Guidance Note 3/16

Measurement of the photometric performance of LED lighting

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Background

The ILP Technical Board have been made aware of a number of instances where it is being claimed that the application of the performance measurement procedures as described within BS EN 13201-4:2003 *Methods of measuring lighting performance* and ILP Technical Report TR28 *Measurement of road lighting performance on site* are not suitable for:

- Installations where LED lighting has been installed;
- Measurement within the mesopic range.

The purpose of this guidance note is to clarify the requirements for photometric performance measurement and specifically address these two points.

Requirements for undertaking photometric performance measurements

Measurement of photometric lighting performance should only be undertaken by persons who are professionally qualified and competent in the discipline of illuminating engineering. Those undertaking such work should be fully aware of:

- Measurement standards and guidance;
- The properties and calibration of the instrument(s) being used;
- The lighting installation design/measurement grids;
- Health and safety requirements for the site.

Where the task relates to highway lighting installations those undertaking measurements should be registered under the National Highways Sector Scheme (HERS)[1] for Quality Management in Highway Works. There are two key competency requirements for the role:

- Found 01 Basic Health & Safety (ECS Highway Electrical Test);
- Test 04 Photometric performance testing.

1 http://www.thehea.org.uk/HERS/

Measuring instrument

Technical Report TR28 discusses the requirements for measuring new installations and on-going performance parameters. It advises with regard to the photometers to be used and what the purchaser should look for in an instrument. These relate not only to the quality of the instrument but also the requirements for the sensor – ensuring that it has, for example, the correct detection field and that the sensor's response closely matches the CIE $V(\lambda)$ photonic eye response curve. It also advises on the requirements for the correct calibration of the instrument, especially where readings are to be undertaken for contractual purposes, and the need to maintain an operational log.

Instruments used for measurement of photometric parameters shall be Type F (for field use) as characterized according to BS 667:2005 for illuminance meters and BS 7920:2005 for luminance meters.

Photometers are generally calibrated against a standardized tungsten light source (i.e. one calibrated by an accredited laboratory by reference to national measurement standards), and in the past photometric performance measurements have generally been adjusted to correct to the spectral performance of the light source being measured by the application of a colour correction factor (CCF). This factor can vary from less than one per cent to several tens of per cent, depending on the light source and the spectral match of the photometer to the $V(\lambda)$ function. This approach has been replaced by a requirement to use a photometer with a specified colour match performance, as characterised by the so-called f'_1 mismatch index defined in CIE 69:1987. If you need to calculate a particular correction factor for a given light spectrum and photometer combination, then the procedure given in annex C.9 of BS667 should be used.

It is this aspect that is being referenced with the comment that special

considerations need to be made when measuring the performance of LED installations. This is a consideration for all light sources and not specific to LEDs.

The type of light source under which the measurement is taken makes no difference to the procedures and does not require any change in the type of illuminance meter used. For all measurements, whether of an LED installation or any other light source, the spectral mismatch of the photometer is a potential source of measurement error, which is minimized by using an instrument with a small f'_1 mismatch index.

Measuring highway illuminance

The standards are based upon photopic lighting levels, which is what is generally measured, and these are the values used in all design guidance. Scotopic lighting performance can also measured but these values are rarely, if at all, mentioned in design guidance because the light levels are extremely low.

Outdoor lighting installations generally fall within the range of 2 to 50 lux and are therefore within the mesopic range. The exact thresholds of the mesopic range depend on the amount of light that a surface reflects to a person's eye and so for a typical road surface (with an average luminance coefficient of around 0.1) the mesopic range would run from about 50 lux down to about 0.05 lux. The mesopic illuminance will fall somewhere between the photopic and scotopic illuminances, but the position between these limits changes with adaptation level so it is not a straightforward correlation. Additionally, although CIE 191:2010 defines the system to be used for calculating mesopic quantities according to the photopic adaptation luminance and the S/P ratio of the adaptation field, there is currently no agreed method for evaluating these adaptation conditions. This means it is currently not possible to make photometric measurements in the mesopic range for actual installations. CIE technical committee TC2-65 *Photometric measurements in the mesopic range*[2] is awaiting research relating to the size, shape and location of the adaptation field within the entire visual scene, which will allow the appropriate visual adaption coefficient to be evaluated so that practical, on-site measurements can be made.

The approach used within BS5489-1:2013 is one of first choosing the lighting class and the light source. Where the task being lit permits, the S/P ratio of the light source may be used to determine the allowed reduction in the specified photopic illuminance. This reduction is scaled using the CIE system for mesopic photometry[3] and is the method described in PLG03 (Lighting for subsidiary roads: Using white light sources to balance energy efficiency and visual amenity).

When considering the requirements of TR28, the measurement procedure is set against the design calculations and is therefore based upon the performance of the luminaire and light sources as provided by manufacturers in their data files.

TR28 requires the production of test/survey grids based on the design calculations which are generally taken along the kerb and centre lines of the road. Those undertaking the surveys then measure the actual illuminance levels at these points and compare them to the calculated levels to determine the performance of the installed installation against that calculated. This can all be undertaken with a standard photometer and there is no requirement to measure the S/P ratio on site.

As an example:
1. Choose lighting class and lamp type.
2. Run design programme. Where the lamp Ra and S/P ratio permit, the programme will target lower

2 Chair Teresa Goodman National Physical Laboratory, email teresa.goodman@npl.o.uk

3 Commission International De L'Éclairage. Recommended system for visual performance based mesopic photometry. CIE 191:2010. Vienna: CIE

illuminances than that stated for that class.
3. These lower illuminances are the values that should be found in on-site measurements.

For example, assume class P2 and a lamp having Ra>60 and S/P = 2.4 (for example, a cool white metal halide lamp). For this lamp the design programme will target an average illuminance of 7.3 lux rather than 10.0 lux (see Table 1 in PLG03). On-site measurements using a standard photometer will be expected to demonstrate an average illuminance of 7.3 lux.

When considering an existing lighting installation where there is no design data and the standards permit the application of an S/P ratio to reduce the target photopic illuminance, then the measured results could be 'reverse assessed' based upon the light source S/P ratio and the measured results, using PLG03 to assign the appropriate lighting class.

In the example above, if the full measured grid provides an average illuminance of 7.3 lux, then, through the application of PLG03, this can be determined as complying with the requirements of a P2 class.

Uncertainties

As discussed in TR28 and CIE 194 there will be uncertainties within the measurement process and these should be considered.

References

- CIE 194:2011 On site measurement of the photometric properties of road and tunnel lighting
- BS EN13201-4:2003 Part 4: Methods of measuring lighting performance
- CEN/TC 169 N 1246 prEN 13201-4:2013 Road Lighting, Methods of measuring lighting performance
- ILP TR28 Measurement of road lighting performance on site
- BS 667:2005 Illuminance meters. Requirements and test methods
- BS 7920:2005 Luminance meters. Requirements and test methods
- ILP PLG03 Lighting for subsidiary roads: using white light sources to balance energy efficiency and visual amenity
- CIE 191:2010 Recommended system for visual performance based mesopic photometry

Acknowledgements

Allan Howard WSP | Parsons Brinckerhoff

Consultation:

Teresa Goodman	National Physical Laboratory/Chair CIE TC2-65
Peter Raynham	University College London
Steve Fotios	Sheffield University

The ILP runs a Practical Skills Course: *Light meters, photometers and measurement*.