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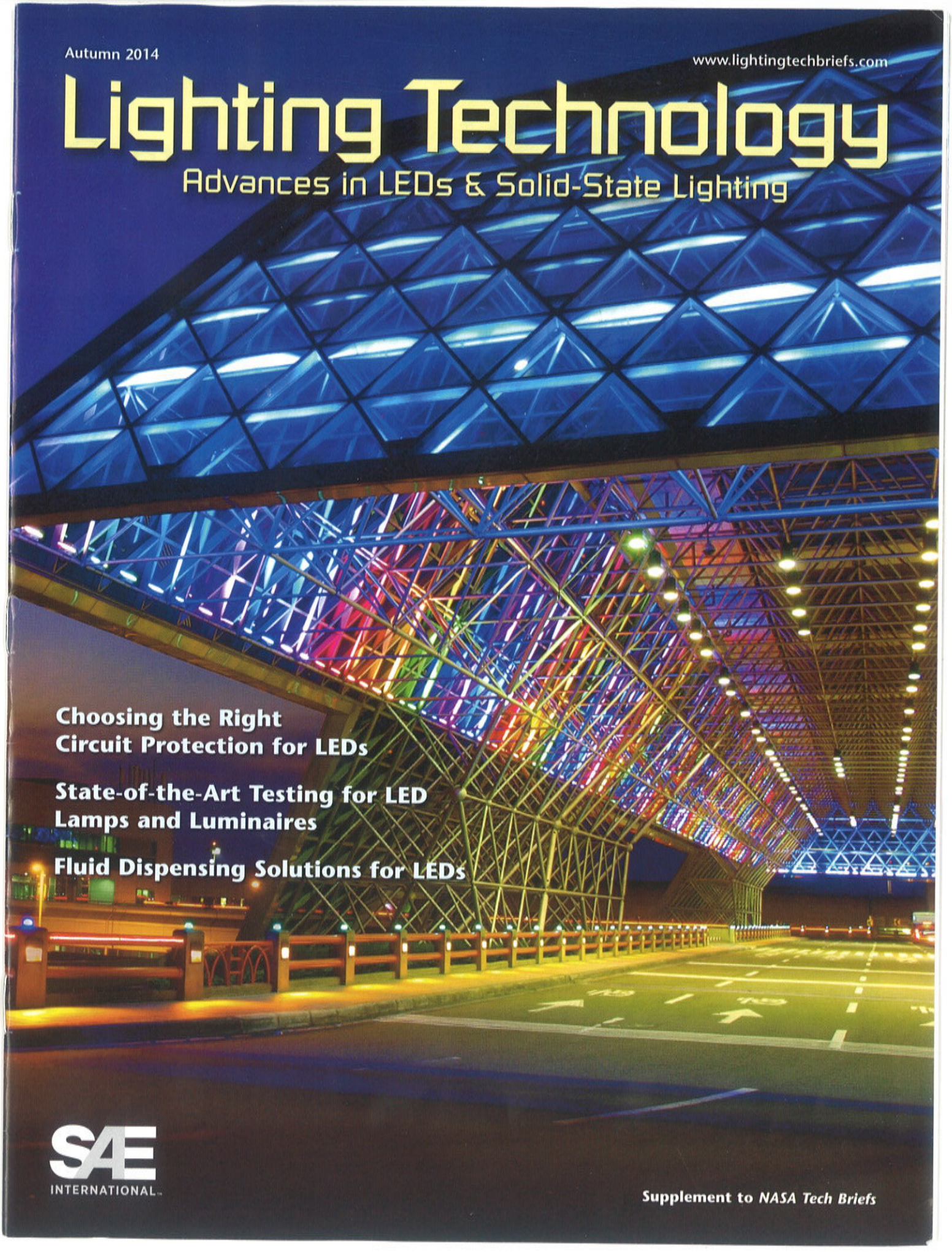
Advances in LEDs & Solid-State Lighting



Choosing the Right Circuit Protection for LEDs

State-of-the-Art Testing for LED Lamps and Luminaires

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State-of-the-Art Testing for LED Lamps and Luminaires

By David M. Delgado, MaxLite, West Caldwell, NJ

MaxLite opened its first US assembly operation, including state-of-the-art testing facilities, in 2012 at its West Caldwell, New Jersey corporate headquarters.

Unlike previous lighting requirements, LED testing has become more stringent and complicated, and involves a significant number of tests for various lighting characteristics. From measuring lumen output, efficacy, correlated color temperature (CCT), color rendering index (CRI), and photometrics to calculating life spans, MaxLite has advanced its rigorous procedures of testing and inspection in the new world of solid-state lighting.

Previous requirements or relative photometry for testing a fixture with lamps required that the lamps be "seasoned" for 100 hours prior to testing when installed in the luminaire as a system, to determine its total lumen output. LED luminaire testing (LM79) tests the entire luminaire with minimal stabilization of the luminaire, thus creating an absolution photometry – the absolute lumen output of the luminaire with the lamp installed and measured. Individual lumen and efficiency are not reported.

MaxLite tests for electrical and photometric measurements of its LED lamps and luminaires (the complete product) to meet IES LM-79 standards and procedures for performing reproducible measurements of LED properties, including: total luminous flux, luminous intensity distribution, electrical power, luminous efficacy and color characteristics such as CRI, CCT and chromaticity. The scope of LM-79 applies to LED products that incorporate control electronics and heat sinks. LM-79 testing requires complete luminaire testing on an absolute photometric basis. However, for solid-state lighting products, the LED lamps typically cannot be separated from their luminaires.

Well-equipped testing labs utilize an integrating sphere and goniophotometer to complete LM79 testing. Lumen output is measured by using an integrating sphere where photometers take measurements of total luminous flux. A goniophotometer is a device used for measurement of the light emitted from an object at different angles. Its use has been increasing in recent years with the introduction of LED-light sources, which are mostly directed light sources and the spatial distribution of light is not homogeneous.

The integrating sphere, also known as an Ulbricht sphere, is an optical component consisting of a hollow spherical cavity, with its interior covered with a diffused white reflective coating, with small holes for entrance and exit ports. Its relevant property is a uniform scattering or diffusing effect. Light rays incident on any point on the inner surface are, by multiple scattering reflections, distributed equally to all other points. The effects of the original direction of light are minimized. An integrating sphere may be thought of as a diffuser which preserves power but destroys spatial information and is typically used with some light source and a detector for optical power measurement.

The GO-2000 goniophotometer from Everfine features a fixed photometer head around which the lamp or luminaire rotates. (Photo courtesy of Everfine)

A similar device is the focusing or Coblentz sphere, which differs in that it has a mirror-like (specular) inner surface rather than a diffuse inner surface. The practical implementation of the integrating sphere was due to work by R. Ulbricht (1849–1923) published in 1900, and it has become a standard instrument in photometry and radiometry. The sphere has an advantage over a goniophotometer for measuring the light produced by a source so that total power can be obtained in a single measurement.

The life span of an LED luminaire is measured from an ISTMT (In Situ Temperature Measurement Testing) test, which takes thermal readings at the LED chip and driver. This information, along with testing data from the LED chip manufacturers' LM80 report, is then calculated using the TM21 calculator from Energy Star, to achieve a life expectancy of the product in a number of hours (eg. 80,000 hours). Information is inputted into a TM21 report from Energy Star for life expectancy of product, and records of all files including LM9, LM79, LM80 and TM21 are available when required by engineers or inspectors.

MaxLite currently works with six testing laboratories – three on each coast – to test and certify LED lamps and fixtures. In addition, the company will open a UL-authorized testing lab in its new LEED-Certified office in Anaheim, California in 2015. They will also expand the West Caldwell, New Jersey headquarters to include a NVLAP-certified lab.

NVLAP

The National Voluntary Laboratory Accreditation Program (NVLAP) provides an unbiased third-party evaluation and recognition of performance. NVLAP accreditation signifies that a laboratory has demonstrated that it operates in accordance with NVLAP management and technical requirements in areas such as quality systems, personnel, accommodation and environment, test and calibration methods, equipment, measurement tractability, sampling, handling of test and calibration items, and test and calibration reports. NVLAP accreditation does not imply any guarantee (certification) of lab performance or test/calibration data; it is solely a finding of lab competence. A lab may cite its accredited status and use the term NVLAP and symbol on reports and in business and trade publications, provided that this use does not imply product certification. For a testing lab to achieve NVLAP certification, it must pass stringent requirements showing its capability of handling and testing products in a manner that is required by the NVLAP-certification process.

Products are rated for use in dry, damp and wet locations by UL (Underwriters Lab) or ETL (Electrical Testing Labs), a product safety-listing lab of the Intertek Group. UL and ETL test products for the applications that a manufacturer designates. Dry application can be tested for IC (insulation contact) or Non IC (no contact by insulation). Damp location testing subjects products to periodic condensation of moisture for use in partially protected locations. Wet location testing requires the product to be exposed to rain and to verify if water enters the luminaire or if there are holes for drainage on the oft chance moisture does seep into the luminaire.

Our application and certification department retains specialists that provide technical assistance and ensure that lighting plans and product designs conform to industry codes and standards, including Energy Star, California's Title 24, the Illuminating Engineering Society (IES), DesignLights Consortium (DLC), Lighting Facts, Lighting Design Lab (LDL) and NSF International (formerly the National Sanitation Foundation). In addition, we work with the International Association of Lighting Designers (IALD) and Green Building Standards (GBS) organization to ascertain certifications for LEED (Leadership in Energy and Environmental Design) buildings. Each organization has its own stringent requirements that must be met or exceeded. Some, for example, re-

Example of a large integrating sphere used to measure transmittance and reflectance. ("Luminance Chamber" by Swoolverton)

Assembling and testing LED products in the U.S. enables MaxLite to maintain tighter quality control and conformance to standards.

quire high CRI, zonal performance, and high efficacy (Lumens per Watt).

Energy Star

Introduced by the U.S. Environmental Protection Agency in 1992 as a voluntary market-based partnership to reduce greenhouse gas emissions through increased energy efficiency, Energy Star offers businesses and consumers energy-efficient solutions to save energy, money, and help protect the environment for future generations.

The DLC is a collaboration of utility companies and regional energy efficiency organizations that is committed to raising awareness of the benefits of efficient lighting in commercial buildings. The DLC helps builders, architects, designers, and commercial property owners to implement improved design practices in all areas of the commercial lighting market while ensuring that high-quality, energy-efficient lighting design becomes commonplace in all lighting installations. DLC requirements are different for each of the 37 categories currently listed on the QPL. The requirements range from Minimum Lumen Output, Zonal Lumen Requirements, Minimum Efficacy, Allowable CCTs (per ANSI specs), Minimum CRI, L70 Lumen maintenance and warranty.

Many LED lighting solutions must be designed and engineered to conform to municipal codes and energy efficiency standards, such as California's Title 24 and the IES B.U.G. (Backlight Uplight and Glare) rating. These standards include the photometric and energy analyses of projects, the coordination of custom fixture opportunities for projects, and working closely with municipalities and industry associations. California has one of the most stringent energy-efficient requirements in the country. The majority of these products must have dimming drivers or ballasts, and outdoor products require photocells or occupancy sensors. All LED lamps must achieve a minimum of 90 CRI to be listed on the California Energy Commission website. Title 24 of the California Code of Regulations governs the structural, electrical, mechanical, and plumbing systems of buildings constructed or altered in the state after 1978. The lighting portion of Title 24's Building Energy Efficiency Standards requires high efficacy luminaries or dimming controls for most commercial and residential spaces. New standards, which took effect July 1, 2014, introduce requirements for photosensors, occupancy sensors and multi-level lighting controls, both indoors and out.

MaxLite works with the LDL, which qualifies LED products while they are being reviewed by Energy Star and DLC and uses their standards to qualify products for the Pacific Northwest utility companies. LDL lists products for no longer than one year until Energy Star or DLC qualification is usually completed. LDL's interim qualified products list ensures that products qualify for rebates for one year by most utility companies in the Pacific Northwest region of the United States, which includes Washington, Oregon, Idaho, Montana, Utah and Alaska.

L70 testing is an industry-accepted measurement of testing LED fixtures and lamps for lifespan. The results of these tests are used to meet Lighting Facts and DLC requirements of TM21, the IES-approved method for calculating useful LED lifetime projections using LM-80 and In Situ Temperature Measurement Testing (ISTMT) data. LM-80 is the industry standard for measuring the lumen depreciation of the LED light source and is a requirement for Energy Star qualification.

ISTMT data are implemented to calculate the LED source case temperature within the lamp or luminaire. The tests are performed by Occupational Safety and Health Administration (OSHA)-approved NRTLs or Department of Energy (DOE) Caliper Recognized or UL Data Acceptance Program laboratories. The measurements are based on the temperature measurement point (TMP) indicated by the LED chipset manufacturer, which includes thermal management and heat sinking. The ISTMT testing is achieved by attaching a Thermal Conductor to the LED chip at a location that the LED chip manufacturer assigns in the LM80 report. The test result is the temperature of the LED chip as it performs inside the luminaire.

As controls play a greater role in energy-efficient lighting, we spend an extensive amount of time testing LED lamps and fixtures for compatibility with a broad range of dimmers, timers, motion detectors and daylight harvesting. When incorporating these elements into lighting designs, architectural luminaires must be tested on both a component and system level.

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