



STANDARDIZATION ACTIVITIES FOR SOLID STATE LIGHTING IN THE USA

Yoshi Ohno

National Institute of Standards and Technology, Gaithersburg, Maryland, USA

With the initiative of the U.S. Department of Energy (DOE), efforts to develop a series of standards for solid state lighting (SSL) started in March 2006, as the DOE announced the initiation of Energy Star program for SSL starting in 2008. The standardization efforts are coordinated among the standardizing bodies and related groups including American National Standards Institute (ANSI), National Electrical Manufacturers Association (NEMA), Illuminating Engineering Society of North America (IESNA), Underwriters Laboratories (UL), National Institute of Standards and Technology (NIST), International Commission on Illumination (CIE)-USA, and Canadian Standards Association (CSA). Several standards needed to support the Energy Star program were identified such as for chromaticity specification, photometric measurements, lifetime, terminology, LED drivers, and product safety. Performance standards are developed by ANSI, and measurement standards (or test methods) by IESNA, and safety standards by UL. The committees mainly involved in this effort were ANSI C78-09 and C82-04 working groups, and Testing Procedures Committee of IESNA, in particular, the SSL subcommittee. Efforts are made to harmonize with any existing international standards. DOE also requested NIST National Voluntary Laboratory Accreditation Program (NVLAP) to develop an accreditation program for solid state lighting products. Separate from these activities, a series of industrial recommendation documents ASSIST Recommends are available, some of which can be bases for future standards.

The DOE Energy Star specification was issued in September 2008. Two step approach is taken, first with Category A that lists several niche application lighting products and Category B for general applications. Only Category A is now applicable. The requirements depends on product type, and includes luminous efficacy (20 to 35 lm/W), chromaticity (per ANSI standard), color rendering (CRI Ra>75 for indoor applications), lifetime (25,000 h indoor, 35,000 h outdoor), and others (minimum light output, zonal flux, etc.). In late 2011 Category A is planned to be eliminated and unified to Category B that requires 70 lm/W. The product listing of Category A is being expanded, and the lm/W requirements are revised (increased) every year to approach 70 lm/W in next few years. To monitor the quality of the SSL products on the market, the DOE runs Commercially Available LED Product Evaluation and Reporting (CALiPER) program.

The first standard developed is ANSI-NEMA-ANSI C78.377 Specifications for the chromaticity of SSL products, published in February 2008. NIST led the effort to develop this standard. This standard specifies the ranges of white light chromaticity for eight nominal correlated color temperatures (CCT) from 2700 K to 6500 K, which were chosen mostly to be consistent with those for fluorescent lamps. The differences are that 4500 K and 5700 K are added in order to cover the whole CCT range continuously, and also that the flexible CCT specification is added, whereby any nominal CCT at 100 K steps can be freely selected in the CCT range. The flexible CCT, however, is not accepted in the Energy Star. Also, the concept of Duv (signed distance from the Planckian locus on the CIE (u' , $2/3v'$) coordinate) is introduced, and the chromaticity range is defined as quadrangles for tolerance of CCT and Duv.

The second one published was IES LM-79 Electrical and Photometric Measurements of SSL Products. This standard is a joint effort of the ANSI and IESNA committees, with major contribution by NIST. This document is a key standard needed by Energy Star, and provides the standard test methods for photometric and colorimetric measurements of SSL products, including luminous efficacy (lm/W), chromaticity, and color rendering. This standard first specifies operating conditions for SSL products for measurement, including ambient temperature, electrical measurements, and stabilization. "SSL products" in this standard includes LED luminaires and integrated LED lamps (replacement lamps). Therefore, this standard encompasses aspects of luminaire photometry as well as lamp photometry. Traditional luminaire photometry uses what is called Relative Photometry method, whereby the luminous efficacy (lm/W) of a luminaire is determined by the measured fixture efficiency and the rated lumen output of the lamp used in the luminaire. This method cannot be used for SSL products, as in most cases the LED sources cannot be separated from the luminaire and also because published LED data will not reproduce in the luminaire due to thermal effects. Therefore, what is called Absolute Photometry method (not common for traditional luminaire photometry) is used for LED luminaires, just like traditional lamps and integrated LED lamps are measured. Methods using sphere-spectroradiometers, sphere-photometers, and goniophotometers are included. For expressing color uniformity and deviation in chromaticity, the use of $Du'v'$ is recommended rather than a number of steps of McAdam Ellipses.

Another important standard published in fall 2008 is IES LM-80 Measuring Lumen Maintenance of LED Light Sources. This standard applies to LED packages, LED arrays, and LED modules. LED luminaire manufacturers are expected to determine the lifetime of the products based on the LED source performance measured according to this standard and the temperature of LED sources measured in the SSL products. LM-80 specifies the operating conditions and measurement of LEDs at three case temperatures with ambient temperature also controlled. It does not include the methods for predicting the lifetime of LED sources by extrapolation, for which another IES document TM-21 Lumen Depreciation Lifetime Estimation Method for an LED Module or Array is being prepared.

For terminology for LED and SSL, Addendum a to ANSI/IESNA RP-16-05 (6.8 Light Emitting Diodes) was published in 2008. This document defines such terms as LED package, LED array, LED module, LED lamp, LED luminaire, etc. Several other documents are under development. NEMA white paper on Recommendations for Solid State Lighting Sub-Assembly Interfaces for Luminaires is a preliminary step for developing a standard for electrical, mechanical, and thermal connections between LED light sources and LED luminaires. A new project to develop an IES standard on measurement of high power LEDs based on the recent NIST study also started.

NIST actively participates in these standardization activities and conducts research needed on SSL, and related NIST work is supported by the U.S. Department of Energy.