UVC Standards – Physical and Documentary

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Standards come in many forms. Two forms presented here are documentary standards and physical standards. Documentary standards include guidance publications, test measurement procedures, recommended practices, and performance level documents. The development and approval of a documentary standard usually follows a set procedure agreed upon by the stakeholders of the documentary standards. Physical standards are artifacts that when used or operated correctly provide evidence of physical quantity. Physical standards in this case include lamps, detectors and specific materials that have been characterized or calibrated. This talk describes the ongoing development of documentary standards in the UVC community and development of physical standards at the National Institute of Standard and Technology (NIST) for the UVC community.

As described in another talk in the Assessing the Needs for Standards for Light Disinfection session the UVC disinfection community can leverage the standard developing infrastructure of the general lighting community to produce standards to ensure a reliable, consistent market. Four topics have been identified as areas of need for documentary test measurement standards: Total radiant flux and radiant intensity distribution measurement of discharge sources; Total radiant flux and radiant intensity distribution measurement of LED chips and arrays; Total radiant flux and radiant intensity distribution of complete UV devices; and the Application distance radiometry of UVC devices.

The discharge source document will leverage existing Illuminating Engineering Society standards like IES LM-09-99/R17 “Electrical and Photometric Measurements of Fluorescent Lamps”. [1] The scope of this document covers the electrical and photometric measurements of two-ended fluorescent tubes under standard operating conditions. It is probable that the discharge source document will be a series of documents covering low pressure (LP) mercury tubes, medium pressure (MP) mercury tubes, xenon tubes including pulsed, and excimer lamps. The calibration and measurement procedures are described for using an integrating sphere system, a goniometer system, or using the Keitz formula (for LP tubes). The application of the Keitz formula will be based on the Lawal, et al publication. [2] Additional guidance is provided including measurement uncertainty considerations and information that should be provided in a test report.

The measurement of radiant flux of LED packages document scope describes procedures to determine the total spectral radiant flux (W/nm) and/or the distribution of radiant intensity (W/sr) over a wavelength range of 200 nm to 400 nm under standard electrical and operating conditions. The electrical and thermal management of the LED in a standard condition is significantly different than mercury tubes. The IES has published a measurement method for LEDs identified as LM-85-14 “Approved Method: Electrical and Photometric Measurements of High-Power LEDs”.[3] While this document focuses on the 380 nm to 780 nm wavelength range, the protocol and techniques discussed in the standard can be extended to cover the 200 nm to 400 nm range.

Similarly, the IES has published a measurement for LED devices identified as LM-79-19 “Approved Method: Optical and Electrical Measurements of Solid-State Lighting Products”.[4] This document has recently been revised considering total radiant flux and radiant intensity measurements. With small modifications LM-79 can become a measurement method for UVC LED devices.

The fourth topic is the measurement of irradiance – the amount of radiant flux falling on a surface. The IES has a current project in the Testing Procedures Committee, Project C303-16 - Application Distance Radiometry, which focuses on describing the method for measuring illuminance, irradiance, and/or photon irradiance (i.e., photon flux density) at multiple points on a plane at a specific application distance. This method would used to measure handheld UVC devices or UVC irradiating boxes or ‘ovens.’

NIST is taking an active role by improving UV measurement scales and UV measurement facilities to support the application of the documentary standards. The Ultraviolet Spectral Comparator Facility (UV-SCF) is undergoing a significant upgrade to enable the calibration of UV sensitive detectors for the quantity of power responsivity and irradiance responsivity. The improvements are based on better scale realization at NIST’s Primary Optical Watt Radiometer (POWR), picometer level wavelength control of the monochromator, environmental control of the measurement, and new sources such as laser drive plasma sources.

Using the calibrated detectors, spectroradiometer’s are calibrated using a pulsed laser system which relies on the straylight correction method developed by Zong. [5] The calibrated spectroradiometer is planned to be used in variety of applications including calibrating deuterium lamps for spectral irradiance. The laser calibration method will also be used to calibrate two sphere systems, a 30 cm diameter system mainly intended for LED measurements and 1.5 m diameter system mainly intended for customer products. The 1.5 m system is coated with a version of PTFE film intended for UV water reactors. The development of these facilities will allow the dissemination of UV scales and artefacts to the measurement community to support UV disinfection.

References:

[1] Illuminating Engineering Society, IES LM-09-99/R17 “Electrical and Photometric Measurements of Fluorescent Lamps”, 2017.

[2] Lawal, et al; Method for the Measurement of the Output of Monochromatic (254 nm) Low-Pressure UV Lamps; IUVA News, Vol 19. No 1, Spring 2017. (<http://iuvahcuv.org/wp-content/uploads/2018/06/IUVA-Protocol-for-Measuring-the-Efficiency-of-a-low-pressure-UV-lamp-190101_LawalEtAl_Spring_2017.pdf>)

[3] Illuminating Engineering Society, IES LM-85-14 “Approved Method: Electrical and Photometric Measurements of High-Power LEDs”, 2014.

[4] Illuminating Engineering Society, ANSI/IES LM-79-19 “Approved Method: Optical and Electrical Measurements of Solid-State Lighting Products”, 2019.

[5] Zong Y., Brown S. W., Johnson B. C., Lykke K. R., and Ohno Y., Simple spectral stray light correction method for array spectroradiometers, Appl. Opt., 2006, 45, 1111-1119.