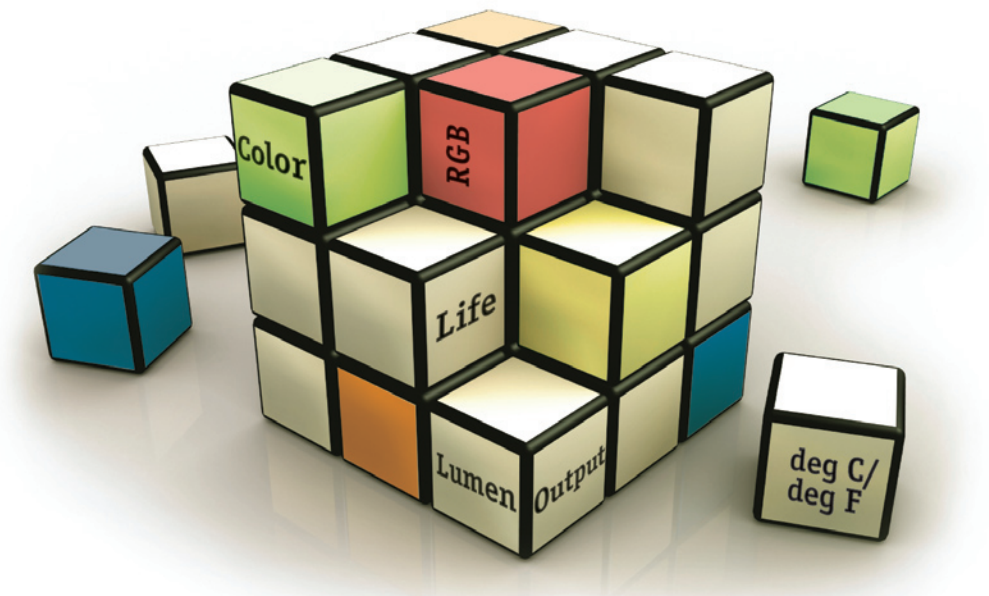
LEDs FOR GENERAL ILLUMINATION: A CALL FOR STANDARDS

BY RON NEWBOLD



While it's not quite the 'Wild West,' the LED landscape has been characterized by a lack of standards regarding product performance. If LEDs are to gain widespread acceptance, that must change

Light Emitting Diodes (LEDs) are increasingly being introduced into general illumination lighting products with many recent technological advancements paving the way. However, those that specify fixtures using LEDs must be aware that there are virtually no standards in the industry for how to measure, report, apply or test them. In the absence of such standards, inconsistencies in how lighting manufacturers report performance characteristics of LED fixtures may occur. Here are some areas involving LEDs that standards should address to ensure consistency in how they are selected and applied.

1. Photometry Measurement & Reporting

There are no standards for manufacturers to follow in measuring light output in an LED fixture. Some standard proposals are beginning to emerge, but there is a great deal of debate over how they should be drafted. This debate may extend the time it takes to produce industry standards for LED testing and measurement. Anyone publishing LED photometry has done so by following their own guidelines, and the accuracy of such data is entirely dependent upon their tendency to exercise conservative judgment. There is potential to overstate the light output of an LED fixture, especially when conducting relative photometry. The lumen value of an LED source is manually input into a conversion program to create the IES file and can easily be overstated based on the data provided by LED manufacturers that may also be overstated. This is due to the amount of tax on lumen output the LED can experience when married into the fixture. Poor thermal management, for example, will lower an LED's lumen output from its rated lumen value.

2. Technical Data

Color. There are essentially two ways to create a white LED. First, the RGB (red/green/blue) configuration of LEDs can be controlled to produce a clean white light with very little variance in Kelvin. However, RGB is often cost prohibitive for use in general illumination and is more commonly used for color mixing applications. Second, a PCB (phosphor converted blue) LED is mostly used for general illumination due to cost. PCB LEDs possess inherent color variations with certain bins. Binning is the process an LED manufacturer uses to sort LEDs by characteristics such as color and light output. The tighter the color range requested by a lighting manufacturer, the higher the cost to the manufacturer. Therefore, lighting manufacturers must strike a delicate balance between cost and color variation. Because of this, some manufacturers will have higher variance than others with regard to color.

Life. How LED life is presented is probably the most misunderstood variable regarding performance. Unlike most traditional sources, LEDs have passive end of life in that their light output diminishes over operating life. With this in mind, it is critical to know the lumen maintenance for an LED at the stated hours of life. For example, an LED may last 100,000-plus hours, but few manufacturers will state the lumen maintenance for this same amount of time. Others may state 50,000 hours with 70 percent lumen maintenance, which provides a more realistic and workable expression of LED life.

Lumen Output. Most traditional light sources have stated lumen ratings for initial and mean lumens. These values are fairly consistent within a production run of

Stumping for Standards

Standards for solid-state lighting products appear to be high on the "to do" list at the U.S. Department of Energy. This past March, DOE hosted an LED Standards Industry Workshop to provide a forum for greater cooperation and coordination among standards organizations, including the IESNA, National Institute of Standards and Technology (NIST), National Electrical Manufacturers Association (NEMA), American National Standards Institute (ANSI), Underwriters Laboratories (UL), International Electrotechnical Commission (IEC), International Commission on Illumination (CIE), and Canadian Standards Association (CSA).

Following that meeting, in July, the DOE and IESNA signed a Memorandum of Understanding, agreeing to work together on the development of standards. Among the goals of the MOU are the development of "guides and procedures to assist the lighting community in the photometric measurement of SSL devices."

the same type. However, LED lumen output can vary as much as +/- 20 percent from one LED to the next within a given bin. In addition, LED light fixtures commonly use multiple LEDs to achieve the quantity of light required for the intended application. Lighting manufacturers are free to state the low or high of this range, the average, or some other lumen value they desire. Also, the initial lumens published by LED manufacturers apply only for the first few seconds of illumination. LEDs will lose five-to-10 percent of their initial lumens within a few seconds of illumination due to thermal stabilization. This initial loss can be as much as 20 percent if the fixture design has not adequately taken into account thermal management requirements. A lighting fixture manufacturer should derate the lumens being used for published photometry to take into account these two variables. This would ensure the most conservative estimates of fixture performance for a lighting designer.

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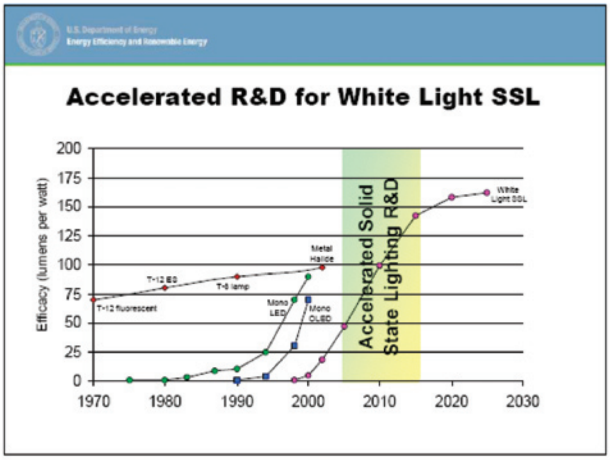
3. Fixture Performance

Ambient Temperature. The typical ambient temperature in which lighting fixtures are tested for thermal performance and photometry is 25 deg C/77 deg F. An LED's performance is directly dependent upon the temperature at its junction, which is the region directly behind the diode. LED manufacturers publish maximum allowable junction temperatures to ensure optimal performance of the LED itself. In general, LEDs operate better the cooler they are, and when pushed to extreme high temperatures, they will lose life and light output. Considering this, lighting specifiers must understand the maximum ambient temperature the manufacturer recommends for a given fixture to ensure that the life and performance are not jeopardized by the conditions of the application. Manufacturers should always publish an ambient temperature maximum for an LED fixture in their specification sheets for this reason.

Wattage Consumption. LEDs need to be driven with constant current. There are some methods to drive the LEDs with direct AC, although this is currently a fringe method. LEDs will vary in the turn-on voltage resulting in the amount of energy they consume. This is an inherent characteristic of LEDs where the same LEDs for a given bin may have input watt consumption that varies –19 percent/+24 percent off the typical value published by the LED manufacturer. This consumption will also vary based on the amount of current being delivered to the LEDs. For example, a 3-W LED may be intentionally under-driven resulting in consumption that might be closer to 2.5 watts. This will make the junction temperature run cooler, thus extending life and enhancing performance. ASHRAE has not yet identified how to calculate power densities (lumens per watt) for LEDs, so it is recommended the average be used until this is formalized in code. The best practice is to always refer to the lighting manufacturer's specifications or technical support group for how to calculate the power draw of an LED light fixture.

FUTURE TRENDS

Reputable LED manufacturers are making big strides towards more consistently performing LEDs with higher lumen per watt ratings. Being able to meet power density requirements has been one of the most common obstacles in utilizing LEDs in general illumination. However, the U.S. Department of Energy has forecasted white LED LPW ratings to exceed that of fluorescent and HID sources by 2010 (see **Table**). Based on this, it is easy to imagine LEDs becoming one of the main sources for general illumination in the very near



Based on U.S. DOE forecasts, LEDs for general illumination appear poised to gain significant market share.

future, bearing in mind the ever increasing pressure to conserve energy.

LEDs are in the infant stages of development for use in general illumination. The technology has reached a point where light levels and life expectancy make LEDs ideal sources for applications where this was not the case as recently as one year ago. Standards will eventually be put into place to ensure consistency in performance and specifications, but until that time, lighting designers should take the variables contained in this review into account when specifying LED light fixtures for general illumination.

About the Author: Ron Newbold, Member IESNA (2003), is senior product manager for the Prescolite Division of Hubbell Lighting, Inc., and has worked in the lighting industry for 16 years serving Prescolite, Lithonia Lighting and Progress Lighting. Most of this time has been in product management and product development. He holds five patents and has a B.S. in Psychology from Indiana University and a Masters of Science in Management from Indiana Wesleyan University.