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Additional Comments on the Title 24 Flicker Specification

Additional submitted attachment is included below.

Additional comments on the Title 24 flicker specification, proposed by the California Energy Commission and the associated Joint Appendix JA8.

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Additional comments:

The following comments are a follow-on from our submission of 22nd November, 2017, entitled '*Response to California Energy Commission Consultation on 2019 Building Energy Efficiency Standards Pre-Rulemaking'*. In particular, we wish to both re-emphasise the grounds for our objection to the proposed use of NEMA 77 as an alternative to the measurement procedure outlined in the current JA8 and to address the concerns raised by Dr Gaines, in his submission on behalf of Philips, docketed on 20th October, 2017.

Re-emphasis of grounds for objection:

NEMA 77 is centred around the proposed use of a metric referred to as 'Stroboscopic Visibility Measure', or SVM.

In summarising the shortcomings of NEMA 77 in this regard, I can do no better than to quote from a recent submission by Professor Arnold Wilkins, to the Commission:

'SVM is derived substantially from Philips' own measurements of the stroboscopic effect. It does not apply to the phantom array. With its suggested 'acceptability' threshold of 1.0 (with some proposing even higher values) the shortcomings can be summarised as follows:

a. SVM captures a restricted subset of flicker/TLA sources and phenomena

b. This restricted subset relates to the (relatively) less serious manifestations of TLA – includes the stroboscopic effect, but excludes phantom arrays, etc

c. The proposed SVM=1.0 threshold corresponds to a detection-rate amongst a sampled population, of 50%!

d. The latest 'lobbied for' limit of 1.3 corresponds to a significantly higher detection-rate, thereby allowing TLA levels that are detected by a majority of the healthy population. There is no consideration of the visibility of flicker by the minority of light-sensitive people. Lighting should be satisfactory to all sectors of the community.

Therefore, in summary, SVM limits exposure to the relatively less-serious forms of TLA, to an extent that would be deemed acceptable by half the population, or less, whilst neglecting more serious forms. To place it, therefore, on a level-footing with IEEE 1789 would be, in our view, both a categorical error and an inappropriate use of a restricted dataset.'

In addition to this, it is worth noting that the level of SVM now being suggested as a sensible limit is actually 1.6. In the simplest case of a single modulation at 120Hz, this corresponds to a level of flicker that is a factor of around 50% higher than the level detected by 50% of the population, even when the only TLA being considered is the stroboscopic effect. To put this into some 'real world' context, this equates to a level of flicker at 120Hz that is a factor of 4 greater than that produced by a typical incandescent lamp at the same frequency. Even a value of SVM=1.0 corresponds to a level of flicker at 120Hz which is similar to that produced by a magnetically-ballasted fluorescent lamp – a technology associated with increased occurrence of headache and eyestrain. This then brings us to our response to the concerns raised by Dr Gaines in respect of the interpretation of Wilkins et al (1989) and Veitch and McColl (1995) in his submission of 20th October, 2017.

Response to concerns raised by Dr Gaines, on behalf of Philips:

In a perfectly reasonable request for clarification, in his submission, Dr Gaines states:

'The effects observed by Wilkins were actually obtained with magnetically-ballasted fluorescent lamps having modulation depth of 43-49% at 100 Hz (Annex B), which is considerably different1 than what is mentioned in the McHugh and McGaraghan paper. Wilkins did observe an increase in headaches and eyestrain under some circumstances.'

Following communication with Professor Wilkins I can probably clear-up two aspects of confusion here:

1. The 'light modulation' referred to in Wilkins et al (1989) is modulation excursion divided by maximum amplitude – (A-B)/A, where A and B are the maximum and minimum luminance values over a cycle. Whereas, the metric used in both JA8 and IEEE Std 1789 is Michaelson Contrast (aka 'percent flicker') which is given by (A-B)/(A+B) – and is of course, then multiplied by 100 to obtain a percentage value. If we call the first of these metrics 'PT' (peak-to-trough) then the conversion is simply:

$$Michaelson\ Contrast = PT/(2 - PT)$$

   Where both PT and Michaelson Contrast are in absolute measure (not percent)

   Therefore, PT values in the range 0.43 to 0.49 correspond to Michaelson Contrast values in the range 0.274 to 0.325 (27.4% to 32.5%). These values therefore do correspond closely with the 30% value given in the current draft Title 24 specification. However, and very importantly, this brings us to our second point

2. Wilkins et al (1989) used magnetically-ballasted fluorescent lamps with these values of flicker – and did indeed observe an increase in headaches and eyestrains – as these levels of flicker are typical for magnetically-ballasted fluorescent lamps. The results therefore do not establish a sensible limit (at 100Hz) of 30%, but rather of somewhere below 30%. Research carried out since 1989, covering stroboscopic effect, phantom

arrays, eyestrain, headaches and malaise indicate that a) this limit, applied at 100-120Hz is itself overly-permissive and b) flicker-levels should be measured across a wide range of modulating frequencies, in recognition of the fact that different effects dominate over different frequency-bands – hence the frequency-dependent levels specified in IEEE Std 1789, and the measurement procedure outlined in JA8

Dr Gaines goes on to state:

'Veitch and McColl observed no health related effects, including headaches.'

Vetch and McColl (1995) was aimed at studying visual performance and visual comfort, not health-related effects including headaches. It does, however, cite two references that cover this – namely, Lindner & Kropf (1993) and Wilkins et al (1989).

In Summary:

1. The procedure outlined in the current JA8 is designed in accordance with one of the inescapable conclusions of the research-base as a whole, and which also underpins IEEE Std 1789. Namely, that different effects of flicker (stroboscopic effect, phantom-arrays, headache, eyestrain, etc) are prevalent over different frequency-bands. By contrast, SVM considers only the stroboscopic effect
2. Even a value of SVM=1.0 (the lowest value discussed by its proponents) would allow levels of stroboscopic flicker that are detectable by half the population, whilst neglecting/ignoring other flicker effects
3. A value of SVM=1.6 would therefore allow levels of stroboscopic effect that are detectable by a clear majority of the population, whilst again neglecting/ignoring other flicker effects (which would then, of course, be greater, in line with the increased value of SVM)
4. Much of the criticism of IEEE Std 1789 is founded on misconception and the erroneous interpretation of the research-base, both in terms of the metrics deployed and the effects under investigation
5. In conclusion, therefore, SVM is no substitute for the current JA8 procedure