Standards Are the Future

DR. NADARAJAH NARENDRAN, JENNIFER TAYLOR

For end users to accept LED products, manufacturers need to present consistent and accurate life data. One industry group is here to help set the standards.

SOLID-STATE LIGHTING: WHAT IMPACT IT WILL HAVE ON THE lighting industry is on everyone's mind. Although the dream of lighting indoor spaces with light-emitting diodes (LEDs) began almost four decades ago, the hope of achieving this dream did not come alive until the mid-1990s, when Nichia marketed commercially viable blue LEDs. Subsequently, the white LED, created by incorporating a yellow phosphor with the blue LED, marked the beginning of the solid-state lighting revolution. But while the LED industry cheers the continued success of white LEDs and exalts their position as the future of lighting, a problem looms: The absence of standards for LED lighting is creating a roadblock between unbounded technological potential and consumer acceptance. Greater light output and efficacy are key to future success, but without measures to ensure product reliability and consistency, consumers may be unwilling to make the leap.

INTEREST AND CONFUSION

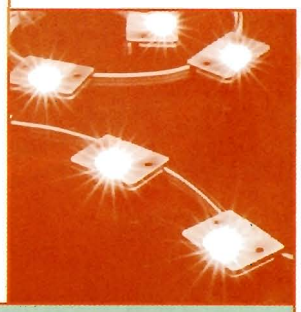
The first white LED produced less than 1 lumen of luminous flux with an efficacy around 10 lumens per watt. Since then, manufacturers have gradually released high-power LEDs (now around 30 lumens per watt for white), and the industry is pushing for white LED technology over 100 lumens per watt. Laboratory demonstrations have shown values exceeding 80 lumens per watt.

The LED's transition from indicator to illuminator has given the architectural lighting world reason to notice the technology's potential, and the LED industry has quickly promoted LEDs as an energy-efficient lighting solution. However, the benefits touted have led to confusion, underscoring the need for standards. For example, long life is one of the most commonly advertised benefits of LED technology, with product literature typically claiming 100,000-hour life. Does this mean these products can be used in applications for 100,000 hours without replacement? Unfortunately, it is not clear from most of the product literature what this number actually means. The common practice in the lighting industry is to subject light sources to a specified on-off cycle (different for each technology), and determine the time at which half the number of lamps stop producing light. Alternatively, the electronics industry (producers of LED technology) defines life as mean-time-between-failure (MTBF). In certain instances, the electronics industry has used light-level depreciation criteria to define the life of LEDs. The Lighting Research Center (LRC) has monitored the life performance of LED technology since the late 1990s. Although initial white LEDs experienced rapid light output degradation at rated current and room temperature, the newer high-power versions are showing a much slower rate of degradation. Some of these devices are lasting over 50,000 hours before their light output reaches the 50 percent depreciation mark.

To benefit the user, the LED system or fixture, not just the individual LED, has to operate for a long time. An unfortunate feature of LED technology is that with increased heat at the light-emitting area (commonly known as the junction), the rate of light output degradation increases. For example, if the temperature at the junction increases by 10 degrees, some LEDs can experience double the degradation rate, cutting the life in half.

DEFINITION AND MEASUREMENT

Given the confusion that long-life claims can generate, how does the industry ensure satisfaction from the ultimate judge and jury of LED lighting, the consumer? The Alliance for Solid-State Illumination Systems and Technologies (ASSIST) has taken a first step toward standards that protect against unsubstantiated life claims by recommending guidelines for LED life and methods for measuring life. Founded in 2002 to help speed acceptance of energy-efficient LED lighting technologies, ASSIST is an industry collaborative funded by traditional lighting manufacturers, LED manufacturers, large-scale purchasers of LED systems, and government agencies. The goal for these new guidelines, called *ASSIST Recommends*, is to help manufacturers present consistent and accurate life data for their products, which will help consumers make product comparisons and life-cycle cost estimates.



PRESENTING LIFE DATA FOR LEDs

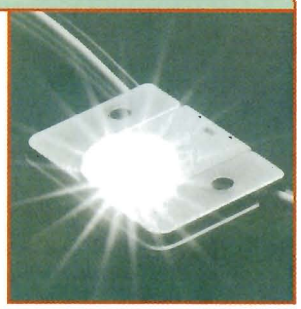
ASSIST recommends that LED component and system manufacturers report the following information in their data sheets for each specified testing condition.

LED COMPONENTS

- Life (hours) at 70% and at 50% lumen maintenance with plot graph of measured and extrapolated data
- Number of samples tested
- Heat sink description
- Ambient temperature
- Thermal resistance coefficient
- Voltage and current
- Junction temperature

LED SYSTEMS

- Life (hours) at 70% and at 50% lumen maintenance with plot graph of measured and extrapolated data
- Number of samples tested



Because LEDs generally do not experience catastrophic failure, it is possible for them to continue to operate but not produce enough lumens for a given task or space. Based on studies of visual perception, ASSIST selected lumen maintenance values of 70 percent for general lighting applications and 50 percent for decorative lighting. Thus, the end of life for an LED or LED system occurs when

it has lost 30 to 50 percent of its initial light output. (Within this time period, LED color shift should be within a 4-step MacAdam ellipse, a customary tolerance range where color changes are imperceptible to most.) ASSIST asks manufacturers to estimate the number of hours to 70 percent and 50 percent lumen maintenance, which consumers can use as relamping criteria for LED fixtures.

Getting accurate life-hour estimates, however, has not been easy. Manufacturers ordinarily do not provide measured life data for their products. The absence of a standard measurement method is partially to blame. The need for long testing periods—years in some cases—has also been a hindrance. To aid the process, ASSIST developed an abbreviated life-test method that provides reliable estimates for product life. The group established separate methods for high-power and low-power components (individual LEDs running over and under 100 milliamperes) and systems (for example, optics or fixtures with housing).

Measuring both components and systems requires a minimum 6,000-hour life test with the product running at rated current and at certain temperatures. The first 1,000 hours is an initial seasoning period for the LEDs; the next 5,000 is for collecting light output data, which are used to measure the hours needed to reach 70 percent and 50 percent lumen maintenance. During the initial seasoning period, LEDs undergo abnormal changes and increases in light output before settling into a more predictable rate of decline. Inclusion of the first 1,000 hours of data can lead to false estimates of life, and therefore ASSIST proposes that these data be discarded. If 70 percent and 50 percent are not reached within the first 6,000 hours, manufacturers can extrapolate life values by applying a mathematical fit to the light output data collected between 1,000 and 6,000 hours.

Components measured under specific conditions, as outlined by ASSIST, will also give a realistic picture of how the rate of degradation changes at different temperatures, providing life estimates for an average, industry-accepted ambient temperature.

ASSIST's proposed definition and methods will help transition between recommending to standardizing LED life and life measurement. Obviously, creating standards can be a very long, involved process, but encouraging manufacturers to look at the issues and agree upon compliance is critical, since consumer confidence in this new, evolving technology will only increase when LED products meet their claimed life values.

The ASSIST collaborative consists of Boeing, GELcore, the LRC, New York State Energy Research and Development Authority, Nichia America, Osram Sylvania, Philips Lighting, and the Environmental Protection Agency. ASSIST Recommends *is available at: www.lrc.rpi.edu/programs/solidstate/assist/recommends.asp.*

Dr. Nadarajah Narendran is director of research at the LRC and an associate professor in Rensselaer Polytechnic Institute's School of Architecture. Jennifer Taylor is a senior communications specialist with the LRC.