To: Member State Regulatory Committee Members

From: Peter Bennich, Swedish Energy Agency

Date: 12 December 2018

Re: Flicker requirements in draft Ecodesign implementing measure for Lighting

Disclaimer: This cover note, together with the attached report, is not an official position of Sweden but are merely intended to inform the RC committee on recent findings on flicker, or Temporal Lighting Modulation, that may affect the proposed limit for SVM, SVM < 1.6.

Temporal variation in light output from a light source that is periodic is known to, under certain circumstances have an adverse impact on people's health. Recognised effects range from the distraction of visible flicker, to low grade health ailments such as eyestrain, reduced task performance through to critical health conditions of migraines, photosensitive seizures and autistic behaviour.

LED light sources are basically electronic components with very fast response times and are controllable in ways not experienced previously with traditional light source technologies. The draft Ecodesign measure for lighting sets requirements on two metrics – Pst^{LM}, the short-term flicker metric for visible flicker and SVM, Stroboscopic Visibility Measure – which taken together cover the most important flicker frequencies for people. The limits are set as follows: $Pst^{LM} < 1.0$ and SVM < 1.6, however these have drawn criticism from health authorities as being too high. For this reason, six governments who are all members of the IEA 4E SSL Annex conceived and launched a subject-based study focusing on SVM and the threshold detection level.

The attached report presents the results of an experiment designed to find the level of detection at varying levels of TLM in a sample of the population. The findings of this study indicate that specifying a maximum level of 1.6 SVM is unlikely to adequately address the issue of non-visible flicker in LED light sources. The proposed level of 1.6 SVM was already known to be slightly higher than the levels set for old magnetic-ballasted T12s in the 1980's, which were known to cause headaches and eyestrain. This study shows that:

- The most sensitive 25% of the people detected stroboscopic effects in the experiment 90% or more of the time at a lower level of SVM=1.4 (75th percentile overall), suggesting that the maximum level for SVM must be still lower.

- A level of SVM 0.9 may be a compromise, since the experiment found that the most sensitive 25% of the sample could detect the stroboscopic effect more than 63% of the time at SVM 0.9.

- However greater certainty would be provided by setting a level closer to SVM 0.4 as at this level and below, the detection rate for the most sensitive quarter of the people detecting the stroboscopic effect dropped to 10%.

The attached report is an 'interim report' of the results so far, to give the Regulatory Committee some technical evidence for deciding on Monday next week (17 December). The labs will be continuing to conduct this study in the new year, adding more subjects and further strengthening the findings already available. The final report on this work will be placed in the public domain as a contribution to the global dialogue and policy-making around light flicker.

In addition to this research on SVM sensitivity, the SSL Annex also investigated how much more does a low SVM driver cost compared to one with high SVM values? In general, the feedback we received was that there is *no real retail price difference* between those with high and low SVM values – there are lamps and luminaires in the market which have high and low SVM values – and they compete on price. The following three examples support this feedback and summarise our main findings on this question of the cost difference for low SVM drivers:

Example 1) One of the SSL Annex Experts consulted an OSRAM expert in February 2017 and was told that the incremental manufacturing cost increase for a low SVM driver was approximately ten Euro cents (€0.10).

Example 2) Peter Erwin, a German researcher and expert on flicker who has purchased and tested >1000 LED lamps over the years commented that the retail price paid in shops and on-line is the same or even in some cases less for SVM=0 and SVM>4.0. Thus, the small incremental manufacturing cost of the improved driver design to achieve an SVM=0 is simply being adsorbed by those suppliers through slightly less profit.

Example 3) One of the SSL Annex Management Committee members contacted an industry source in November 2018 who estimated that the driver cost was "an extra 30%". To try and compare that estimate to the number quoted from OSRAM, we referenced the US Department of Energy's Solid State Lighting Multi-year Program Plan from 2016 which says that for a typical A-type lamp, the driver is 15-20% of the manufacturing cost, so assuming a 100% retail price mark-up on cost, we can roughly estimate the incremental cost of the SVM=0 driver:

1. Retail price of LED Lamp: €4.00
2. Manufacturing cost of that LED lamp: €2.00 (assumes 100% retail mark-up)
3. Manufacturing cost of SVM >4.0 driver (15-20%): €0.30 – 0.40
4. Incremental cost of SVM=0 driver (+30% of (c)): €0.09 – 0.12
5. This estimate of €0.09 – 0.12 is right in line with Osram's estimate of €0.10

Thus, this 2018 industry estimate corroborates the 2017 estimate from Osram and is consistent with Peter Erwin's observation of lamps he's purchased and tested in his lab in Germany.

Overall, the evidence shows that from a manufacturing cost point of view, having stringent SVM levels would have a negligible impact on retail prices and yet they would protect the public health and well-being.