



Natural Resources Defense

Comments from the Natural Resources Defense Council on the CEC's Staff Report and Proposal for LED Lamps and Small Diameter Directional Lamps

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On behalf of the Natural Resources Defense Council (NRDC) and its more than 80,000 members and electronic activists in California, we respectfully submit our comments on the CEC's draft staff report and proposals dated September 2014 on LED lamps and small diameter directional lamps. **In summary, NRDC is supportive of the stringency and effective dates of the CEC proposals and we provide specific recommendations on test methods and inclusion of a few additional requirements tied to some key consumer acceptance issues such as audible noise and product durability/longevity.**

The stated goal of this standard is to reduce the State's energy use of lighting products by ensuring that LED bulbs sold in California are not only energy efficient but also meet minimum performance requirements. This standard will help the State meet its targets set by Assembly Bill 1109 that require the State to reduce by 2018 its residential lighting energy consumption by 50% and commercial and outdoor lighting consumption by 25%.

Products with inferior performance may: fail prematurely, produce unacceptable levels of audible noise via humming or buzzing, not dim well, flicker, especially when dimmed, not adequately distribute the light to where the consumer expects it, or not adequately render the color of objects when viewed under the light. With some modifications to its initial proposal, we believe the CEC can satisfactorily address these issues and thereby increase the likelihood that consumers will have a positive experience with their LED lamps and thereby reduce the state's lighting related energy use and emissions of climate change pollution. Most of our recommendations below intentionally utilize the metrics and test methods specified in ENERGY STAR's Lamp's specification. As such manufacturers will in almost all cases be able to perform

a single test to demonstrate compliance with the California requirements and for their submission for ENERGY STAR qualification.

These written comments supplement the oral testimony and powerpoint presented by NRDC's Noah Horowitz during the CEC's September 29, 2014 staff workshop.

I. LED Lamp Requirements

A. NRDC supports CEC's proposed approach and levels for lamp efficiency and color rendering index (CRI).

There was much discussion during the CEC workshop on how to address CRI and its interaction with cost and efficacy. As NRDC stated during our testimony, there is no evidence that consumers are not satisfied with the color rendering of today's current products which have a CRI typically in the low 80's¹. In addition we documented the incremental cost and sacrifice in performance (either dimmer bulbs or increased power use) of today's LEDs that offer CRI of 90 or higher.

We believe the CEC proposal represents a solid approach and reasonable compromise whereby it sets minimum levels for CRI (82 and 84) and efficacy while providing a mechanism that allows lamps with high CRI to continue to be sold in California even though they are less efficient. In addition it sets a reasonable floor to prevent LED lamps from being sold that are inefficient or at CRI levels below today's typical products.

We support CEC's intent to set minimum requirements for all color values between R1 and R8 to prevent the lamps from being weak in rendering any group of colors. The proposed minimum value of 75 for each color component should be carefully reviewed to make sure it is not set too high. If so too high, it could have the unintended consequence of removing today's good performing products that meet the CRI of 82 or 84 from the market and thereby setting a *de facto* 90 CRI requirement. **We encourage the CEC to work with industry stakeholders to better understand the R1 through R8 values of their products and as necessary to lower the proposed minimum of 75 to some lower value.**

¹ In the absence of any scientific studies or data showing that consumers are not satisfied with the color rendering of LED lamps with CRI in the low 80's, NRDC is unable to support requests by some stakeholders to establish a minimum CRI of 90, which is significantly higher than most products on the market today. If new studies on this topic emerge during the comment period, we would encourage CEC to evaluate this information and consider altering its CRI requirements. While we think it's appropriate for California to set a "stretch" goal for lamps that includes efficiency and elevated performance requirements such as CRI 90+ and to offer incentives for qualifying lamps as part of its utility energy efficiency programs, we do not think the State should require all lamps sold in the State to meet those levels.

B. NRDC recommends CEC include requirements that address product durability or lifetime.

As stated above, one of the main goals of this regulation is to ensure consumers have a good experience with LED lamps and to prevent inferior lamps from being sold in California. Lamps that fail prematurely or offer dramatically less light within an unacceptably short period of time will result in a dissatisfied customer and can result in that customer reverting back to less efficient alternatives and general backlash against LEDs.

To help identify lamps that might fail prematurely or suffer from accelerated lumen depreciation, we recommend CEC incorporate requirements based on the following approach:

- require a sample of 10 lamps be tested
- testing of all lamps shall be done at an elevated temperature of 45 C for a total of 3,000 hours. The lamp's output at 0 and at 3000 hours shall be measured and reported.
- the lumen maintenance for each lamp at 3,000 hours shall be calculated and the arithmetic average of the 10 samples must be at least 95% for lamps with a rated lifetime of $\geq 25,000$ hours, and at least 93% for lamps rated 15,000 – 24,999 hours.² (Note, a lamp that has failed during the testing and does not emit any light shall be reported as zero lumens and this value will be included in calculating the average.)
- utilize the requirements in the ENERGY STAR lamp specification for lamp orientation, luminous flux measurement, cycling, etc.

This approach is meant to serve as a useful screening tool to weed out poor performing LED lamps, while avoiding an overly long testing time period that would delay introduction of models to the market or result in excessive testing costs. As overheating and poor heat management is the main source of premature lamp failure or accelerated lumen depreciation, we required all lamps, both directional and non-directional lamps to be tested at the elevated temperature of 45 C. This approach also provides consumers with confidence that any LED they buy will perform reasonably well in an enclosed fixture such as a globe or jelly jar type enclosure. We feel this approach is warranted as roughly 10 to 20% of the sockets, excluding downlights, in an older home may be enclosed fixtures and most consumers will not notice or adhere to the fine print warning on the package that states the bulb is not suitable for use in enclosed fixtures. In fact many consumers will not know what an enclosed fixture or enclosed luminaire is referring to. As such one must assume that the A-lamp that the consumer buys might

² ENERGY STAR allows lamps to qualify for early interim certification after 3,000 hours of testing. Based on the 3000 hour data, EPA allows manufacturer to make a maximum life claim (hours to LM70) of 15,000 and 25,000 hours when the minimum lumen maintenance after 3,000 hours is 93.1% and 95.8% respectively. Our proposal is based off of these numbers.

go into almost any socket in the home (except recessed cans) and that they should be assured of a good user experience.

We selected a testing time of 3,000 hours as a compromise, as 1,000 hours might be too short of a time to identify potential issues and a longer time period could delay introduction of new models to the market. Also if a manufacturer does not have test data to demonstrate their model will last at least 3,000 hours, we don't understand how they can responsibly claim that it will meet a projected lifetime of 15,000 to 25,000 plus hours and continue to produce acceptable light output levels.

D. NRDC recommends CEC include minimum requirements that address a lamp's audible noise

Noticeable hum or buzzing is one of the main criticisms observed by customers in the on-line comments on the product webpages at retailer websites such as Home Depot, Amazon.com and Target. We recommend CEC adopt the test method and requirements for noise currently included in the ENERGY STAR specification. We also understand that EPA has been involved in discussions with some of the testing laboratories and is evaluating feedback that would minimize the number of locations the sound measurements must be made at, while still providing an accurate result. We encourage CEC to work with EPA on this and to consider using a modified version of the current test method as appropriate.

E. NRDC recommends CEC include minimum requirements for flicker and to utilize the test method used by ENERGY STAR with some slight modifications

Another potential consumer dissatisfier is noticeable flicker. To address this concern, we recommend CEC include flicker testing and requirements. We support the detailed suggestions supplied by the California IOUs and their consultants on this topic which include: a) utilization of the EPA test procedure with additional specificity on the test set up conditions; and b) setting a maximum allowable % flicker value at frequencies of $\leq 20,000$ Hertz. This approach is consistent with and builds off ENERGY STAR's requirements. There will not be any additional manufacturer testing burden as the test results to satisfy the CEC requirements would also be valid for submission to ENERGY STAR.

F. NRDC supports the CEC's approach to dimming and recommends CEC provide additional specificity on the dimmers to be used during testing.

NRDC supports CEC's requirement that dimmable lamps must dim down to at least 10% of initial light output. As the interaction between the bulb and dimmer used during the testing can impact the results of testing for noise and flicker, we recommend CEC:

a) Require manufacturers to test their lamps on three types of dimmers which must include one digital-type dimmer, one analog rotary dimmer, and one occupancy sensor dimmer that meets California's manual on, automatic off dimming requirements as specified in Title 24.

b) Allow manufacturer to choose which specific dimmer model within each of the three groupings above to use during the testing and to require the manufacturer to report the specific dimmer models that were used during testing.

c) Follow EPA's testing guidance that testing be done with both 1 lamp per dimmer and with 4 lamps per dimmer.

While it would be ideal for the CEC to specify exact dimmer models of the most common dimmers to perform the testing with, we recognize this could provide an unfair advantage to the dimmer manufacturers' whose dimmers were called out as the industry would design specifically to that model, resulting in higher sales of those dimmers. Having access to model numbers of the dimmers that were used during testing allows the CEC to conduct testing using the exact same dimmer during potential future market surveillance testing and enforcement activities.

We also encourage CEC to align with ENERGY STAR's testing conditions for noise and flicker using 100% and 20% of lamp light output.

G. NRDC supports CEC's establishment of incandescent equivalencies for lamp light output for A-lamps and recommends development of similar tables for decorative lamps and small diameter directional lamps.

For the near and mid-term future most consumers will continue to rely on their historical purchasing behavior and knowledge of buying lamps based on the incandescent power levels they are familiar with, e.g. 25, 40, 60 75 and 100 Watts. It will take several years before most consumers begin to shop for lamps based on its amount of lumens. As such manufacturers prominently include claims on the front of their package such as "10W = 60W", or "replaces 60W bulb". The equivalency requirements will prevent a manufacturer who offers a 600 lumen watt bulb from improperly claiming equivalency to a 60Watt incandescent bulb which historically provided approximately 800 lumens.

We support the current incandescent equivalency table shown in Table 6 of the CEC staff proposal and encourage staff to develop and issue a similar table for small directional and decorative lamps similar to those included in section 9.2 of the ENERGY STAR specification. In developing equivalencies for small directional LED lamps such as MR-16s, CEC should consider both the lamp's center beam candle power (CBCP) and its beam angle.

II. SMALL DIAMETER DIRECTIONAL LAMPS

There are currently no federal efficiency regulations for small diameter reflector lamps (2.25 inches or less) and this category provides the opportunity for dramatic energy savings. NRDC strongly supports CEC's proposal to require these lamps to meet an energy efficiency standard of 80 lumens per watt (LPW) by January 1 2018. This

standard is extremely cost effective due to the greater efficiency and much longer life of the LED lamps compared to the incumbent halogen based products.

Today, more than three years from the effective date of the standard, there is a plethora of LED small diameter reflector lamps that are offered in a wide range of styles (eg line and low voltage), light output levels, and by numerous manufacturers. While most of today's products do not meet the proposed 80 LPW requirement, several are already very close and we fully expect new products offered in the next few years to meet this level. New products will build off of the historic and ongoing trend of increasing efficiency of the individual LEDs, which drives down the amount of power needed to illuminate the lamp. This trend also allows manufacturers to produce brighter lamps without any incremental heat buildup.

We would also like to highlight the fact that even small manufacturers such as San Mateo based [Green Creative](#) are already producing MR-16 lamps that produce 500 lumens, are rated to last 30,000 hours and only use 7 Watts, yielding an efficacy of 71.4 LPW today. This lamp replaces an equivalent halogen lamp that uses 50 Watts and only lasts 2,000 hours.

While there are improved halogens (halogen infrared or HIR) on the market that cut power use by up to 40% (e.g. 50 W down to 30W), these lamps still use 4 times more power than an equivalent LED lamp and have an efficacy of only 17 LPW. NRDC urges the CEC to keep its standard at levels that will require LED like performance for these lamps given the dramatic power savings (up to 85%) and the energy savings they provide over their much longer life than halogen lamps.

Should new data become available showing that the 80 LPW level will not be attainable by 2018 for portions of this market we would not oppose consideration of a lower level provided it would still require LED efficiency levels.

More specific comments regarding small diameter reflector lamps are provided below.

A. The CEC shall apply most of the performance criteria established in its proposed Title 20 LED performance requirements to small diameter reflector lamps.

The current CEC LED lamp proposal does not include many of the lamp types that fall under the small diameter reflector category such as lamps with a 2 pin base with the ANSI designation GU 5.3. The CEC could choose to expand the scope of its LED lamp regulations to include small diameter reflector lamps, or cut and paste the applicable sections of the LED lamp requirements into the small diameter reflector lamp requirements.

While we do not have an opinion as to which path is preferable, we feel it's very important that this category of lamps be subject to minimum performance requirements for key criteria such as audible noise, flicker, durability, etc. as other LED lamps do.

B. The CEC should require manufacturers to report model number information about the power supply/transformer that was used during the laboratory testing of low voltage lamps (e.g. 12 and 24 Volt lamps).

In order to reproduce testing conditions during potential future compliance assurance and enforcement activities, the CEC must have access to information on the transformer used during testing. This is important as the performance of the lamp and test results may be dramatically affected by the transformer it is tested with.

C. The CEC should develop lumen equivalency tables that manufacturers must comply with when making power equivalency claims e.g. 7W = 50W)

This table should include values for lamps with specific beam angle and central beam candle power (CBCP) levels.

D. The CEC should ensure that its efficiency requirements do not preclude the future sale of efficient high CRI LED lamps

In order to maintain the light output of a LED lamp, raising the CRI of a lamp can result in a 20 to 30% power increase and corresponding reduction in efficacy. As such we think the CEC needs to amend its proposal to include reduced efficacy levels for lamps with high CRI. We are open to application of a similar approach that the CEC proposed for LED lamps that established a minimum CRI and efficacy levels, and then allowed a tradeoff between efficacy and CRI for high CRI lamps. An alternate simpler approach would be to establish tiers as shown below with the hypothetical values listed.

Color Rendering Index	Minimum Efficacy (lumens per watt)
CRI 80 -85	LPW > 80
CRI 85- 90	LPW > 70
CRI 90 -95	LPW >60
CRI >95	LPW <50

E. The CEC should establish labelling requirements to assist purchasers, in particular individual consumers, purchase the right small diameter directional lamp as the market will shift from high wattage to low wattage products

It is more challenging to purchase directional lamps than everyday general service lamps. With directional lamps one must also consider the beam angle and be able to easily tell if the lamp can be used with line voltage or only with low voltage systems. We support the IOUs proposal to require the outer box for these lamps to include labels based on the DOE LED Lighting Facts Program Label. In addition we also

recommending that wattage equivalency be listed on the packaging, in accordance with the equivalency tables set by the CEC.