UK comments on directional beam angle documents submitted by ELC/CELMA to the European Commission

Submitted by the UK Market Transformation Programme on behalf of UK's Department for Environment, Food and Rural Affairs (Defra)

This document presents a commentary on an ELC submission combining a variety of files and memos that provide an overview of the ELC's position on regulations for directional lamps. This document provides context and background for some of ELC's positions taken in their recommendations to the ELC. The table below provides the title, filename and brief summary note about the ELC comment.

Title	Filename	Notes
Directional (Retrofit) LED lamps ELC survey with relevant (LED) data supporting the inclusion of Directional (Retrofit) LED lamps in the EU Regulation on ecodesign requirements for household lamps, Part II	CELMA LED(SM)054A_ELC Background info_directional LED lamps_domestic part 2 Regulation.pdf	An ELC document that compiles various files and memos, brought together in order to give an overview of ELC input for the new European regulation, in particular related to Retrofit LED lamps of the Directional type therein. March 11, 2010.

This document focuses on the four proposed correction factors that ELC recommends the Commission adopt when establishing directional lamp regulatory standards. It recommends that these correction factors be applied when adapting the regulation for clear non-directional lamps (EC 244/2009) for directional lamps. There are four correction factors, each of which are discussed below:

- Beam angle group correction factors
- Spill-light and reflector efficacy multiplier
- Lumen maintenance correction factor
- Ballast losses correction factor

1.1 Beam Angle Group Correction Factors

The European Lamp Federation (ELC) made a proposal to the Commission to establish seven groups of reflector lamps standardising the available beam-categories. These proposed beam-width categories would be applicable to all directional lamps – including incandescent, halogen, CFL, ceramic metal halide and LED – and they would apply a consistent methodology across the directional lamp technologies for classifying and describing the lamps. These groups of beam angles are reasonable, and will provide a structured typology upon which to base a future regulation.

ELC conducted luminous flux measurements on a selection of halogen lamps that span the range of beam angles. They found that the luminous flux for certain narrow beam angle lamp types is lower than it is for flood lamp versions. For this reason, ELC is proposing that the measured luminous flux of these narrow beam angle lamps be increased by the "lumen correction factors" presented in the following table.

Table 1. ELC Proposal for Beam Angle Groups and Correction Factors

Name of Group	Acronym	Range of Beam Angles	Nominal Beam Angle	Lumen Correction Factors
Narrow Spot	NSP	3 - 9°	6°	80%
Spot	SP	9 - 15°	12°	85%
Narrow Flood	NFL	15 - 20°	17.5°	90%
Flood	FL	20 - 30°	25°	100%
Wide Flood	WFL	30 - 40°	35°	100%
Very Wide Flood	VWFL	40 - 60°	50°	100%
Extra Wide Flood	XWFL	> 60°	100°	100%

MTP is aware that as beam angles become increasingly narrow, tungsten filaments and halogen capsules can shadow or scatter some of the light emission, reducing the lumen output. However, this is less of an issue for 12V halogen lamps which have shorter filaments. Furthermore, from the data provided, it is unclear whether this effect has been observed in CFL, ceramic metal halide and LED directional lamps. MTP is concerned about the magnitude of the correction (as large as 20%), and would find it helpful to review the certified test results for the actual lamps tested to determine the necessary correction factor. MTP is currently concerned that this correction factor would give lamps with beam angles less than 20 degrees a larger reduction in efficacy than is required, and suggests that Commission solicit further evidence and explanation of ELC's position before this proposal is adopted.

Furthermore, it should be noted that this proposed correction factor would be in addition to the 1.25 multiplier (see section 1.4 below) and the 10% tolerance[1] on the EC 244-2009 regulatory requirements.

1.2 Spill-Light and Reflector Efficacy Multiplier

ELC proposes a so-called "integrated correction factor" which consists of 2 elements – the spill-light correction factor and reflector efficacy correction factor. The spill-light correction factor recognises that all directional lamps have spill-light which is emitted in any direction (e.g., backward, through the reflective coating) other than the intended direction, forward from the lamp. The ELC states that the ideal system is able to project 95% of its light forward and proposes to base the correction factor on that value. For the reflector efficacy correction factor, the ELC states that the average reflector system is able to reach an efficiency of 85%, thus it calculates the integrated correction factor as: 1/(0,95x0,85) = 1.25.

In order to make a comparison between the regulation for a reflector lamp with the same formula as a non-directional lamp, ELC recommends taking the rated luminous flux in the 90° cone and correcting it by 1.25. Taking this, the proposed regulatory formula could be:

$$P_{max} \text{ system} = Y * (0,88\sqrt{\Phi R}+0,049\Phi R)$$

[1] In regulation EC 244/2009, Annex III, Verification procedure for market surveillance purposes, it states: "The batch shall be considered to comply with the provisions set out in Annex II as applicable, of this Regulation if the average results of the batch do not vary from the limit, threshold or declared values by more than 10%." Thus, the regulation allows manufacturers to produce and sell lamps that are 10% below the required minimum efficiency performance standards (MEPS) equation.

Where: $\Phi R = \Phi_{90^\circ} \times 1.25$

Concerning this proposed correction to the measured luminous flux, MTP has the following views:

a. The most accurate measurement of luminous flux from narrow and wide-beam directional lamps is to measure the total downward flux emitted from the lamp. That is, the measurement of light emitted in a solid angle of 2π steradians[2] (180° cone, or half a sphere). Following the approach proposed in the EuP preparatory study that limits the measured light output to π steradians will not allow for accurate comparison of lamps having different beam patterns. For example, two directional lamps, which have the same or different beam angles (i.e., point where lamp is at 50% of the optical axis intensity), could emit different amounts of light outside of the measured cone, due to their photometric properties. Thus one lamp would be unnecessarily disadvantaged.

b. It is common to find directional lamps (e.g., MR-16 lamps) being used in general service illumination applications such as kitchens and bathrooms, and therefore all directional light emitted by the lamp is useful and should be measured.

c. Expanding the functional unit from π steradian to 2π steradians would also have the advantage of allowing the light output from the lamp to be measured in an integrating sphere (less expensive test method), rather than requiring use of a goniophotometer (or a costly photosensitive wall). This approach would reduce the costs of regulatory enforcement. [note: see discussion of test procedures in the Task 1 report]

d. The adjustment of adding 25% to the measured light in order to account for the reflective surface is imprecise and excessive. As discussed in the Task 2 report, aluminium (the most common material used to create reflective coatings) maintains a photometric reflectivity greater than 90% across the visible spectrum. At these levels of reflectance, the adjustment for reflective losses can be lower.

e. The proposal put forward by the ELC only discusses making adjustments to correct the efficiency of clear lamps from regulation EC 244/2009. The equation for non-clear lamps that might be applied to CFLi or certain LED directional lamps is not discussed. The table below is inserted as a reminder that there are three maximum power equations to discuss in the context of making the Part 1 regulations applicable to the Part 2 products. Non-clear directional lamp efficacy requirements need to be addressed.

Table 2. Regulation for Non-Directional Light Sources, EC 244/2009

Application Date	Maximum rated power (P_{max}) for a luminous flux (Φ) (Watts)	
	Clear Lamps	Non-clear Lamps
Stages 1 to 5	$0.8 * (0.88\sqrt{\Phi}+0.049\Phi)$	$0.24\sqrt{\Phi}+0.0103\Phi$
Stage 6	$0.6 * (0.88\sqrt{\Phi}+0.049\Phi)$	$0.24\sqrt{\Phi}+0.0103\Phi$

[2] The steradian (symbol: sr) is the metric unit of measurement of a solid angle. It describes a cone created by angular spans in three-dimensional space (i.e., on the surface of a sphere).

1.3 Lumen Maintenance Correction Factor

The ELC comments that the efficacy of certain lamps decreases over time. They recommend that the Commission adopt a lumen maintenance factor for certain lamp categories to account for reduced lumen measurements that may be taken after 100 hours:

- INC: 0.965
- HAL: 0.975
- LED: 0.85[3]
- HID: 0.85
- CFLi-R: 0.85 (see also applicable data in Table 4 of DIM 1)

Taking into account the integrated correction factor proposed by ELC in the previous section, the combined, corrected lumen output of a lamp would therefore be:

Φ in cone of 90°= $\Phi_{90°}$ x 1.25 x Lumen Maintenance Factor

The mathematics of this proposal is unclear and would need to be checked with the ELC. The term $\Phi_{90°}$, if measured after 100 hours, would presumably be lower than it would be if measured before that point. However, the proposed lumen maintenance factors provided are all less than one, so that would cause the measurement of Φ in cone of 90° to be even smaller. If the measurement were taken before 100 hours, then the Φ in cone of 90° would be considerably higher both because the lamp hasn't been operated for very long and because this lumen maintenance factor wouldn't be multiplied through. Perhaps the ELC intended to divide by the lumen maintenance factor, rather than multiply?

MTP is concerned that these corrections, which may be applicable after several thousand hours of service for these lighting technologies would, under the ELC's proposal, become applicable after 100 hours. While MTP recognises that there would be lumen degradation of sources over time, we would not support the application of correction factors that over-correct for performance. Furthermore, it would seem more appropriate to discuss lumen correction factors once required "seasoning period" for certain lamps has been defined.

As discussed in the Task 1 report (and shown in the table below), the test methods for directional lamp seasoning periods are slightly different between Australia, Canada and the United States.

Table 3. Test Method Seasoning Periods for Australia, Canada and the United States

Item in Test Procedure	Australia	Canada	United States
Lamp Seasoning	Lamps shall be aged at a voltage between 100% and 102% of rated voltage. The required duration of this aging is 24 hours ±1 hour.	Rated voltage for a minimum of 1% of rated life; or 2 hours if the lamp is a tungsten halogen type	One half of one percent of rated life at rated voltage.

[3] For LED lamps, the lumen maintenance factor is defined as the average available luminous flux over life, assuming a linear depreciation. For L70 this means that (30%/2 =) 15% average lumen loss has to be taken into account, resulting in a LMF = 0,85.

In Australia, the seasoning period is 1 day (i.e., 24 hours). In Canada, it is 1% of life, or 2 hours for a tungsten halogen lamp. In the US, it is simply one half of one percent of rated life at rated voltage. Both the Canadian and US test methods only apply to incandescent and halogen reflector lamps – they do not include CFL, HID or LED directional lamps. Therefore, these seasoning periods that are based on a percentage of rated life are only applicable to the incandescent type of reflector lamps, which tend to have much shorter rated lifetimes.

The ELC comment specifies 100 hours as a point from which these correction factors would apply. One percent of a lamp rated for 10,000 hours is 100 hours – thus, it would appear that the ELC is anticipating a similar type of test method in Europe. However, this is not entirely clear due to the mathematical presentation of this factor in the ELC comment, which implies a reduction in measured luminous flux. MTP suggests that the Commission solicit further evidence and explanation of ELC's position before this proposal is adopted.

Finally, it should be noted that in EC 244/2009, lumen maintenance factor was a requirement adopted in Tables 4 and 5 of Annex II. In these tables, lumen maintenance is defined has achieving a minimum level (percentage of initial flux) after a prescribed period of time. MTP recommends that the Commission request further clarification on this issue for directional lamps, and the rationale behind the departure from the lumen maintenance requirements published in EC 244/2009.

1.4 Ballast Losses Correction Factor

The ELC comment notes that ballast losses for MR16 reflector lamps are often not taken into account, and that they believe this power loss should be incorporated in the calculation for lamps that use transformers or ballasts. They believe this true for halogen, metal halide, and LED lamps – all of which require a ballast or electronic driver. ELC proposes the following correction factors:

- Low Voltage Halogen with external transformer: 1.06
- Metal Halide with external ballast: 1.10
- Low Voltage LED lamps with external driver: 1.20

These correction factors are the same ones that were proposed in the EuP preparatory study in the first table of Chapter 8, suggesting a correction for LV halogen of 1.06 and for LED lamps of 1.20. However the way in which ELC presents it in their comment is not as a denominator in the calculation of "Maximum rated power (W)" which would have the effect of reducing the maximum rated power; rather they propose to increase the maximum rated power – with the statement: "Lamp power need to be increased by this factor for Low voltage and metal halide (with external ballast or transformer)."

It is unclear how this correction factor is intended to be used, as it also appears in Table 3 of Annex II to EC 244/2009, as shown below. However, in this context, the P_{max} of a filament lamp requiring an external power supply lamp is reduced by dividing by 1.06, not increased. Similarly, the LED lamp requiring external power supply is adjusted by a factor of 1.1 in the table below, not 1.2 as is requested by the ELC. A correction of 1.2 seems too high, as MTP understands that most LED drivers are operating in the upper 80% to low 90% efficiency range.

The correction factors in Table 3 are cumulative where appropriate and also applicable to the products covered by the exceptions of Table 2.

Table 3

Correction factors

Scope of the correction	Maximum rated power (W)
filament lamp requiring external power supply	$P_{max}/1,06$
discharge lamp with cap GX53	$P_{max}/0,75$
non-clear lamp with colour rendering index ≥ 90 and P ≤ 0,5 * (0,88√Φ+0,049Φ)	$P_{max}/0,85$
discharge lamp with colour rendering index ≥ 90 and Tc ≥ 5 000 K	$P_{max}/0,76$
non-clear lamp with second envelope and P ≤ 0,5 * (0,88√Φ+0,049Φ)	$P_{max}/0,95$
LED lamp requiring external power supply	$P_{max}/1,1$

Figure 1. Screen Capture of the Table of Correction Factors from EC 244/2009.

There is currently no clear test method for measuring the performance of these lamp types. In the absence of such a test method MTP suggests that a simpler solution may be to measure the power losses associated with ballasts and deduct these from the system. MTP suggests that the Commission solicit further evidence and explanation of ELC's position before this proposal is adopted.

Should you have any further queries or comments on the points made above please contact: Arani Mylvaganam, MTP Product Analyst (Arani.Mylvaganam@aeat.co.uk) or Michael Scholand, MTP Support Team (MScholand@navigantconsulting.com)