at a given number of hours of use – such as at 25,000 hours, which is already being adopted by the [LED Lighting Facts](#)[®] program. This would allow for expedient product comparisons using manufacturer literature.

Although it may seem a prudent approach for a relatively unproven technology such as SSL, there are considerable consequences to capping the LLD for LEDs at 0.70. Effectively applying the same LLD to all LED products ignores the large variation in performance and is inconsistent with current methodology for characterizing other lighting systems. Long-term test data show that 0.70 is far too conservative for some LED products and hinders efforts to ensure specification of high-quality products. But the current link between LED rated lifetime and lumen maintenance effectively precludes the use of traditional methods for calculating LLDs.

Any revised method for determining LLDs should be consistent across different light-source technologies and allow for effective comparisons of product performance, so that specifiers can differentiate products with less depreciation over time. In turn, this can save substantial amounts of energy and provide a more pleasing visual environment.

For a much more in-depth treatment of this important topic, please see the full article, which is accessible from the [DOE SSL website](#).

As always, if you have questions or comments, you can reach us at postings@akoyaonline.com.