

## PWDAS-29

# CHARACTERIZATION OF SOLID STATE LIGHTING PRODUCTS FOR MEASUREMENT INTERCOMPARISONS

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As part of new energy efficiency standards created by the United States Energy Policy Act of 2005, the program known as ENERGY STAR<sup>®</sup> was formally recognized. This program is to identify and promote energy-efficient products and buildings in order to reduce energy consumption, improve energy security, and reduce pollution through voluntary labeling of, or other forms of communication about, products and buildings that meet the highest energy conservation standards. As part of the ENERGY STAR<sup>®</sup> program for solid state lighting (SSL) products, the U.S. Department of Energy (DOE) requested the National Voluntary Laboratory Accreditation Program (NVLAP), which is the Laboratory Accreditation Group within NIST, to add to the NVLAP Energy Efficient Lighting Products (EEL) LAP specific test methods used in testing certain types of SSL products.

To meet the request of the DOE, NVLAP had to develop Handbook 150-1A, *Energy Efficient Lighting Products – Solid State Lighting*, which is a supplemental handbook and checklist to ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*. In Handbook 150-1A is the requirement that laboratories will participate in two levels of proficiency testing. When the laboratory initially applies for accreditation, a bilateral proficiency test between the laboratory and the National Institute of Standards and Technology (NIST) will be conducted. In following years, the laboratory will participate in round robin testing with the other accredited laboratories. NIST was tasked to develop the protocol for the bi-lateral and round robin comparisons and to obtain and characterize appropriate SSL products to be used as proficiency artifacts. The proficiency test protocols and the characterization results of the artifacts chosen are presented in this paper.

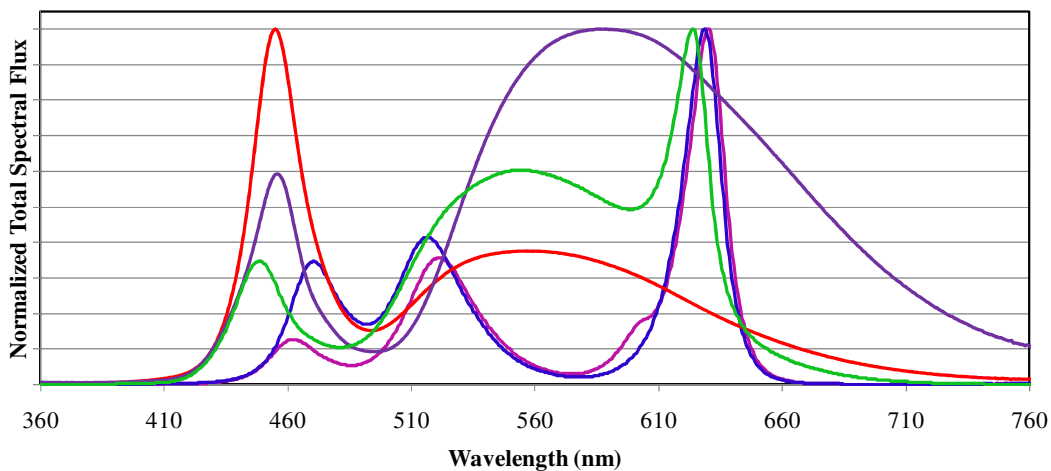
### Proficiency Test Protocols

The protocol for the bilateral proficiency test begins with NIST selecting and characterizing a variety of SSL products that qualify as different niche products defined in the ENERGY STAR guidelines. The SSL products along with instructions for specimen handling, preparation, conditioning, mounting, and testing, and data forms are provided to the participating laboratory. The completed test data forms and SSL products are sent by the participating laboratory to NIST where the SSL products are measured again. Generally, the specific proficiency test procedure is conducted in accordance with the applicable standard test method (e.g., IES LM-79 for luminous flux). At times, however, NVLAP may specify special conditions or provide out of scope products in order that the operation of a laboratory might be evaluated. For example, four SSL products may be included in the bilateral package that individually produces blue, green, amber and red light. By having the laboratory measure such special products, the quality of their wavelength calibration can be assessed if they use spectral detection or the quality of the spectral mismatch correction can be assessed if photopic detection is used. In addition, the amber product has a larger temperature coefficient for wavelength shift than the red, blue and green; therefore, with all four lamps we can assess wavelength issues and temperature conditions in the laboratory.

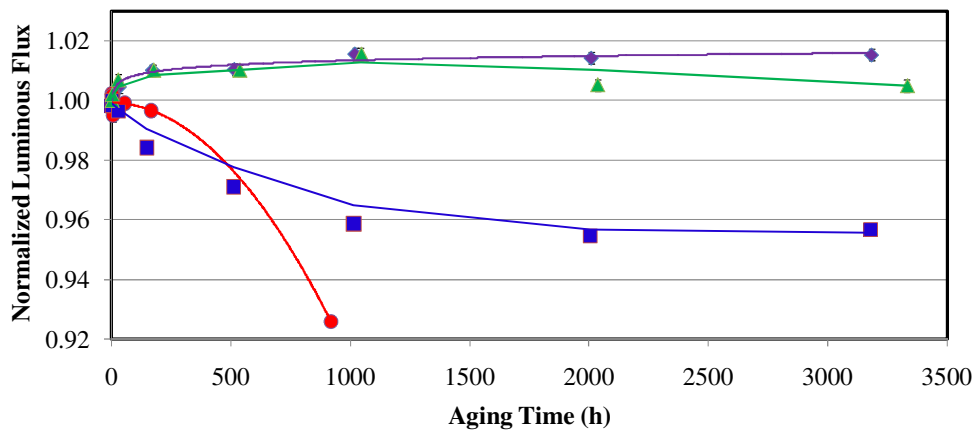
For the round robin testing four identical sets of various SSL products will be distributed to laboratories simultaneously. As with the bilateral comparison, SSL products along with instructions for specimen handling, preparation, conditioning, mounting, and testing, and data forms are provided to the participating laboratory. The SSL products in the sets are representative of the ENERGY STAR niche applications. The completed test data forms are sent by the participating laboratory to NVLAP. As the sets are returned to NIST, they are crosschecked and sent to the next laboratory. This flower or star approach minimizes the time if a laboratory is delinquent in returning the set. The results of all participants are summarized in a Tech Brief, which is edited and sent by NVLAP to the participants. The identity and performance of individual laboratories are kept confidential.

### Artifact Selection and Characterization

The SSL products selected are all available commercially. The initial selection of products was purchased based on the results of the DOE Commercially Available LED Product Evaluation and Reporting (CALiPER) program. The intention is to select the products that are most reproducible, represent a wide range of niche markets, and have a wide range of spectral and photometric qualities. Several products were chosen with different correlated color temperatures as shown in the figure.



Each product that was purchased was measured for total luminous flux and total spectral flux before aging. Each product was allowed to thermally stabilize according to LM-79, which was typically between 45 min to 120 min. The total luminous flux was then measured after total aging times of 24 h, 150 h, 500 h, 1000 h and each multiple of 1000 h. Representative data is shown below.



Information and data on chromaticity stability, product variation and repeatability of multiple products lines will be presented. This work was supported by the U.S. Department of Energy.