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ENERGY STAR Luminaires Draft 2 Comments

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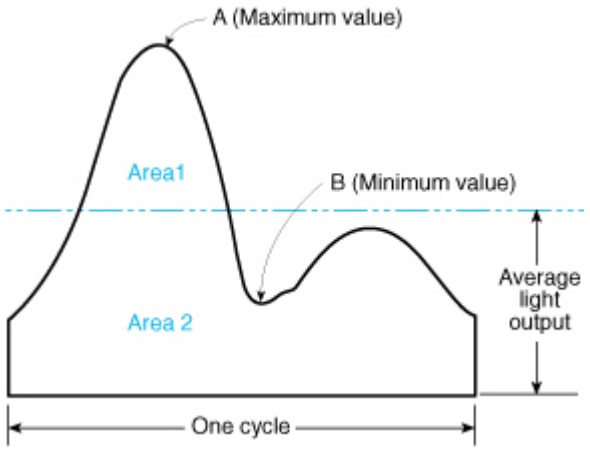
The phrasing as presented indicates that SSL products will be required to meet (2) separate criteria:

≥120Hz and modulation depth of <50%

There are five specific issues with this as written that need to be addressed in order to make any definition or standard intended to address flicker that are not effectively represented by the standard as written:

Issue One: The use of modulation depth is an obsolete standard, abandoned by the IES for a more meaningful Flicker Index. Modulation depth fails to recognize the effect of duty cycle (modulation emission width), therefore does not represent an accurate metric for determining lighting quality.

The current metric of Flicker Index is defined by the relationship of luminance area above average to total area as follows (from IES Handbook 9):



Calculation: Area 1 / (Area 1 + Area 2) = Flicker Index

A flicker Index of "0" is the highest rating achievable, with a rating of "1" being the worst. Photometric data collected by LTL (Grather 2009) indicates an incandescent lamp has a flicker index of roughly .0194, while a Metal Halide Lamp has a flicker index of 0.1398, and a T12 fluorescent lamp on magnetic ballast operates with a flicker index of 0.0897.

Based on this, a maximum Flicker Index of 0.130 should be established.

This places SSL on par with the other typical sources included in the standard, and assumed to be acceptable based on the lack of any flicker calculations required beyond the frequency stated. Any greater requirement for Flicker Index would then be required to be applied to all other light sources to avoid holding SSL products to a standard that will not be met by products approved without a standard limit.

Further, since a test standard will need to be developed to establish compliance (none now exist), it is recommended that the proper metric of Flicker Index be used and references to Modulation Depth be omitted.

Issue Two: The Flicker Index does not reflect or include any representation of modulation frequency. Considerable research has proven that as frequency increases, human perception and sensitivity to flicker, in both visible and non-visual response is decreased. There has been no evidence indicating that modulation of any type is problematic in either perception or impact on human health at frequencies >2KHz. Therefore, any additional cost or effort on the part of manufacturers to meet both the modulation frequency and Flicker Index requirement over 2KHz is a wasted effort and likely to add cost unnecessary to the proper and satisfactory function of the end product.

Based on this, ONLY products operating between 120Hz and 2KHz should be required to comply with a Flicker Index maximum of 0.130.

Issue Three: The issue of perceived flicker has been studied and proven to be highly dependent on visible source brightness and emission source size. The higher the brightness in contrast to background luminance, the greater the perception of flicker will become. Failure to address this dynamic for an overly simplistic frequency/Flicker Index value standard will likely lead to products utilizing highly visible LED sources to gain optimal efficiency, that are both glare inducing, and aggravating of the flicker issue. This is particularly important for task lighting and directional products, and for products that may be viewed at unexpected viewing angles, such as children looking upward into under-cabinet lighting employing exposed discrete LED sources.

There is a need for more research to establish a maximum luminance metric (MPE, or W/cm²) divided by the total luminous area of an optic or source or reference to a contrast ration and maximum illuminance established to mitigate the perception of flicker from low frequency

sources, and potentially elsewhere in the standard relative to eye safety. This is not a difficult standard to test to (is included in photometric test data collected in LM-79, plus one additional calculation), but requires some investigation as to the maximum energy allowed to be meaningful that is not now defined, as well as a maximum acceptable contrast ratio between source and background by target application.

Issue Four: The simplistic definition of Flicker Index and Frequency fails to recognize that in non-rectified AC LED arrays that operate ½ of LEDs on one side of the 60Hz sine wave, and the other on the flip side, sources must be in close enough proximity to be integrated in the eye. If a luminaire simply utilizes (2) LEDs, separated by a distance large enough to preclude integration, the standards will have been met, as measurement equipment will not reflect this separation effect, while the end product generates a visible flicker to human observers of 60Hz, regardless of Flicker Index.

Visible pitch spacing between individual LEDs in an array must be close enough together to produce a visual integration of light emission to preclude the visibility of any individual LED modulation.

Issue Five: There has been no industry level standard or recommendation for flicker characteristics at frequencies greater than 100Hz, agreement on specification of flicker to mitigate impact on human health, or conclusion as to the actual visibility of flicker at 120Hz using LED sources, Therefore, inclusion of the metric as written is premature and unfounded on accepted or industry agreement.

Recommendation 1:
Retain the standard of Flicker Frequency of ≥120Hz based on photometric measurement, and eliminate all other metrics referenced. Redress the metrics when the work of the IES, IEEE, and other organizations addressing flicker is complete and objectively defined.

Recommendation 2:
Maintain the ≥120Hz requirement, and add more comprehensive definition of flicker that reflects known information and research on the topic as follows:

For all AC and DC products operating at ≤2KHz recommend the following additional requirements be established:

Maximum Flicker Index ≤ 0.130

Establish a minimum spacing between individual die or individual light sources is close enough to facilitate visual integration (suggest no greater than 2mm in any direction.)