July 2, 2013

Taylor Jantz-Sell

US Environmental Protection Agency

1200 Pennsylvania Avenue, NW

Washington, DC 20460

Subject: ENERGY STAR® Lamps V1.0 Specification Draft 4

Dear Ms. Jantz-Sell,

Cree has reviewed the ENERGY STAR® *Lamps v1.0 Specification Draft 4* received via email on April 19th, 2013. Similar to the ENERGY STAR Program, it is one of Cree's primary goals to accelerate the adoption of high-quality, energy efficient lighting in the marketplace. As a manufacturer, Cree is able to support this goal through continuous innovation and by designing high-quality, cost effective products for consumers.

The following package contains proposed specification changes and supporting data as it relates to luminous intensity distribution for omnidirectional lamps, rapid cycle stress testing, and lamp shape dimensions. Cree respectfully submits this information and request that each be carefully considered prior to finalizing the specification for release.

Thank you in advance for your consideration. Please feel free contact me at 919.407.5047 with any further questions that you may have.

Sincerely,

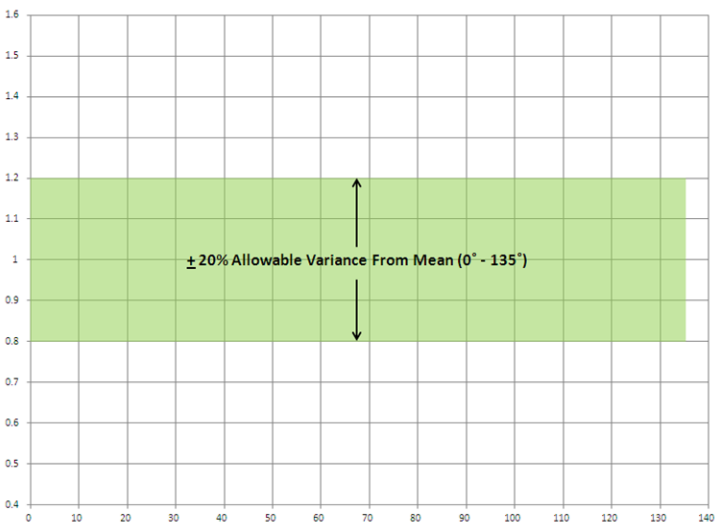
Tim Henning

Specialized Testing Manager

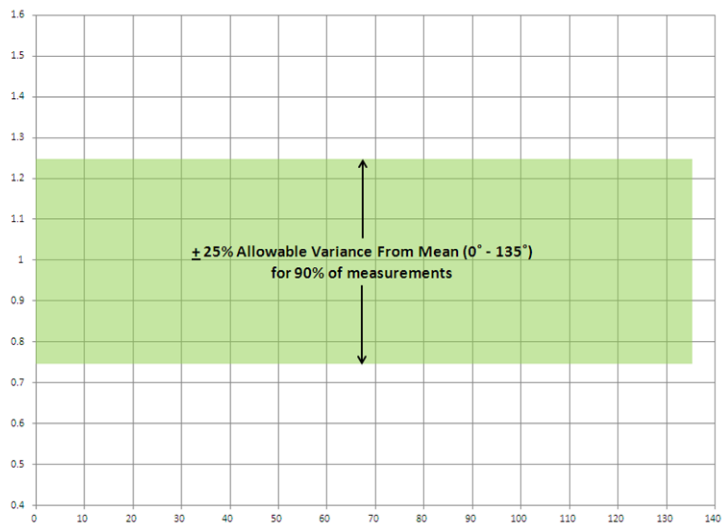
SECTION 9 - PHOTOMETRIC PERFORMANCE

Luminous Intensity Distribution (Page 13)**:** The current proposed specification states that the luminous intensity distribution for omnidirectional lamps shall emulate that of a standard incandescent lamp. The specification's proposed luminous intensity distribution does not adequately capture commonly available, general purpose incandescent light bulbs on the market today - even though the specification claims to use the light distribution performance of an incandescent lamp as the benchmark. The included data in the subsequent pages support this finding. The products that were purchased as part of this engineering evaluation include incandescent bulbs from a variety of different manufacturers and were purchased off-the-shelf from different national retailers.

The following two figures graphically depict the luminous intensity distribution requirement in the current specification (ILL 1.4) as well as the proposed draft specification (Lamps 1.0).



Integral LED Lamps Version 1.4 (Current)

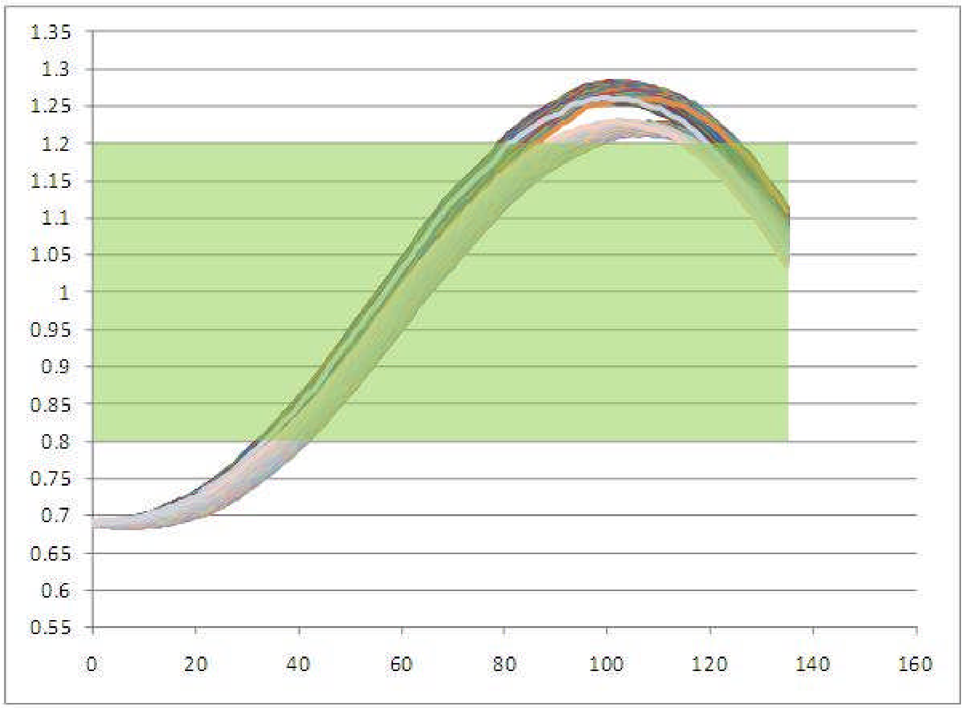


Lamps 1.0 (Proposed)

We believe that the relaxation of the requirement in the new specification is appropriate, however, feel as though the allowances do not appropriately reflect the light distribution of many commonly available incandescent products. As can be seen in the following figures, almost all of the products that were tested fail the requirement as it is written in the Integral LED Lamps 1.4 specification as well as the Lamps 1.0 draft specification.

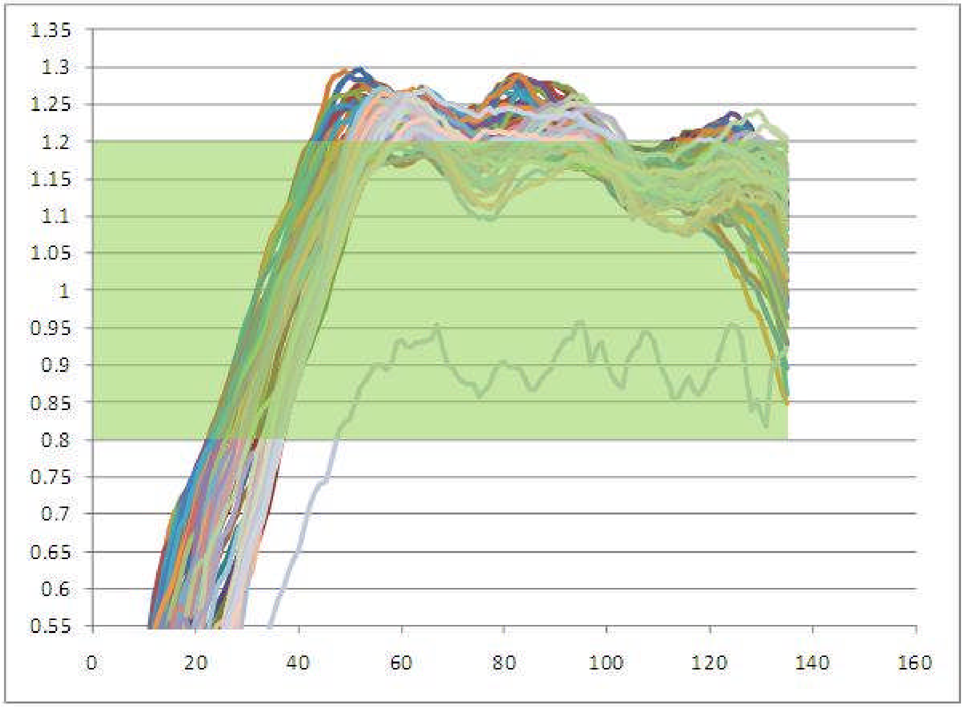
Off-the-Shelf Incandescent Bulb Tests

Wal-Mart 60W Frosted Incandescent A19



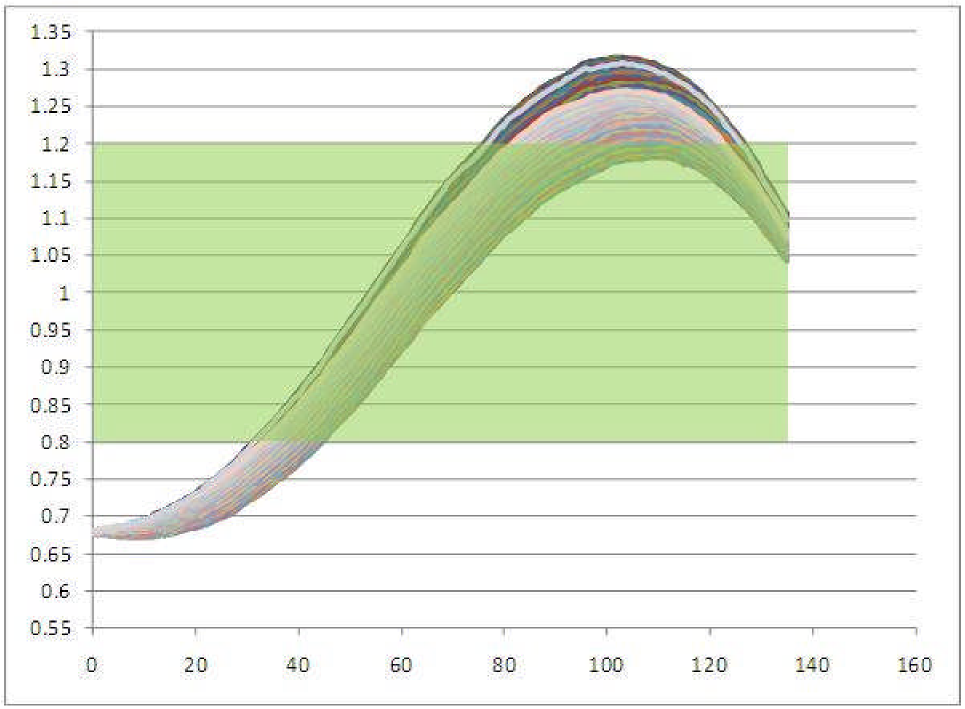
Off-the-Shelf Incandescent Bulb Tests

Sylvania 60W Double Life Clear Incandescent A19



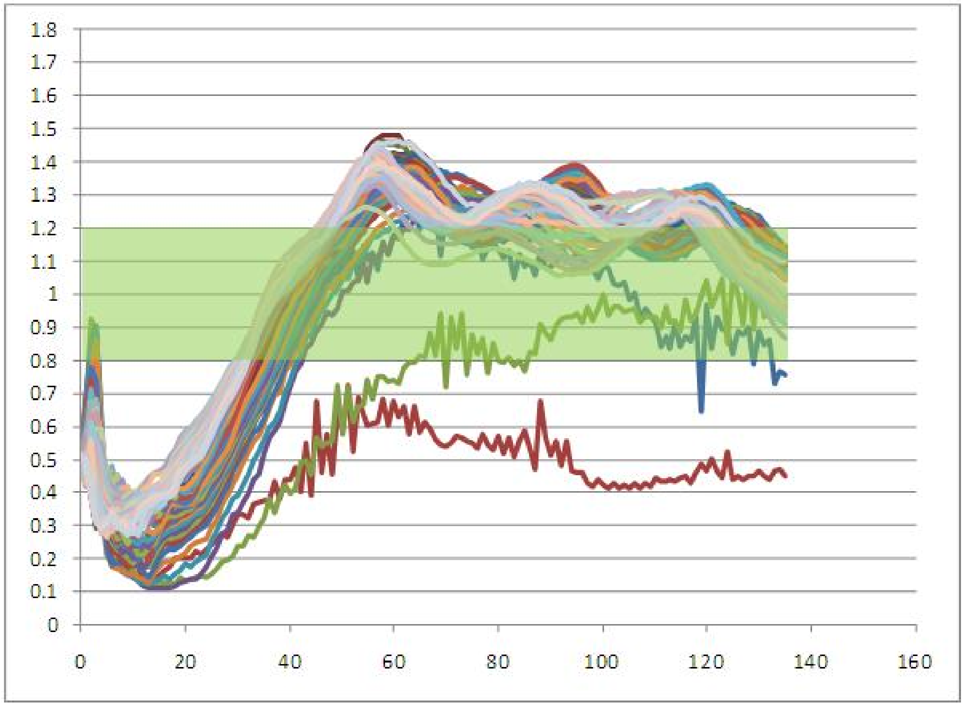
Off-the-Shelf Incandescent Bulb Tests

Sylvania 60W Double Life Frosted Incandescent A19



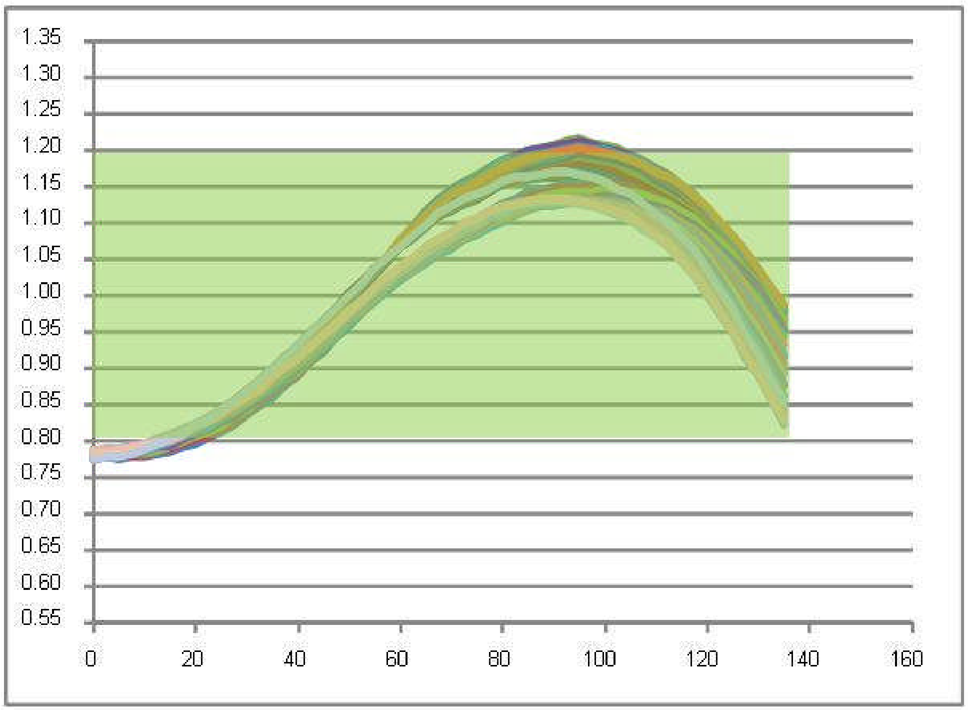
Off-the-Shelf Incandescent Bulb Tests

Sylvania 43W Halogen Type Incandescent Clear A19



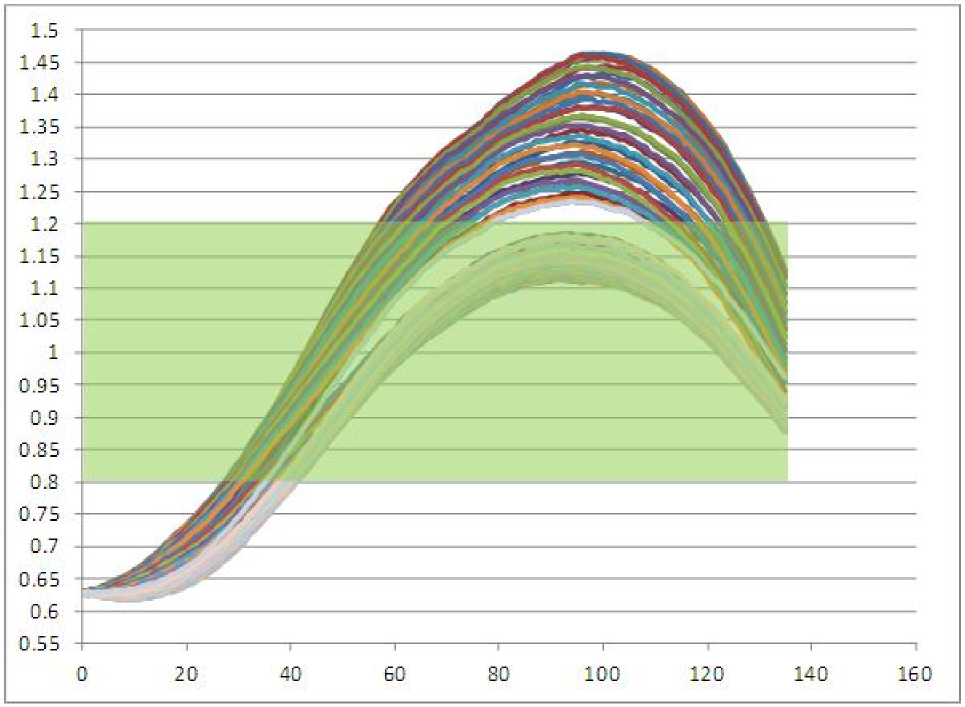
Off-the-Shelf Incandescent Bulb Tests

GE 60W Frosted Incandescent A19



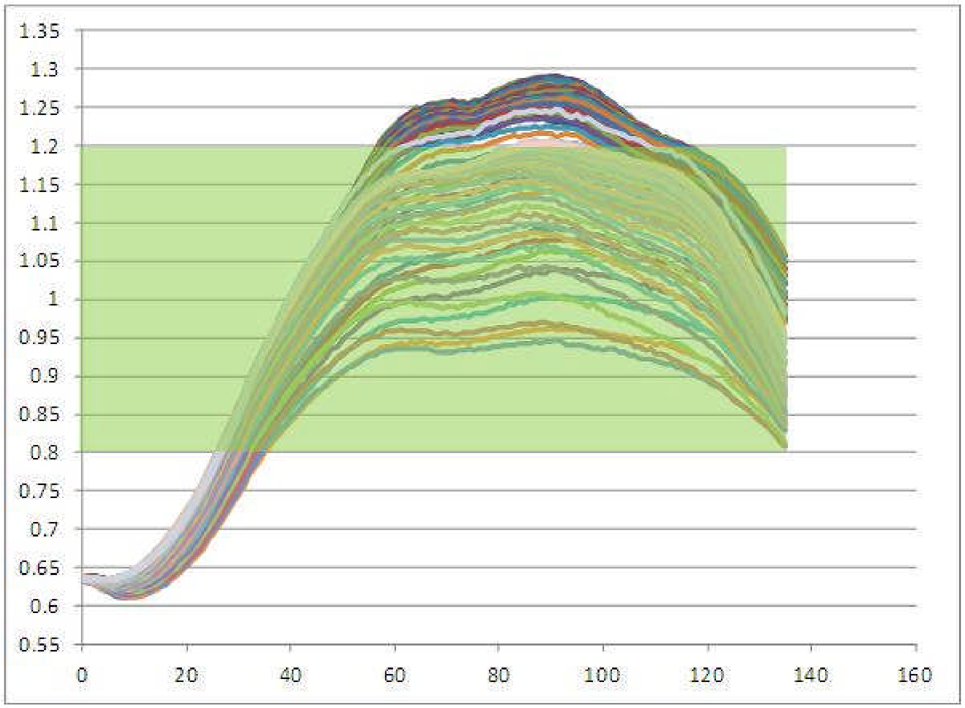
Off-the-Shelf Incandescent Bulb Tests

GE 43W Frosted Halogen Type Incandescent A19



Off-the-Shelf Incandescent Bulb Tests

Philips 43W Frosted Halogen Type Incandescent A19

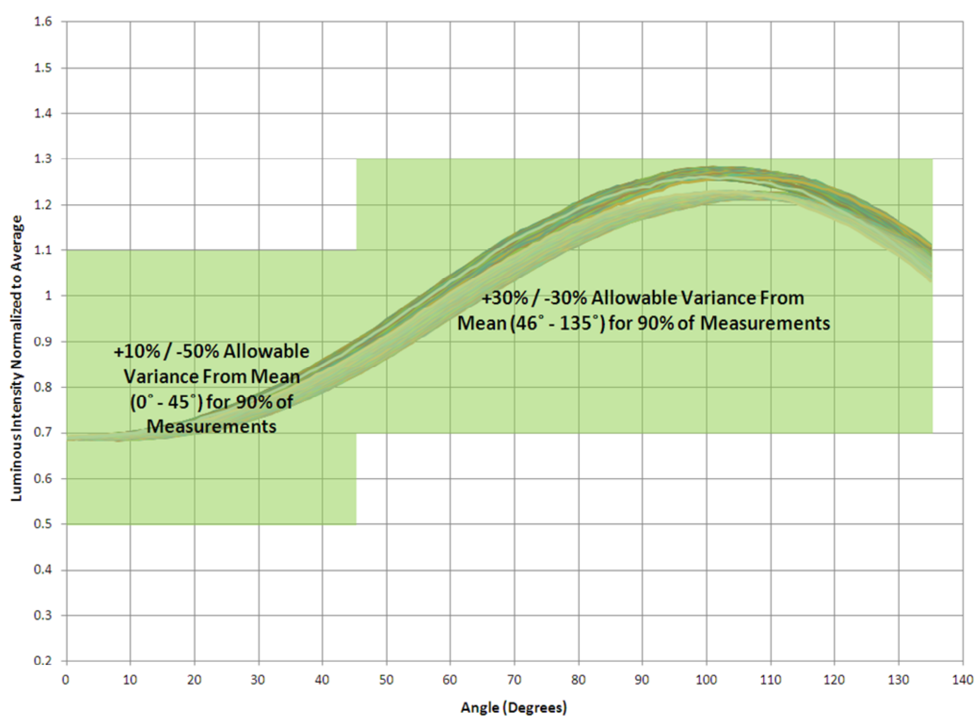


In an effort to accurately reflect the light distribution of commonly available incandescent bulbs, we propose that the Luminous Intensity Distribution requirement be reworded as follows:

Lamp luminous intensity distribution shall emulate that of a referenced incandescent lamp as follows:

90% of the luminous intensity measured values (candelas) within the 0° to 45° zone shall vary by no more than +10% / -50% from the average of all measured values. 90% of the luminous intensity measured values (candelas) within the 46° to 135° zone shall vary by no more than +30% / -30% from the average of all measured values. All measured values (candelas) shall vary by no more than +30% / -70% from the average within the 0° to 45° zone and +50% / -50% from the average within the 46° to 135° zone. No less than 5% of total flux (zonal lumens) shall be emitted in the 135° to 180° zone.

We feel as though it would be of value to include a graphical depiction as part of the specification to clearly convey the revised requirement - similar to the one provided below. A tool similar to the Center Beam Intensity Tool that manufacturers and testing laboratories could use to evaluate the pass / fail criteria for this requirement would also be beneficial. We would be happy to support any development efforts required to make this available.



Proposed Allowable Tolerances

SECTION 10 - LUMEN MAINTENANCE AND RATED LIFE

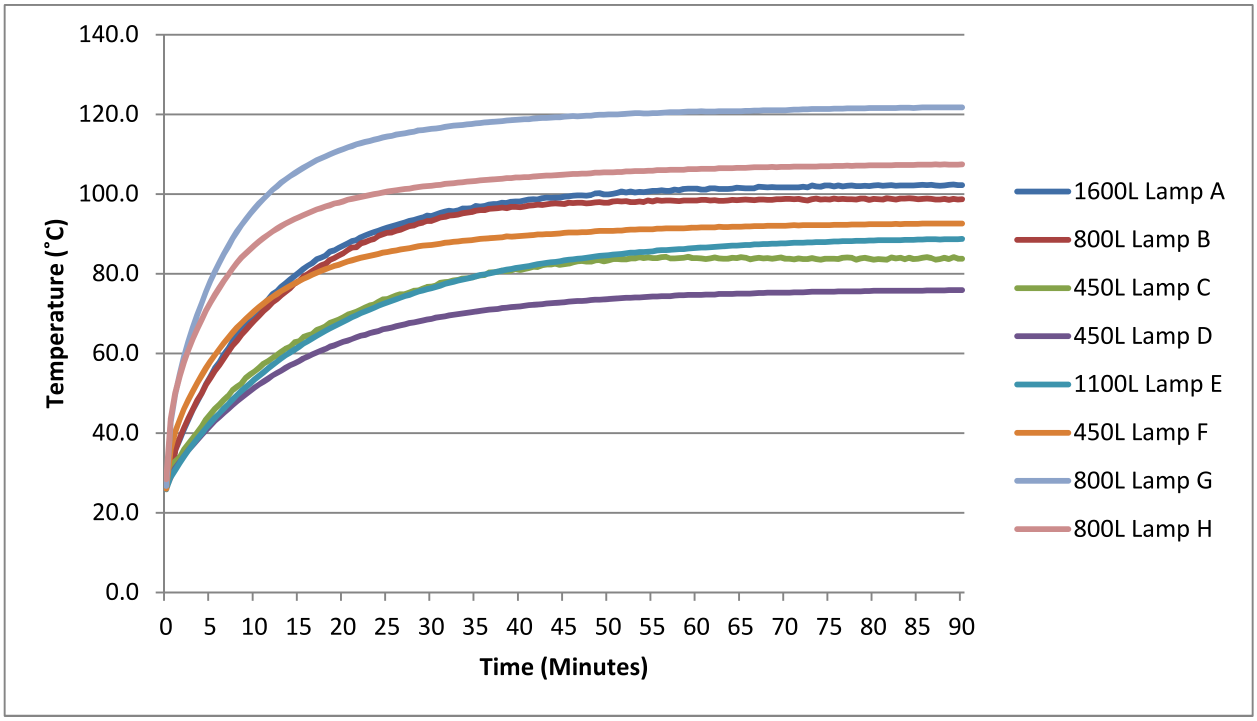
Rapid Cycle Stress Test (Page 20)**:** As the requirement is written in the proposed specification, the 5 minute on / off cycle does not adequately address the stated goal of increasing thermal stress in order to reduce instances of premature lamp failures. The comment box in Draft 1 of the Lamps 1.0 specification clearly states that the primary reason for the increased cycle time was to increase the ΔT values to insure that the lamps under test were properly stressed. While the proposed 5 minute rapid cycle stress test aligns the LED and CFL requirements, the failure mechanisms between the two technologies are very different. It is our opinion that this requirement needs to be modified for LED-based lighting products to accommodate these differences in technology.

Furthermore, adopting a single rapid cycle test time for all LED bulbs would ignore significant differences in lamp design and implementation. LED bulbs have long been characterized by large heat sinks that create an unattractive look for the consumer which ultimately limits adoption. Rather than applying innovative techniques to the LEDs, power supply and secondary optics, some LED lamp designs take a traditional approach that results in a large heat sink, less efficient LEDs, and higher power consumption all at a greater cost, further limiting adoption. The proposed increase in time for the cycle test penalizes those truly innovative designs that are bringing down the size and prominence of heat sinks, increasing efficiency and lowering costs. The subsequent data clearly shows that these less efficient designs are not being stressed nearly as much as their highly efficient counterparts when tested for an arbitrary fixed time interval. As proposed, the standard is effectively encouraging inefficiency.

The following products were tested in the base-up orientation in accordance with UL1993. This test configuration includes a non-IC rated test box with a 6" recessed can installed inside. The face of the recessed can was covered with Plexiglass to insure that there was limited / no air circulation from the room. All products were instrumented with Type K thermocouples placed as closely as possible to the LED solder points and powered with a conditioned AC power source set to 120VAC to eliminate the potential of any voltage variations between tests.

Figure 1 clearly shows that LED lamps (such as G and H) which utilize higher efficiency LEDs are able to use smaller heat sinks, which achieve higher temperatures faster than lower efficiency designs with larger heat sinks. The lamps with these larger heat sinks take significantly longer to achieve these higher temperatures and therefore are not being stressed as much as more efficient designs under single fixed cycle.

Figure 1: LED Solder Point Temperature vs Time



	ΔT	Temp Rise @ 2 Min	% ΔT at 2 Min	Temp Rise @ 5 Min	% ΔT at 5 Min
1600L Lamp A	76.1˚C	14.7˚C	19.3%	28.0˚C	36.8%
800L Lamp B	72.6˚C	15.1˚C	20.9%	27.7˚C	38.2%
450L Lamp C	57.7˚C	9.7˚C	16.8%	18.6˚C	32.3%
450L Lamp D	49.8˚C	8.1˚C	16.3%	15.8˚C	31.7%
1100L Lamp E	62.8˚C	8.2˚C	13.1%	16.7˚C	26.5%
450L Lamp F	66.6˚C	20.1˚C	30.1%	32.0˚C	48.1%
800L Lamp G	95.0˚C	32.3˚C	34.0%	51.4˚C	54.1%
800L Lamp H	79.0˚C	29.3˚C	37.2%	44.3˚C	56.2%

A calculation-based cycle time, appropriately aligned for each individual lamp's thermal design, would ensure that the goal of increasing thermal stress in order to reduce instances of premature lamp failure is achieved. A proposed procedure is as follows:

1. Place a unit with a thermocouple at the T_{sp} in the rack to be used for cycle testing, and log temperatures every 30 seconds from cold to thermal stabilization.

2. Calculate the ΔT by subtracting the t=0 temperature from the fully stabilized temperature.

3. Multiply the ΔT by 0.5 (50%) and add this number to the cold temperature Tsp measurement. This is the target temperature.

4. From the temperature log in step #1, find the first temperature that exceeds the temperature target as calculated in step #3 and note the time taken to reach this temperature.

5. On/off cycle time will be set by the time determined in #4. (If 10 minutes, then 10 minutes on, 10 minutes off.)

6. Cycle lamps once for every 8 hours of L_{70} lifetime that is claimed.

T_{sp} was chosen as the closest indicator of heat sink temperature near the LEDs, and already an established measurement point. A smaller number of cycles are required (3,125 for 25k hours, 6,250 for 50k hours) due to much larger temperature excursions. 3,125 cycles for lamp E would still require over 54 days of testing (12.5 minutes on, 12.5 minutes off.) Larger numbers of cycles would place increasing burdens on manufacturers and slow introduction of new designs.

SECTION 9 - DIMENSIONAL REQUIREMENTS

Lamp Shape Dimensions: (Page 26)**:** The current proposed specification does not clearly identify an allowable tolerance around the ANSI standard dimensions. All materials and products that are manufactured have inherent manufacturing variations and as such should have allowable tolerances associated with them. The variation in bulb height was measured for two A19 incandescent bulbs from different manufacturers. After measuring approximately 100 lamps, the following total variation was observed:

- Manufacturer #1 Incandescent: 2.5%
- Manufacturer #2 Incandescent: 3.1%

As can be seen from the enclosed data, commonly available off-the-shelf incandescent lamps have a wider manufacturing variation than 2%. Even established manufacturers, who have had decades to automate and refine their processes, have a wider manufacturing variation than 2%. We expect that as LED product technology matures and product lines stabilize, automation and design refinement will allow for similar reductions in manufacturing variation. Most current LED lamp designs are not affected by this constraint because they almost uniformly use die cast or extruded metal and injection molded plastics in their construction. The processes that use these materials are capable of tighter tolerances than glass, which is more suited to mass market products. Requiring the industry to maintain tolerances that are only achievable with expensive manufacturing technologies and materials will only prolong the time during which LED-based products must necessarily carry higher price points, delaying adoption and the associated reduction in energy consumption enabled by these products. A manufacturer's total variation with a product population of 5% is proposed.