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**Comments on Energy Star Requirements for SSL, Draft 12/20/06**

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p.3 The table of Device Requirements (p.3) for CCT says "… 7-step quadrangles as defined in the Appendix." I am not sure if "7-step" will be understood by general SSL engineers. MacAdam ellipse is not explained until the Annex, so I would suggest not to use "7-step" in this section, and maybe just say "the chromaticity quadrangles …".

p.3 Color Spatial Uniformity. "4-step ANSI MacAdam ellipse" may be difficult to understand or calculate for many people, except for those who are experienced in fluorescent lamp design. Its shape changes at different CCT or location of chromaticity and actually they are not easy to define and reproduce. A reference for the ellipse formulae is not given, either. I would suggest not to use the MacAdam ellipses in the specification, especially because it is not used for the chromaticity specification. We can specify chromaticity differences more generally by the distance on CIE (u',v') chromaticity diagram, which is easy to calculate by anybody. Please see Section 11.5 of LM-79 draft, which recommends a specific *test method for color uniformity*, and defines $\Delta u'v'$ as a metric. $\Delta u'v'$=0.001 corresponds approximately to the radius of 1 step MacAdam ellipse, so you can rewrite the color spatial uniformity requirement as "The variation of chromaticity in different directions from the average chromaticity shall be within 0.004 on CIE (u',v') diagram." I'd also suggest that LM-79 be referred to in the table, or add "Color spatial uniformity" in the document table in p.11 and put LM-79.

p.3 Color maintenance. For the same reason mentioned above, I suggest not using the term "MacAdam ellipse." Similar to above, the requirement can be rewritten as "The change of chromaticity over the lifetime of the product shall be within 0.007 on CIE (u',v') diagram."

p.6 For Category A, Luminaire Efficacy is defined with adjustment with CRI, as given in the equation including a term "Application CRI / 0.8". A few comments related to this.

1) What is "Application CRI"? Is it different from "CRI"? If it is the same thing, I suggest you use just "CRI". If different, please explain.

2) CRI is a number with 100 as maximum. If you put the CRI number, like 70 or 80 in the equation, divided by 0.8, would give results wrong by two orders of magnitude. In the equation, CRI should be divided by 100, or "0.8" should be replaced by "80."

3) This definition, adjusted by CRI, is different from the normal definition of "Luminaire Efficacy", as given in p.5. To avoid confusion, it should be called by a different name. My suggestion would be "Adjusted Luminaire Efficacy", and use this term consistently in the subsequent tables of specification for Category A products.

p.7 Minimum CRI for these three Outdoor applications is 70. I think 60 would be okay for these outdoor applications, just to make it a little easier for manufacturers. For example, spectrum of Cool White FL (CRI=63) may be okay for these applications. The higher, the better for users, of course, but I think 60 and 70 may make a big difference for manufacturers. The same comment applies to Outdoor luminaires (CRI >70) of Category B requirements. It can be (CRI > 60).

p.9 Category B. Why does the luminous efficacy specification dependent on CCT? 50 to 70 lumens/watt is a large difference. I do not see any scientific reasons why luminous efficacy should be higher for higher CCT sources. I would rather see opposite trend in case of RGB LEDs. Lower CCT (with stronger red components) tends to produce higher lumens per watt because red LEDs have higher efficiency and efficacy than blue LEDs (at least now). But that difference is small, and I do not mean that the requirements should be different for different CCT.

p.11 Color Rendering Index: Refer first C78.377A, then LM-79, then CIE 13.3, and LM-58. Note that C78.377A draft has Section 5 Color Rendering Index (Ra). Also, note that LM-79 has Section 11 Test Methods for Color Characteristics of SSL Products.

p.11 Correlated Color Temperature: Change the title to "Chromaticity and Correlated Color Temperature". It is not enough to measure just CCT. Chromaticity specification also requires measurement/calculation of Duv or chromaticity coordinates. Adding "Chromaticity" in the title will solve this problem.
Also, in the reference space, refer first LM-79, then CIE 15:2004, then LM-58 and LM16. I don't think C78.377A needs to be listed here (C78.377A does not define CCT nor provide measurement methods). CIE 15 is important in that it gives the latest official definition of CCT.

p.15 Appendix, Chromaticity Specification and Tolerance Quadrangles
The table of Device Requirements in p.3 says "… 7-step quadrangles as defined in the Appendix." Then, in the Appendix, only the (x,y) coordinates table is shown for quadrangles. This may cause a misunderstanding that the quadrangles are defined by (x,y) coordinate, which is not true. Quadrangles are actually defined by the CCT (direction along Planckian locus) and Duv (direction across the Planckian locus). This definition explains by itself how these quadrangles are drawn. CCT/Duv can also be used for easy judgment of Pass/Fail. The (x,y) table is given additionally (in the ANSI standard) for convenience for those who want to plot them on (x,y) diagram. My suggestion for a minimum change to the draft would be to add a paragraph below, after the 2nd paragraph and before the (x,y) table:

"Each quandrangle is defined by the range of CCT and the distance from the Planckian locus on chromaticity diagram. Refer to ANSI C78.377A for the details of these definitions. Figure 1 below shows the plot of these chromaticity quadrangles and the table below shows (x,y) coordinates of the center points and the corners of each quadrangle."