Email received on June 21, 2010 from Eric Bretschneider.

The following are comments from Lighting Science Group with respect to the ENERGY STAR Luminaires First Draft

Elimination of flex bins as defined under ANSI/NEMA C78.377 will force some customers into compromise situations. It also means that any such custom or short run products may never be able to meet energy star requirements. As an example, a restaurant wanting mood lighting with CCT = 2500 K would not be able to use an energy star approved product. Some consideration should still be given to the flex bins scheme or at least a provision to allow products to bridge 2 adjacent color bins. Will manufacturers be required to double certify a product that spans two standard bins as defined under C78.377?

A standard needs to be developed for evaluating the full lifetime of SSL lighting products that includes driver/LED power supply. At a minimum perhaps guidelines based on MIL-HDBK-217F and a standard for de-rating lifetime based on operating temperature would be advised.

Testing reports via external laboratories for in situ LED temperatures are problematic. The primary issue is that unless the lab (regardless) of certification and expertise may have difficulty in making in situ temperature measurements. The problem is that virtually all SSL products will not have exposed LEDs meaning that some disassembly and reassembly will be required to make the in situ temperature measurements. If units are reassembled incorrectly then measured temperatures are likely to be below the actual temperatures in productions units. In correct or improper placement of the thermocouples (assumed temperature measurement method) will also lead to artificially low temperature readings. Either situation would lead to an error in which calculations and estimates would *overestimate* lifetime/reliability.

Even as an alternative, if the manufacturer were to place thermocouples, reassemble and then ship to an external lab for measurement, then it is possible for the thermocouples to be displaced due to impact/vibration during shipping. End result again would be an in situ temperature measurement that is below that of a nominal manufactured product. Again this would lead to temperature measurements that would *overestimate* LED lifetime/reliability.

Some standard does need to be developed to address this. We would recommend a protocol that would allow verification of temperature measurements (essentially auditing of the measurements). Alternatively personnel from the manufacturer would need to travel to the testing labs to verify and validate that placement of the thermocouples was performed correctly and that the units had been reassembled correctly. This will add significantly to the cost of such measurements and pose a severe issue with respect to coordination of personnel. An example report (LSR3 L70 Estimate Report) is attached as a possible initial guideline for a protocol. A detailed thermal model showing all assumptions in adjusting temperatures for different ambient temperatures is included.

There should also be a standard in terms of ambient temperature. The majority of indoor products will be at a nominal 25 C ambient temperature. Should/will lifetime estimates be based on this temperature or the maximum design operating temperature.

Recommendations for lifetime based on 6,000 hour data for an *entire* fixture are likely to severely constrain and restrict improvements in technology. In order for initial estimates for lifetime to be completed, LED packages will need to complete LM80 testing which means that ~ 9 months after release of a new LED package, SSL manufacturers may begin using it in production. Requiring an additional 6,000 hours of testing means that an additional 9 months will be required for Energy Star approval. Thus no Energy Star rated products would be available until 18 months after an LED company has developed a new/improved LED package or design. This would be expected to completely eliminate and LED manufacturer's incentive to introduce new, more efficient products as they are developed. Why should an LED manufacturer push a new product into production until a minimum of 18 months since the last product introduction if they cannot achieve any volume shipments of the first product?

Recommend that IES begin work on a new TM for standardizing extrapolation methods for LED lifetime. As a nominal starting point, LED aging could be viewed as a chemical reaction where the reaction rate is dependent on temperature. This would require lifetime measurements made on LEDs at significantly more temperatures than the current LM80-08 standard. With more data points, a fit could be completed that would clearly correlate LED lifetime to operating temperature and not require extrapolation to higher temperatures. There should also be a standardized method for adjusting LED lifetime based on drive current. LED lifetime is a function of both operating temperature and drive current, yet the current standards only focus on operating temperature. (see white paper on LED aging/lifetime included in the LS3 L70 Estimate Report).

Best regards,
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LIGHTING SCIENCE GROUP CORPORATION