

## CODES AND STANDARDS ENHANCEMENT INITIATIVE (CASE)

# Statewide Utility CASE Team Responses to Stakeholder Comment Letters on the Proposed Title 24 Standards for Residential Lighting

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Residential Lighting

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## 2016 CALIFORNIA BUILDING ENERGY EFFICIENCY STANDARDS

California Utilities Statewide Codes and Standards Team

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# INTRODUCTION

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This document contains the Statewide Utility Codes and Standards Enhancement (CASE) Team's responses to several stakeholder comment letters as they relate to the Residential Lighting CASE Report and the CEC's draft proposal for residential lighting. The stakeholder comments are in black text and the Statewide CASE Team's responses are in blue text.

## NEMA COMMENT LETTER: NOVEMBER 24, 2014 (POSTED DEC 3, 2014)

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### NEMA Comment 2 (November 24, 2014 Letter)

"Failure to Consider and Respond to Prior Submissions: NEMA members previously submitted numerous technical, testing, and market related comments to the June workshop proposals for Title 24. While subsequent conversations with CEC staff led us believe our proposals were taken into consideration and that there would be related modifications to regulatory language in a number of areas, the materials presented at the 11/3 workshop did not seem to incorporate any of these modifications, save one."

### CASE Team Response to NEMA Comment 2 (November 24, 2014 Letter)

The draft language presented at CEC's November 3, 2014 pre-rulemaking public meeting did consider several of NEMA's comments from their July 25, 2014 letter (see the end of this document for NEMA's July 25, 2014 comment letter). The following comments were taken into consideration in CEC's November proposal:

- NEMA's recommendation of a minimum R9 value of 50 was included in the draft proposed language presented by CEC on November 3, 2014.
- NEMA's recommendation that only LED sources should be required to comply with NEMA SSL7A was included in the proposed language presented by CEC on November 3, 2014.
- NEMA's recommendation that warranty not be included in the JA8 requirements resulted in the CEC removing the warranty requirements from the proposed draft language presented by CEC on November 3, 2014.
- Though there were many public comments during the June public meeting against the prohibition of screw base lamps in recessed luminaires as proposed by the Statewide CASE study, NEMA recommended that CEC not respond with a compromise position that might allow screw based lamps in these luminaires. NEMA suggested that this should be the "subject of a public discussion." The CEC has honored this request by keeping the prohibition of screw bases in recessed luminaires and by holding a public discussion on this topic during the November 3, 2014 CEC pre-rulemaking public workshop.
- NEMA objected to the original proposal that the elevated temperature life testing requirements apply to all lamp types, and proposed that they only be applied to lamps that are likely to be installed in high temperature locations, especially recessed and enclosed luminaires. The

proposed language presented by CEC on November 3, 2014 only applied the elevated temperature requirements to omnidirectional light sources equal or greater than 10 Watts, and directional sources of all wattages that are not labeled with the following statements:

- "not for use in enclosed luminaires" or
- "not for use in recessed luminaires," and
- In regards to start time, the proposed draft Standards language presented by CEC at the November 3, 2014 pre-rulemaking public meeting did not completely eliminate the start time requirement as NEMA had proposed but they did significantly scale back the requirement by increasing the maximum start time from 0.3 seconds to 0.5 seconds.

### **NEMA Comment 3 (November 24, 2014 Letter)**

“Prescriptive versus Performance Requirements: Title 24 is an excellent standard to promote energy efficient buildings by setting performance standards. However, with each cycle during the past few years these requirements are becoming more and more prescriptive. We submit that the current proposals for residential lighting with the 2016 code are entirely prescriptive. This approach limits consumers, designers and builders to a set of product and design solutions that may not be aligned with the end user's priorities. The prescriptive approach also limits technology development by forcing manufacturers to design components that may not maximize the overall efficiency or other consumer features. To correct this, we encourage the CEC establish a policy which encourages performance-based energy efficiency requirements and discourages prescriptive requirements. One way to do this is to prohibit CASE study teams to submitting proposals that require, in effect, that a limited test study setup be adopted as the sole solution for energy savings in the regulation, a practice that has proliferated in recent years. Should the regulations continue to be allowed to become overly prescriptive, such action could increase challenges post-adoption during legal review if more representatives of excluded technology take exception.

### **CASE Team Response to NEMA Comment 3 (November 24, 2014 Letter)**

The most prescriptive requirement of the proposed Standard is to prohibit screw bases in recessed downlights. The rest of the requirements are performance-based in terms of energy efficiency and lighting quality. Any technology that achieves the Standards for efficacy and lighting quality (e.g., CRI, CCT, start time) is still permitted. The State is not required to protect the market share of inefficient technologies.

### **NEMA Comment 4 (November 24, 2014 Letter)**

“Consumer Preference and Lack of Feasibility Analysis: The current residential lighting proposals assert that superior performance in each attribute is required for every application in a residence. The proposals have not provided the substantiation with regard to consumer preference for specific threshold levels of performance and may not be technically justified. There is no consideration in the proposals to account for different consumer needs with respect to the applications such as kitchens, bathrooms, garages, and outdoor lighting. Furthermore, no economic justification has been provided for the cost analysis of systems that require the combination of all of the performance attributes. Given the very short timeline for Title 24 adoption, there would appear to be insufficient time to conduct proper economic analysis. It is our understanding that this analysis is required, and we ask the CEC to explain how it will accomplish this in very limited remaining amount of time before the process of adoption begins.”

## CASE Team Response to NEMA Comment 4 (November 24, 2014 Letter)

The Residential Lighting CASE Report documents the history of consumer dissatisfaction with CFLs and the resulting barriers to the proliferation of that particular lighting technology. The CASE Report proposes a number of features that are reasonably expected to improve consumer acceptance and retention of high efficacy lighting. The CASE Report also includes the results of the CASE Team's analysis that these products, including those that meet all of the performance attributes, are cost-effective. NEMA's arguments have not included any quantitative data or survey data that the requirements would decrease satisfaction with high efficacy lighting. NEMA has provided no data that high quality and high efficacy lighting is not cost-effective as compared with low efficacy lighting. In addition, there is no requirement for the cost-effectiveness calculation to be done on a room by room basis. The cost-effectiveness requirements in the Warren-Alquist Act for building standards state:

*The standards adopted or revised pursuant to subdivisions (a) and (b) shall be cost-effective when taken in their entirety and when amortized over the economic life of the structure compared with historic practice. When determining cost-effectiveness, the commission shall consider the value of the water or energy saved, impact on product efficacy for the consumer, and the life cycle cost of complying with the standard.<sup>1</sup>*

The Residential Lighting CASE Report indicates a benefit-cost ratio of at least 6:1 as compared to the current practice.<sup>2</sup> Any ratio greater than 1 means the measure is cost effective. NEMA has not provided any evidence that would indicate that high quality, high efficacy lighting has a higher life cycle cost than low efficacy lighting. Furthermore, the proposal does not ban the use of lower performance products (e.g. with lower CRI) where they cannot be reasonably be expected to be replaced with low efficacy lighting. Thus legacy high efficacy products with GU-24 bases, bi-pin fluorescent bases, etc. are still allowed to be installed just as is the case in the 2013 Title 24 Standards.

## NEMA Comment 5 (November 24, 2014 Letter)

"Technology Neutral" Should Be Truly Neutral: The proposed Joint Appendix 8 requirements add significant restrictions to product availability and are applied inconsistently by technology. The requirements applied to recessed luminaires are not technically substantiated. Many of the requirements appear to relate to LED test methods for light sources or lamps, but are included in the appendix with the intent to apply to residential luminaires. As we note in a preceding comment, certain proposed requirements are based on assumptions about consumer preference which actually may vary depending on architectural design or finishes. The restrictive requirements in JA8 have the potential to revert the marketplace to lighting of lower quality and efficiency as a result of the costs associated with the testing and performance requirements in JA8. In general, Appendix JA8 needs substantial work to clarify the application of test methods and to validate the justification and cost effectiveness of the proposals. NEMA members believe that the list of attributes for performance criteria should be balanced so as to allow adequate choices by consumers rather than fixed to single-choice options via arbitrary and unsubstantiated thresholds."

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<sup>1</sup> Warren-Alquist Act (Public Resources Code Section 25000 et seq) § 25402. Reduction of wasteful, uneconomic, inefficient or unnecessary consumption of energy.

<sup>2</sup> Page 51, Table 27: *Cost-effectiveness Summary*. [http://www.energy.ca.gov/title24/2016standards/prerulemaking/documents/2014-06-24\\_workshop/final\\_case\\_reports/2016\\_T24\\_CASE\\_Report-Res\\_Lighting\\_Oct2014-V5.pdf](http://www.energy.ca.gov/title24/2016standards/prerulemaking/documents/2014-06-24_workshop/final_case_reports/2016_T24_CASE_Report-Res_Lighting_Oct2014-V5.pdf)

## **CASE Team Response to NEMA Comment 5 (November 24, 2014 Letter)**

NEMA has not provided any data or rationale to indicate that the requirements in JA8 would “revert the marketplace to lighting of lower quality and efficiency as a result of the costs associated with the testing and performance requirements in JA8.” NEMA does acknowledge that these requirements are performance-based and that the testing requirements are no more onerous than the ENERGY STAR’s testing requirements. In some cases the selected criteria are more stringent than the ENERGY STAR criteria, but the measurement is obtained using the same test method. It should be noted that ENERGY STAR testing and quality requirements have been commended for increasing the quality of products in the market. NEMA has not provided information that would indicate that less stringent thresholds for CRI, start time or flicker would improve consumer satisfaction. The primary concern has been around the cost of higher quality lighting, but as described above, this cost is more than offset by energy savings. In fact, with these requirements in place, the cost of high quality lighting is reduced due to a unified metric, marking standard, and volume of use in new California homes.

NEMA’s response appears to confuse Title 24 (building standards) with Title 20 (appliance standards). The building standards do not limit the choices of light sources to consumers but rather to homebuilders. Some homebuilders will install legacy high efficacy sources, but more realistically homebuilders will opt for lower cost high quality, high efficacy JA8 sources that can be screwed into the wide variety of luminaires that come pre-manufactured with screw base sockets. By allowing screw bases in all applications except recessed downlights, this code change will allow consumers to easily replace light sources if desired.

## **NEMA Comment 6**

“Joint Appendix 10 and Flicker requirements: NEMA reaffirms its opposition to the CEC establishing its own mandatory flicker test procedures ahead of numerous industry working groups examining this phenomenon and working to identify repeatable objective tests to evaluate it. We caution against adopting the proposed test procedure in Joint Appendix 10 because it has not been adequately tested and it is not related to other, more advanced, efforts taking place in the IEEE and other scientific forums. The number of devices tested by the IOU/CASE team is woefully inadequate and the CEC is taking a significant risk by relying on such a small, unrepresentative data set. An IEEE document drafted and tested by an eminent scientific panel is currently in ballot. We appreciate the comments expressed by the IOU CASE team in which they attempted to downplay the potential confusion inherent in the proposed one-off test procedure. The Flicker Test Procedure in Joint Appendix 10 is not adequately vetted and should not be allowed to proceed into regulation; the draft Appendix should be struck.”

## **CASE Team Response to NEMA Comment 6**

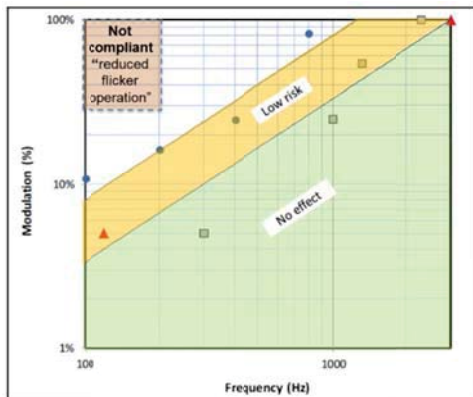
Title 24 has had the same requirements for “low flicker operation” of dimming controls since the 2008 Standards. This requirement pertains to dimming sources controlled by dimming controls that have less than 30% amplitude modulation for frequencies less than 200 Hz. As described in the Residential Lighting CASE Report, this requirement is less stringent than the proposed flicker guideline in IEEE PAR 1789. Figure 3 from the CASE Report is included below.<sup>3</sup> Though the California “low flicker operation” requirement is less stringent than setting a standard at what is not considered to be high risk,

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<sup>3</sup> Page 18 *ibid*.

we believe that once flicker is quantified and published in a CEC flicker database that manufacturers will voluntarily design to even lower amounts of flicker. Thus, the proposal does not require more stringent flicker requirements than what have been in place for a while. However, the proposal does recognize that flicker is not just a function of the control but also of the light source and its driver or ballast.

NEMA appears to support a more stringent flicker standard, such as IEEE PAR 1789. However, NEMA has expressed their opposition regarding a flicker test method and, although many of their members are required to conduct flicker testing as part of their ENERGY STAR certification, NEMA has not yet been able to provide any data on the “one-off test procedure.” NEMA claimed that the standard was not repeatable. The CASE Team provided results from round robin tests between two labs that showed repeatability of the test standard.



**Figure 3: Low risk and no observable effect regions for flicker (Lehman et .a 2014) overlaid with region of graph not compliant with "reduced flicker operation" requirement**

Furthermore, multiple manufacturers and other stakeholders have submitted comments to the CEC docket in support of flicker requirements and/or the proposed JA10 flicker test procedure, including but not limited to the following:

- Cree, a NEMA member and one of the largest LED manufacturers in the U.S., specifically supported the CEC’s proposed flicker requirements and the JA10 test procedure in a comment letter dated November 24, 2014.<sup>4</sup>
- AccurIC, a manufacturer of LED drivers and a member of the IEEE committee developing flicker standard PAR1789, also supported the CEC’s efforts in a comment letter dated January 5, 2015. In fact, AccurIC recommended that flicker requirements should be significantly stronger than what was proposed by the CASE Team and CEC, and the comment agreed that the proposed JA10 test procedure would be suitable to test LED lamps for adherence to the proposed flicker standard.
- Jade Sky, a California driver IC manufacturer, specifically supported CEC’s flicker proposal in comments docketed September 9, 2014.

<sup>4</sup> [http://www.energy.ca.gov/title24/2016standards/prerulemaking/documents/2014-11-03\\_workshop/comments/Cree\\_Comments\\_2014-11-24\\_TN-74046.pdf](http://www.energy.ca.gov/title24/2016standards/prerulemaking/documents/2014-11-03_workshop/comments/Cree_Comments_2014-11-24_TN-74046.pdf)



- Professor Arnold Wilkins, University of Essex, a member of the IEEE committee developing flicker standard PAR1789, commented to the docket on February 4, 2015 recommending that flicker requirements should be significantly stronger than what was proposed by the CASE Team and CEC. He also stated that it was a “major innovation” to at least begin requiring the collection of flicker test data.

## **NEMA COMMENT LETTER, JULY 25, 2014 (POSTED AUGUST 14, 2014)**

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### **NEMA Residential Comment 1 (July 25, 2014 Letter)**

“Consumers like choice and quality means different things to different people. The proposal includes a variety of ‘quality’ criteria, but there are tradeoffs between most of these. We appreciate the interest and share the concern to promote the adoption of quality LED products, but the proposal appears to be requiring the best of class or high quality in every attribute. The McKinsey study mentioned in the June 24th CEC workshop indicated that cost and quality both have essentially equal weight in preference. A homeowner or multifamily property owner may select a lower cost over high color or other quality features as long as they understand the tradeoffs. Luminaires installed in a garage, basement or closet may not need the highest level of color rendering. Luminaires in a bathroom would likely demand very high color quality, at the expense of energy use or brightness. LED products carry the Lighting Facts label, which describes the energy use, color, brightness – allowing consumers or specifiers to make the decision. We recommend that the Commission consider a focus that allows the owner to select from a range of compliant options to select the quality attributes most important to their application(s) and needs, rather than requiring the highest quality attributes in all categories, which ultimately drives up price and delays consumer adoption.”

### **CASE Team Response to NEMA Comment 1 (July 25, 2014 Letter)**

Based on our analysis, all of the high efficacy lighting requirements are extremely cost-effective, with lifecycle savings from high efficacy lamps in excess of five times higher than their incremental cost. Furthermore, a significant number of ENERGY STAR lighting products meet the requirements of the proposal. Code changes are required to be feasible (i.e. product is available and skills to install are reasonable), cost-effective (i.e. life cycle cost for the measure as a whole is reduced over the period of analysis), provide sufficient consumer amenity, and are readily enforceable. The base case against which the CASE Team compared the changes from the existing (2013) Title 24 Standards, include the JA8 requirements for LEDs of a minimum 90 CRI, allowable ranges of correlated color temperature (CCT), allowable bases, and labeling requirements. The cost impact of providing quality lamps is small and is dropping, as validated by a time series collection of cost and product data for thousands of products collected over a period of one year.

The rationale for requiring the builder to provide high quality, high efficacy lamps is so the lamps are retained in their sockets by the homeowner. The significant change to the proposed standard is to relax the definition of high efficacy so that screw based and other traditionally incandescent bases are allowed to be considered high efficacy luminaires if they have a JA8 compliant lamp in the luminaire. Thus, the homeowner will have greater choice in replacing their lamps in response to their preferences than in the past. Key to enforcement of this proposal is to allow lamps that are labeled as JA8 compliant in any screw based luminaire. Building officials have expressed their preference for mandatory lighting

requirements which are simple to enforce. Changing the quality requirements for lamps by room type or luminaire type would add a layer of complexity that is not desired by builders or building officials.

The comments by NEMA above indicate that the JA8 proposals require the “highest quality attributes in all categories” and that the requirement “ultimately drives up price and delays consumer adoption.” The CASE Team does not agree that the proposed standards would require the highest possible quality attributes in all categories. In fact, for every category, there are products that far exceed the proposed requirements (e.g. some lamps have start times faster than 0.25 seconds, some have CRIs above 96, some dim down below 2%, some have power factor above 0.98, etc.) The CASE Team has provided cost impacts of the proposed standards based on analysis of existing products, and shown the requirements to be cost-effective. As described earlier, this is a building code requirement and does not regulate the homeowner but the builder. These requirements do not take effect until 2017 and its effect on consumers is that 3 million high quality, high efficacy lamps would be required for new homes. This creates an economy of scale for low cost but high efficacy and high quality lamps.

The quality specification and the JA8 label provide a sustainable model of high efficacy lighting that preemptively addresses the concerns with the roll out of high efficacy lighting that did not place enough value on the amenity of the light source. This strategy is aligned with not only the Title 24 residential lighting proposal but also the high quality LED specification that is the cornerstone of CPUC policy on LED lighting incentives.

### **NEMA Residential Comment 2 (July 25, 2014 Letter)**

“The only limitation to the energy used in a residential building is the nature of the energy use and savings potential in the building’s equipment. A potential path forward to regulating energy use would be to develop a simple alternate path for compliance based on whole building energy use that could be introduced in the 2016 code and expanded for future standards. This could be an optional compliance path and could provide valuable insight to actually reduce energy use in residential buildings.”

### **CASE Team Response to NEMA Comment 2 (July 25, 2014 Letter)**

A whole building approach was considered for the 2013 Title 24 Standards and was initially considered for the 2016 Title 24 Residential Lighting CASE Report. This approach was rejected based upon feedback provided to CEC staff by building officials. The preference was for mandatory lighting standards that could be more easily enforced. With whole building approach one must calculate the total wattages of lights that are installed, including the proportion that is high efficacy vs. low efficacy in certain rooms, and this is cumbersome for the applicants and building officials. In addition, the installation of hard wired lighting is optional in many rooms within residences, and as such, addressing how one calculates a budget for rooms with no installed lighting would add more complexity to enforcement. The 2013 Title 24 Standards had a combination of mandatory requirements and calculated credits for low efficacy lighting. The calculated credits were confusing and rendered enforcement of the Standards more difficult. NEMA’s proposed alternative compliance path points in the opposite direction from what has been recommended by those who are enforcing the Standards.

### **NEMA Residential Comment 3 (July 25, 2014 Letter)**

“As to the proposal that screw based lamps can qualify as high-efficacy if they meet the performance requirements in Appendix JA8, we request the CEC consider having more discussion on this point. Based on the June workshop discussions and subsequent exchanges, it appears that some groups favor a position that all screw base products in all applications be entitled to this opportunity to classify more products as high-efficacy, while others would continue existing restrictions against screw base products



in some applications (i.e. residential downlights). Rather than CEC attempt to compromise between such disparate positions based on written comments, we suggest this be the subject of a public discussion so that it can be addressed more effectively.”

### **CASE Team Response to NEMA Comment 3 (July 25, 2014 Letter)**

NEMA has expressed their support for the CEC not to compromise on the requirements for screw based sockets in recessed downlights in response to the number of comments during the June workshop in opposition to this requirement. NEMA has proposed that further discussion of these comments occur in a public setting. This is exactly what the CEC did by not relaxing the prohibition of screw base sockets in recessed luminaires and opening this topic up for discussion at the November 3, 2015 pre-rulemaking workshop.

Whatever the outcome of this debate is on the types of bases allowed in recessed luminaires, we consider it very important that the light sources in these luminaires are high quality. According to the Residential Lighting CASE Report half of the projected energy savings from the proposed changes to the standard are in recessed luminaires. Thus the code change proposal recommends that all light sources in recessed luminaires be high quality, high efficacy light sources.

### **NEMA Residential Comment 4 (July 25, 2014 Letter)**

“There was a confusing point in the June workshop where slide 18 of the Residential Proposal brief indicated that JA8 will become technology neutral, however the materials presented and ensuing discussion focused only on LED products. The data on slide 21 illustrates the low volume of products meeting individual quality requirements. Representatives of the building industry in the stakeholder meeting indicated that an even lower volume of products meet all the quality criteria. This could very well result in restrictions in supply or selection of styles of qualified products. There is a continued need to allow other choices in lighting besides 100% high-efficacy, to afford lighting options which are still efficient but can’t necessarily meet the stringent, technology specific, requirements of Appendix JA8.

The permitted percentage of non-high efficacy lighting could be controlled with a vacancy sensor, partial-on occupant sensor, or dimmer. Note: we suggest further public discussions about what percentage, but some leeway is needed.”

### **CASE Team Response to NEMA Comment 4 (July 25, 2014 Letter)**

Responses from the building industry to the proposal for streamlined low-cost, high efficacy requirements have been positive. They appear to understand that quality requirements increase consumer satisfaction and that clearly defined requirements for new homes creates a critical mass of products that places a downward pressure on cost in a competitive market. The proposed code allowance for traditional incandescent bases will allow consumer conversion to low efficacy sources if the consumer has an unacceptable experience with the high efficacy source. However, the importance is still placed on requiring high quality light sources. NEMA seems to indicate there are more low quality sources than high quality sources. For new construction, this proposed Title 24 Standard would reverse this trend and provide consumers with a labeled, high quality light source.

There is already widespread adoption of the quality requirements in LED products proposed by CEC. Most of the JA8 requirements proposed are consistent with the current ENERGY STAR lamps specification, and there are over 3,000 compliant lamps listed on the ENERGY STAR Qualified Products List. Several of the proposed Title 24 requirements are more stringent than the ENERGY STAR lamps specification, including mandatory dimming, higher power factor, reduced flicker operation, shorter start time, and higher CRI/R9. However, products meeting these requirements are

also widely available. For example, over 1,400 low CCT products in the ENERGY STAR Qualified Products List are classified as being both dimmable and having a power factor of 0.9 or greater, and nearly all of these have start times less than 0.5 seconds. Flicker performance is not listed in the Energy Star Qualified Products List, but the CASE Team conducted its own testing and found that half of the tested products meet the proposed flicker requirements (among products purchased in 2012-2013). Increased awareness of the flicker test method and requirements will only increase the availability of low-flicker products.

High color rendering (90 CRI and 50 R9) has historically had lower availability among replacement lamp products, but these products are available and market adoption is increasing quickly. Of the 1,400 low CCT products on the ENERGY STAR Qualified Products List that are dimmable and have power factor over 0.9, 110 have CRI of 90 or higher. These are offered from over 30 manufacturers, including Feit, Green Creative, Cree, Soraa, and Osram Sylvania, and include A19, BR30, BR40, MR16, and many other lamp shapes. As previously demonstrated in the Residential Lighting CASE Report, average CRI trends have been increasing among new lamp models for the last several years. In 2014, over 140 new replacement lamps with CRI's above 90 were added to the DOE Lighting Facts Database, corresponding to about 15 new high CRI lamp products every month. Products are routinely introduced at 96 CRI or higher. 90 CRI no longer represents a high end level of performance only achieved by specialty products.

It is important to note that these products all exist despite not being required by any code or standard. To provide an indication of the market's reaction to proposed standards, CEC should consider the market for LED luminaires over the last few years. CEC has been collecting information on residential LED products with high CRI in its Appliance Efficiency Database since the adoption of the 2013 Title 24 Standards, which included a 90 CRI requirement for residential LED products claiming a high efficacy credit. This public resource now includes a list of over 5,000 90+ CRI "High Efficacy LEDs for Title 24." This list includes over 38 manufacturers and 57 brands, and represents hundreds of unique high CRI dedicated LED luminaire product lines, including downlights, track lights, wall sconces, pendants, and others. If high CRI is required of screw-based lamps, we expect to see a similar influx of high CRI lamp products.

Likewise, there has already been a dramatic increase in products that meet the CEC's Voluntary LED Quality Specification (CEC Spec), which requires an even higher level of performance than is being proposed for Title 24. In the first year of implementation for utility rebate programs that support CEC Spec for replacement lamps, the list of available products increased from about 3 products to over 40. In 2014, the IOU incentive programs provided incentives for over 2 million 90+ CRI LED's that met or exceeded the minimum requirements in CEC Spec.

### **NEMA Residential Comment 5 (July 25, 2014 Letter)**

"The proposed multiple quality attributes will drive up the cost of the products due to high cost of components, financial implications with warranties and administration, additional labeling and additional testing. The cost projections on slides 10, 28, 29 and 30 were not based on the consideration of the proposed code revisions. Therefore the cost projections in the CASE proposal are not accurate since they don't represent products that meet all the overlapping quality attributes. There were comments at the June workshop suggesting that builders should be required to provide the lighting facts info (brightness, watts, color) and cost to the homeowner allowing them to understand the tradeoffs and make a decision about their preferences."

### **CASE Team Response to NEMA Comment 5 (July 25, 2014 Letter)**

This proposal allows screw based lamps in return for having high enough quality to provide a reasonable assurance that the lamps will not be replaced due to poor quality. We agree that customers should be educated about the quality and attributes of lighting products, and would support efforts to encourage this type of communication. However, we do not believe that the builder should have the option of offering customers poor quality lighting products. Allowing a builder to equip a home with poor quality lamps would not meet the intent of this standard. NEMA's recommendation undermines the ease of enforcement as it would rely on a consumer request and documentation.

In regards to costs, NEMA is incorrect in stating that the costs "were not based on the consideration of the proposed code revisions." The cost estimates in the CASE Report were based on products that would meet the proposed standards, including all of the quality aspects. Also the proposed standards align with Energy Star testing requirements where ever possible, and most of the required performance metrics are already reported for Led products to the LED Lighting Facts Database, so there is little additional testing burden. The current price estimates for these products are approximately \$14 for JA8 lamps and about \$35 for JA8 downlights. Current CEC Spec products are already available in this range or lower, including the following:

#### **Residential replacement lamps**

Feit High CRI, CEC Spec, 800 Lumen A lamp: \$9 (Costco)  
Greenlite High CRI, CEC Spec, 800 lumen A Lamp: \$14 (Ace Hardware)  
Cree High CRI, CEC Spec, 800 lumen A Lamp: \$15 (Home Depot)  
Feit High CRI, CEC Spec, 750 lumen BR30: \$13 (Home Depot)  
Greenlite High CRI, CEC Spec, 750 lumen BR30: \$14 (Ace Hardware)

#### **Downlights**

Cree CR6 High CRI, 650 lumen, CEC Spec Downlight \$25: (Home Depot)  
EcoSmart, High CRI, 650 lumen downlight: \$19 (Home Depot)  
Lithonia 90 CRI, CEC Spec 650 lumen downlight: \$17.50 (Home Depot)

Average prices are projected to come down by between 25-50% between 2015 and 2017 based in part on forecasts from DOE and confirmed by research conducted by the CASE Team. The trends observed in historical price data collected for thousands of LED products from nine retailers over a period of more than one year confirmed all of DOE's projections for price declines.

### **NEMA Residential Comment 6 (July 25, 2014 Letter)**

"In response to the excessive proposed requirements in JA8, we propose these alternatives:

- Color rendering R9 value (red) at least 50 (however outdoor lighting should continue to be exempt from color rendering requirements)
- ~~Color Consistency: Within 4 step ANSI quadrangle~~
- Dimmable to 10% without noise or flicker, ~~"Reduced flicker operation" between 100% and 25% input power~~
- ~~< 30% percent flicker at frequencies less than 200 Hz~~
- ~~Power Factor > 0.90~~
- ~~Start time < 0.5 seconds~~
- Elevated Temperature: Same as ENERGY STAR light output ratio, ~~but for all lamps~~
- Early Failure: No failures in 1,000 hr test
- ~~Minimum rated lifetime: 15,000 hrs~~
- ~~5 year manufacturer warranty (based on 1,200 h/yr)~~

- Compatibility:
  - LED Lamps and dimmers must meet NEMA SSL7A as Type 1 or Type 2 products.
- Certification and Labeling:
  - Labeled on the product or in the catalog or packaging as meeting JA-8 high quality specification along with other specific lamp markings
  - Certified in CA appliance efficiency database
  - Labeled with manufacture date or a discernable date code

Our reasons and rationale for these changes are:

- R9: based on our experience, 50 is sufficient.
- Color Consistency: while color consistency is a matter of annoyance to some, in practice few consumers look directly at the light source. It does not affect performance. It does not affect energy efficiency. We acknowledge and appreciate that the CEC removed the proposed requirement of set CCT ranges, which means the Commission recognizes that color appearance is a consumer preference. The Commission should treat this issue consistently and remove this color consistency requirement.
- Dimmability: the SSL-7A requirement addresses dimmability, so additional requirements are redundant.
- Flicker: The test procedures for flicker cited by the IOUs is a draft procedure being evaluated by volunteer participants in the ENERGY STAR Lamps program. It is self-test and self-report, and there are multiple reasons for this. The most important reason is the test procedure has not been used long enough to be certain it provides adequate/accurate assessment, and it has not been verified as repeatable. Internal enforcement challenges and outside litigation would be at risk if a test procedure that is not fully vetted were implemented. We share stakeholder and regulator concerns regarding flicker and the industry is working to address the issue via standards. Until such time as national/international standards exist, flicker cannot reasonably be made a hard and fast requirement. The Commission should allow the ENERGY STAR program to complete its work and industry to respond with standards before making flicker a requirement.
- Power Factor: There is no firm basis for this proposed requirement. As was noted in the public meeting, the combination of lead and lag power factors in the field makes a high-power factor requirement inarguable. This is a utilities-based argument for which utilities have never gathered of publicized substantive data of justification. Strike this requirement. Moreover, power factor is already addressed in the ENERGY STAR program, which is a precursor for most IOU rebate programs. To be consistent with ENERGY STAR and not place additional burden on manufacturers we recommend CEC echo the EPA's requirement of  $\geq 0.7$  power factor.
- Start Time: Remove this requirement. It is not substantiated as a problem, and only adds testing cost and raises final product cost.
- Elevated Temperature: This requirement is only justified for products which are expected to be installed in elevated temperature conditions, i.e. recessed fixtures. Products designed for these applications are marked and marketed accordingly. Products not intended for recessed/high-temp applications are so marked. It is a violation of the manufacturer's guidance to continue. To require elevated temperature capabilities and verification for other products imposes unfair cost and burden on manufacturers and responsible consumers.
- Early Failure: No comment
- Minimum Rated Lifetime: Manufacturers list the lifetime on the product carton and/or specification sheets. The life of a lamp is covered under the manufacturer warranty and is not appropriate in an energy standard.
- Warranty: The issue of warranties carries significant financial and administrative responsibility associated with a product. Regulatory agencies have not required specific warranties in the past because of the financial implications on the manufacturer. It is not appropriate for the

Commission to mandate financial policies, such as product warranties. While ENERGY STAR includes a warranty requirement, it is a voluntary program and manufacturers can choose to list a product or not.

- Compatibility: NEMA SSL-7A only applies to certain specific LED/SSL products; it cannot fairly be required of all high-efficacy products. This proposed requirement must be adjusted, or removed, to allow the technology-neutrality proposed by the IOU CASE team.
- Certification: No comments
- Labeling: due to the small size of some products, it should be allowed that the JA-8 compliance be documented in a manner easily accessible to builders, designers or homeowners. The standard should not specifically require this information on the product. We sympathize with the desire to make an inspector's job easier, but the small size or recessed installation of some products may not be feasible and may not assist in compliance inspections."

## CASE Team Response to NEMA Comment 6 (July 25, 2014 Letter)

Areas where the draft JA8 proposal matches NEMA's recommendations include:

- Minimum R9 value of 50
- Only LED sources required to comply with SSL7A
- Warranty is not included in JA8 requirements
- Elevated temperature requirements apply only to recessed and enclosed luminaires
- Initially the draft proposal did not address outdoor lighting separately but we agree that it should be addressed.

Relative to the CASE Report, CEC's proposed standards have increased the maximum start time from 0.3 seconds to 0.5 seconds. The vast majority of ENERGY STAR rated products have start times less than 0.5 seconds.

**Color consistency** – The intent of the requirement is to ensure that whatever color temperature is selected, that all light sources of that color temperature appear to be the same color. Light sources that have noticeable variations in color temperature are undesirable as described in the CASE Report, even when one is viewing light reflected off of a source such as a wall. In comparison, the incumbent technologies of incandescent lamps are all close to the blackbody locus due to the mechanism of how they produce light.

**Reduced flicker operation** – Since 2008, the Title 24 Standards have required reduced flicker operation, defined as having amplitude modulation less than 30% for frequencies less than 200 Hz. This requirement was not effectively enforced as no one had developed a test method. In response, the CASE Team has developed a reliable test method. The test method is a clear and repeatable method for measuring amplitude modulation for frequencies less than 200 Hz. In the past, the flicker requirement was applied to the controls. However, this new updated requirement reflects the findings that flicker is as much due to the light source as the control, and thus, requires reduced flicker operation of JA8 light sources. Given that 50% of LED products failed the flicker test, this implies two things: 1) a significant number of products do not operate with reduced flicker, and 2) products from multiple providers are able to meet the proposed flicker specification even without a quantitative specification. To date, NEMA has not provided data on flicker for any of their members' products or any specific technical critiques of the flicker test method.

**Power factor** – The costs imposed upon utilities to address power factor is passed onto all customers. It is exactly this split incentive that energy codes are designed to mitigate. The argument that lagging



power factors from motors will overcome the leading power factors from lighting is technically incorrect as the primary basis for poor power factor from lighting is due to distortion power factor (from high Total Harmonic Distortion) rather than displacement power factor. The issues have long been well known and are outlined in the 1993 paper, “Harmonics and How They Relate to Power Factor.”<sup>5</sup> The comment that “it is important to point out that one cannot, in general, compensate for poor distortion power factor by adding shunt capacitors. Only the displacement power factor can be improved with capacitors” was brought up at the November 3, 2014 pre-rulemaking workshop with no response from NEMA to these technical issues. More than half of the lamps currently listed in the ENERGY STAR lamps database have power factors greater than 90%. Power factor requirements are also under consideration for the Title 20 Standards for LED lamps.

In terms of cost, depending on the strategy, some estimates are as low as several cents or less for power factor correction in LED drivers, with the primary cost coming from a slight increase in the silicon area in the chip. To verify that the incremental manufacturer cost for power factor correction is indeed small, the CASE Team collected power factor data from the ENERGY STAR Qualified Products List and DOE’s Lighting Facts Database, and correlated it to over 1,000 price points collected from online retail sites. Based on the analysis, the CASE Team did not find any relation between power factor and retail prices for replacement lamps. In fact, based on price points for over 500 lamps in the 500 – 900 lumen range, average online prices for high power factor ( $\geq 0.90$ ) LED replacement lamp products were slightly lower (\$22.64) than the prices for lower power factor ( $< 0.90$ ) products (\$23.47). This suggests that any incremental manufacturer cost associated with 0.90 power factor is negligible.<sup>6</sup>

### **NEMA Residential Comment 7 (July 25, 2014 Letter)**

“Light Pollution: During the public meeting in June, a participant suggested that outdoor products should include requirements for light pollution. This is not an appropriate consideration for the residential energy standard. Light pollution issues are defined and enforced based on municipal ordinances. If a light pollution attribute is required for individual luminaires, it would not take into account the installation and whether a porch or other architectural or landscape elements block the light. While we believe controlling light pollution is an important issue, the Title 24 residential standard is not an appropriate method to regulate this.”

### **CASE Team Response to NEMA Comment 7 (July 25, 2014 Letter)**

As part of the development of the Title 24 Standards, CEC is required to make a negative determination of environmental impact. It is well within the scope of Title 24 to consider lighting trespass and the distribution of lighting fixtures. It should be noted that Title 24, Part 6, Section 132 regulates the distribution of light from nonresidential luminaires. Light that is scattered upwards or directed towards areas not intended to be illuminated is wasted light and well within the scope of an energy efficiency standard. At this point in time there is no such proposal for residential outdoor lighting.

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<sup>5</sup> <http://users.ece.utexas.edu/~grady/POWERFAC.pdf>

<sup>6</sup> P. 21-24 [http://www.energy.ca.gov/appliances/2014-AAER-01/prerulemaking/documents/2014-09-29\\_workshop/comments/California\\_IOUs\\_Response\\_to\\_the\\_CECs\\_Draft\\_Regulations\\_regarding\\_LED\\_Lamps\\_2014-11-18\\_TN-73993.pdf](http://www.energy.ca.gov/appliances/2014-AAER-01/prerulemaking/documents/2014-09-29_workshop/comments/California_IOUs_Response_to_the_CECs_Draft_Regulations_regarding_LED_Lamps_2014-11-18_TN-73993.pdf)



## **NEMA Residential Comment 8 (July 25, 2014 Letter)**

“150.0(k)1B Blank Electrical Boxes. The total number of boxes should not be limited to number of bedrooms but rather the number of total rooms so that homeowners can install a ceiling fan or luminaire in these boxes for each room if desired.

“Proposed change: ‘The number of electrical boxes that are more than 5 feet above the finish floor and do not contain a luminaire or other device shall be no greater than the number of bedrooms. These electrical boxes must be served by a dimmer, or vacancy sensor, or fan speed control.’”

## **CASE Team Response to NEMA Comment 8 (July 25, 2014 Letter)**

Blank electrical boxes can provide a loophole in the lighting requirements. An exception for blank boxes equal to the number of bedrooms is already a significant exception. In addition, the total number of rooms is not clearly defined and could easily be modified to include more rooms than need boxes.

## **NEMA Residential Comment 9 (July 25, 2014 Letter)**

“150.0(k)2J and 150.0(k)2K. The 2016 Title 24 should require all luminaires in these non-living spaces to be on an energy-saving control, not just one luminaire in those spaces. If anything, it should be written the other way around so that only one luminaire can be uncontrolled. Also, a partial-ON occupant sensor should be allowed as they have been shown to save even more energy than vacancy sensors because occupants are usually satisfied with 50% of the lighting on and they don’t need 100% of the lighting on<sup>7</sup>. This is a step backward from the current standard.

“Proposed changes:

“150.0(k)2 J. In Bathrooms, attached and detached Garages, Laundry Rooms, and Utility Rooms, ~~at least one~~ all luminaires in each of these spaces shall be controlled by a, vacancy sensor or partial-on occupant sensor (with the exception of nightlights or security lights).

“150.0(k)2 K. All screw based fixtures shall be controlled by a dimmer, or vacancy sensor., or partial-on occupant sensor.

EXCEPTION 1 to Section 150.0(k)2K: Luminaires in closets less than 70 square feet.”

## **CASE Team Response to NEMA Comment 9 (July 25, 2014 Letter)**

In most cases all luminaires will be controlled by the wallbox vacancy sensor because it is less expensive to do so. This requirement is written with feasibility in mind as there may be situations where room geometry or other issues makes it undesirable to control all luminaires with a vacancy sensor.

The value of partial-on control in homes stems from the fact that the residential environment is not the same as an office setting. The article by Craig DiLouie referenced by NEMA in their footnote states:

Alternate rows, fixtures or lamps can be switched, offering a choice of 50% and 100% light output. Or the center lamps can be switched separately from the outer lamps in three-lamp fixtures, offering a choice of 33%, 66% and 100% light output. In one study by ADM Associates, the latter option was demonstrated to produce 22% energy savings in private offices.”...“The California Lighting Technology Center (CLTC)

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<sup>7</sup> <http://lightingcontrolsassociation.org/cltc-study-demonstrates-major-energy-savings-for-bilevel-occupancy-sensors/>

organized a study in eight private offices at the University of California – Davis in 2008 to attempt to generate useful data related to these questions. Each office, between 90 and 140 sq. ft. with a ceiling height of 9 ft., is lighted by a combination of indirect/direct pendant fixtures and daylight entering through a window with manually adjustable vertical blinds. The study was sponsored by Watt Stopper/Legrand.<sup>8</sup> *(Underlines added in text above for emphasis)*

This study is not applicable to residential settings where lights are often off during the day either because of the availability of daylight or because the room is unoccupied. Lights in most of a home's sockets are on for less than three hours per 24-hour day. The partial on control for private offices, which is included in the CEC draft proposal, is based on the availability of daylight and the habit of turning on lights when entering an office.

### **NEMA Residential Comment 10 (July 25, 2014 Letter)**

“150.0(k)9 Residential Outdoor Lighting. Landscape lighting is still not addressed. All exterior lighting should be controlled, not just the exterior lighting that is attached to a building.

“Proposed changes: 150(k)9A. For single-family residential buildings, landscape lighting and outdoor lighting permanently mounted to a residential building or other buildings on the same lot meet all of the following requirements in item (i) and the requirements in either item (ii) or item (iii).”

### **CASE Team Response to NEMA Comment 10 (July 25, 2014 Letter)**

The CASE Team did not conduct an analysis of lighting controls for landscape lighting because landscape lighting is rarely installed at the time of new construction. Landscape lighting is usually installed with timeclock or photocell based controls. It is unclear why landscape lighting would also require a separate manual switch (item i) in addition to a time switch. The CASE Team is unsure of how much energy this requirement would save and believes that the ideas proposed need refinement.

### **NEMA Residential Comment 11 (July 25, 2014 Letter)**

“Appendix JA-8. We are concerned that there may not be enough qualifying high efficacy light sources. For instance, there do not appear to be any qualifying high efficacy light sources that would replace the halogen MR-16. Homeowners would lose current options to light up artwork or decorations. It is not clear if there is a qualifiable high efficacy equivalent for low voltage track lighting, or for chandeliers. While the Commission could conduct a study prior to the next workshop to evaluate supply and cost, we believe it is important to recognize the increasing market for MR-16 and not preclude them from use. Nor is it wise to exclude all products that are not high-efficacy per JA8 from use. Per our comment number 4 we recommend the CEC lead further public discussion on some lessening of the 100% high-efficacy requirement.”

### **CASE Team Response to NEMA Comment 11 (July 25, 2014 Letter)**

We would like to make sure NEMA is fully apprised that JA8 compliant MR-16 lamps are allowed in all luminaires including recessed luminaires as they typically do not screw bases. The proposed 2016 Title 24 requirements do not preclude the use of higher efficiency light sources to replace MR16s, like LED MR16s for example. Manufacturers such as Soraa, Cree, TCP, Green Creative and Civilight offer dimmable MR16 products that meet ENERGY STAR specifications and that have high efficacy, a CRI

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<sup>8</sup> Ibid.

>90, and a high power factor ( $\geq 0.90$ ). It should also be noted that the constraints that JA8 places on MR-16 lamps are constraints placed on the builder for the first lamp that is used in the fixture. It is the intent of this proposal to require that the first lamp that comes with the house be a long lived, robust, high efficacy, high quality lamp. The consumer having this lamp is likely to see its value and replace like for like. However this proposal recognizes that the consumer may have different motivations and may change the lamp according to their predilection for different color temperature, CRI, beam angle etc.

### **NEMA Residential Comment 12 (July 25, 2014 Letter)**

“Appendix JA-8. There is a notable error in the Appendix which should be corrected:

‘(i) Light source shall have start time no less more than 0.3 seconds as tested according to the requirements in Title 20.’”

### **CASE Team Response to NEMA Comment 12 (July 25, 2014 Letter)**

We agree with this comment. This error was corrected in the draft language presented by CEC at the November 3, 2014 pre-rulemaking workshop. It should be noted that in response to comments from NEMA and others, the maximum start time was increased to no greater than 0.5 seconds.

### **NEMA Residential Comment 13 (July 25, 2014 Letter)**

“Appendix JA-8. As mentioned at the June workshop, NEMA still feels that the requirement for 90 CRI for high-efficacy LED products unfairly limits product options and constrains consumer choice. We ask the CEC to hold an open discussion on this subject in a future workshop. There are many applications where a lower CRI is sufficient, and other color metrics may be appropriate.”

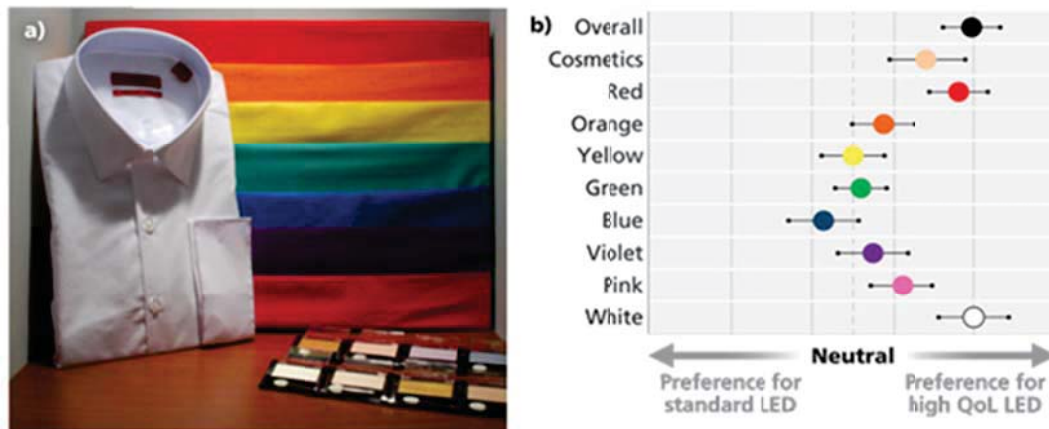
### **CASE Team Response to NEMA Comment 12 (July 25, 2014 Letter)**

The 90 CRI / R950 requirement builds upon the pre-existing requirements for LEDs that are part of the 2013 Title 24 Standards. High quality, high efficacy products with good color rendition are cost-effective as compared with the low efficacy products they replace. High CRI products are widely available and new products are being introduced very quickly. In response to the 2013 Title 24 code, there are now over 5,000 90CRI dedicated luminaires and light engines certified in the CEC’s Appliance Efficiency Database. From a policy perspective, it is desirable to minimize the instances where consumers are exposed to poor color rendition in high efficacy sources.

A consumer preference study published in 2014 by Pennsylvania State University and lighting manufacturer Sora isolates the difference between lower CRI and higher CRI LED products and found a clear preference for the higher CRI version among a majority of study participants. Below is an excerpt from the executive summary, followed by a visual depiction of the test subjects preference for each color.

Here we investigate perceptual responses under illumination from two sources, a blue-pumped LED with a colour rendering index of 85 (BLED85), and a violet-pumped LED with colour rendering index of 97 (VLED97). Forty-eight participants completed three experiments. Neutral, red, and pink were preferred under VLED97. Skin rendition was preferred by Caucasians under VLED97; Asians had no preference.

Teeth and a white shirt were whiter and more preferred under VLED97. We conclude that the colour and whiteness rendition must be considered on a par with luminous efficacy.<sup>9</sup>



## EATON COOPER COMMENT: DECEMBER 10, 2015 (POSTED JANUARY 13, 2015)

### Cooper Comment 1

We appreciate the fact that you have a selection of lighting sources listed as high efficacy, but are concerned that the requirements for LED sources, such as CRI for example in JA8, are much more stringent than the requirements for other sources. We feel this could lead to lower adoption of more efficacious sources.

### CASE Team Response to Cooper Comment 1

The quality requirements are the same for all screw based sources and all dedicated sources, regardless of light source technology. The Commission has modified the proposal so that GU24 sockets are not required to meet JA8, so the quality requirements are also the same for all GU24 sources, regardless of technology. These requirements are intended to encourage more parity among the requirements for different sources.

### Cooper Comment 2

Consumers select lighting products based on the intended use. Attributes that may be important for one area may not be as crucial in another area. Consumers like to have a choice in their selections and will make that choice based on cost, performance, and application. For that reason we would recommend continuing to offer the consumer the current option of a range of color temperature from 2700K –

<sup>9</sup> <http://lrt.sagepub.com/content/early/2014/08/22/1477153514548089.abstract> <http://www.soraa.com/public/docs/News/LRT-14-0060-20140729%20Soraa%20formatted.pdf>

4000K. We feel that only allowing color temperatures 3000K or less is too restrictive and does not provide enough options for the consumer. Understanding that Residential Compliance includes not only standard single family residences but also includes areas such as Senior Living Quarters included as “dwelling”, we find that higher CCTs are often preferred as the eye ages and a limit of 3000K may not be comfortable. We want to ensure that all areas considered as “dwellings” are also considered when proposing requirements.

## **CASE Team Response to Cooper Comment 2**

The proposed standards do allow cooler color temperatures. Linear fluorescent, GU-24 based products, and other legacy high efficacy sources can provide any CCT. Screw-based and other JA8 sources can also provide cooler color temperatures, as long as they are capable of providing warm CCTs as well (color tuning). Furthermore, the limits in the proposed standard are not on consumer choice and preference but rather on the range of lamps initially selected by the builder and contractor for the new home at the time of delivery to the homeowner. The homeowner is provided with a home having high quality and high efficacy light sources throughout the home that match the look of what they would expect from a similar incandescent system. If the consumer is unhappy with the color or other amenity of the light sources they can change them. This is especially easy when the light source is in a screw base -- compatible with a number of incandescent, fluorescent and LED sources. It is because the consumer has so many choices on how to fill a screw base socket that the Title 24 energy efficiency standard is taking extra care in JA8 to make sure these light sources meet the occupants’ quality expectations for color temperature, color rendering, durability, dimmability, etc.

## **Cooper Comment 3**

We suggest that CEC give more consideration to the proposal that would allow screw base lamps in all luminaires with the exception of recessed downlights. Our concern is that less energy efficiency technologies could and will be installed after the initial inspection. We suggest continuing the restriction that exist currently in Title 24 2013. We strongly support the ban of screw base lamps in all recessed luminaires and would suggest adding enclosed luminaires to that ban. We believe that allowing the use of screw base sockets in ICAT downlights and enclosed luminaires will result in misuse of screw based lamp technology creating unreliable results and unsafe conditions leading to consumer dissatisfaction and potential risk of fire. Please see attachment A pertaining specifically to recessed downlights.

## **CASE Team Response to Cooper Comment 3**

There has been a long history of CFL light sources falling short of their rated life time when installed in enclosed or recessed luminaires. The ENERGY STAR program has recognized this shortcoming and in their test methods for CFLs and LED have required that lamps that wish to be considered for use in these luminaire types be rated for durability and lumen maintenance at elevated temperatures. The proposed JA8 standard for high quality, high efficacy lamps builds upon this same standard. As proposed, lamps over 10 watts that qualify for use in enclosed or recessed luminaires would be tested for 6,000 hours with at least 9 out of 10 lamps lasting the entire duration and with an average lumen maintenance not less than 86.7 percent at the end of 6,000 hours. In an interior residential application this is at least 6 years of normal use. We have been promoting a performance based proposal that is focused on placing a high quality, high efficacy lamp in every socket in the home.

Luminaires are required to be labeled with the maximum wattage lamp that can be used safely in the luminaire. The issue of proper lamp wattage and proper application of recessed luminaires has been a long standing issue with safeguards built into thermal protection and design of luminaires. There is



nothing in the proposed standard that requires that the thermal integrity of luminaires being decreased. In fact this standard would allow the use of low wattage LED's being installed in incandescent luminaires that are designed for wattages that are 5+ times higher thus providing a significantly larger thermal safety factor than the with an incandescent installed.

In regards to the shortcomings of the use of the Halo H7UICAT as the basis of the ENERGY STAR "Test A" for elevated temperature testing, it would be helpful if the commenter could suggest an alternative fixture or an alternative test method and a rationale. If Cooper believes the temperatures used for the elevated temperature tests are inappropriate, please suggest what you believe are more representative with the basis for this statement.

Earlier in the letter the following was stated: *"Consumers select lighting products based on the intended use. Attributes that may be important for one area may not be as crucial in another area. Consumers like to have a choice in their selections and will make that choice based on cost, performance, and application."* Allowing screw bases in a variety of luminaire types provides significantly more consumer choice in the range of luminaires that can be applied from a greater range of vendors. It also allows the consumer to change the lamp, its color temperature and color rendering index if they choose. Thus the focus in the code change proposal is on providing a great value option to consumers of high efficacy, high color quality and low lumen depreciation in the first lamp installed in their new home.

#### **Cooper Comment 4**

The proposals for Joint Appendices JA8 contain requirements for numerous quality attributes for qualified product, some of which are not energy related. While quality is of course a consideration when selecting product, cost and application is also a huge consideration. We believe the CRI 90 requirement and the color rendering R9 value will severely restrict customer choice. While there are more recessed downlight products today that can meet the CRI 90 requirement, there are few surface mounted and linear style LED products that can meet this requirement. If the proposals only allow for premium products with a higher cost you may well see a lower penetration of new technology in California in comparison to other areas of the country. We would ask that you reconsider both the CRI 90 requirement and the color rendering R9 value drafted in the broad application of JA8 for High Efficacy products. We would also ask that the commission consider if the inclusion of 90CRI and a 50R9 value inadvertently provides preferential treatment to those that have patents written specifically around those performance characteristics creating a potential for restriction of trade that drives product costs up for those that comply with US laws.

#### **CASE Team Response to Cooper Comment 4**

There were few 90 CRI dedicated residential products available when the 2013 Title 24 Standards were adopted; today there are over 5,000 90+ CRI luminaires and light engines in the CEC's Appliance Efficiency Database. If the requirements for 90 CRI/R950 are adopted to apply to more product types installed in new residential construction (for example screw-based lamps), there will be a lead time of more than 1.5 years before the effective date. In the LED industry, design cycles for many companies are one year or even six months, so this allows manufacturers time to roll out 90 CRI product lines for new product types, as demanded by the market. 90 CRI prices have been coming down rapidly and product availability has been increasing as well. LED products with CRIs of 96-97 are not uncommon now, so 90 CRI no longer represents "best-in-class" performance. Regarding patents, 90 CRI products are available from a wide variety of manufacturers, and those manufacturers are using an array of design strategies, suggesting that patent infringement is not currently an issue impacting the ability of manufacturers to produce 90 CRI products.



## **Cooper Comment 5**

While we believe that color uniformity is important. Three to four MacAdams-ellipses (3 to 4 SCDM) is sufficient to address residential concerns. Defining it to the black body adds complication due to the loose definition of “source” within the requirements. This favors lamps in suspended air. This does not address thermal and optical color shifts and should be removed since it negatively impacts consumer choice and consumer preferences.

## **CASE Team Response to Cooper Comment 5**

The color consistency requirement is based on the ANSI color consistency specification ANSI C77.378, which is an industry standard document. As discussed in the CASE Report, changes in chromaticity greater than four MacAdam steps can be easily detected and can negatively impact consumer experience. The CASE proposal initially considered a two MacAdam step tolerance to ensure that products produce light on or very close to the black body locus. This aspect of the proposal was relaxed to a four MacAdam step tolerance to align with the industry standard ANSI C77.378 specification. Four steps also aligns with the CEC’s Voluntary LED Quality Specification, which is now being met by a variety of light engines, including downlight retrofit kits, A lamps, BR lamps, etc. Each of these light engine types has different thermal and optical properties that impact the measured chromaticity of the products, yet they are all able to produce light that is within four steps of the locus, which is the intent of this requirement.

## **Cooper Comment 6**

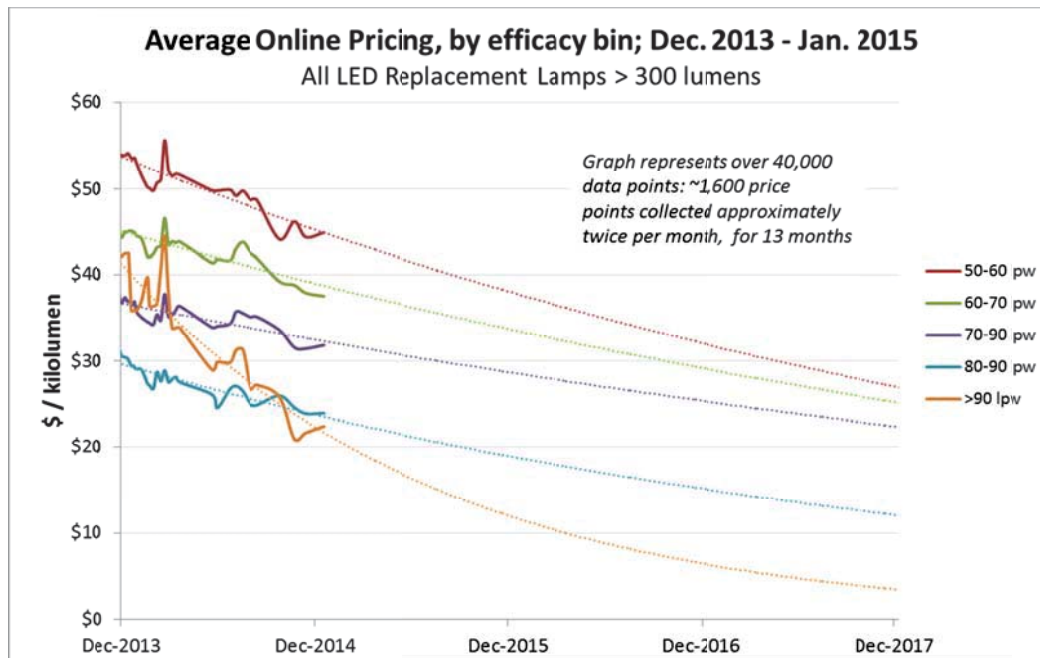
The 45 lumens per watt favors lamps suspended in air. The LED standards have been written around LM-79 with luminaire efficacy paramount. This allows for a 45lpw lamp that will deliver less than 20LPW in a luminaire. We would propose continuing the use of a matrix by luminaire application and/or type using LightingFacts® data analytics to establish the targets.

## **CASE Team Response to Cooper Comment 6**

The author notes that for LED sources, whether they be in integral lamp or a light engine that is part of a luminaire, they are both tested making use of the Illuminating Engineering Society lighting measurement standard IES-LM-79. For integral LED luminaires the light measured by the test method is that emitted by the luminaire. Thus for integral LED luminaires the luminous efficacy is reduced as optical losses in the luminaire reduce the measured light output. In addition, the test is conducted with ambient air temperatures of 25°C around the luminaire. LED efficiency drops off with increasing temperature. The temperature at the LED junction is relatively high because the LED junction is typically not in direct contact with the ambient air temperature but is surrounded by air with a higher temperature due to local heating of the air around the LED source. In comparison the LED integral lamp is measured in 25°C free air and does not suffer the optical losses associated being enclosed in a luminaire. The author contends that this efficacy standard should be more complex and be based upon an analysis of efficacies by different luminaire types and wattages from the LightingFacts database. The 45 lumen per watt standard is a minimum efficacy requirement that uses less than 1/3 the amount of power to provide the same amount of light as from a low efficacy lamp. The LED integral luminaires and light engines that the author describes as being disadvantaged by the efficacy standard based on the LM-79 test method are the only products that are in the current (2013) JA8 database. There are 7,500 products in this database, all have CRI’s above 90 and all but 8 of the products in this database have luminous efficacies that are 45 lm/Watt or higher. Thus this standard is not unduly

limiting the availability of integral LED luminaires (6,582 in JA8 database) or light engines (905 in JA8 database).

Further, we have found in our price collection efforts that higher efficacy products tend to be less expensive than low efficacy products, among replacement lamps in the 40-90 lpw range, so we expect manufacturers to voluntarily and significantly exceed 45 lpw anyways. Below is a graph that demonstrates the trends we've found in collecting thousands of price points from online retailers over the past year.



**Figure 1: Average Online Pricing by Efficacy Bin for all LED Replacement Lamps >300lm**

Source: CA IOU Codes & Standards Program

## Cooper Comment 7

We would also ask that you review the requirement for recessed luminaires in “dwellings” to be both listed for zero clearance insulation contact (IC) and have a label that certifies that the luminaire is airtight (AT) with air leakage less than 2.0 CFM at 75 Pascals when tested in accordance with ASTM E283. While this is very common for recessed downlight style luminaires it is not as common with recessed linear style luminaires. We would ask that you consider changing the verbiage to allow exceptions for recessed linear (troffer) style luminaires. In many High Rise Residential properties, Hotel/Motels, etc. the dwellings do not have insulated ceilings therefore the IC rating is unnecessary. We believe that possibly troffer styles luminaires were not considered when developing these requirements ICAT troffer luminaires are not normally used in dwellings. These are known to be roughly twice the cost of standard troffers used in residential applications.

## CASE Team Response to Cooper Comment 7

This change would have to be carefully considered as allowing uncontrolled leakage in recessed troffer style luminaires is something that potentially could significantly increase the infiltration rate in high-rise residential occupancies. As building heights increase the driving forces for the stack effect and

wind effect increase. This may not be a good idea prescriptively but might be acceptable using a performance approach where a blower door test is conducted on the rooms to assure that the high leakage recessed troffer is not creating a large hole in the air barrier to the dwelling unit. Does Eaton/Cooper have any data they can point to that indicates the energy impact of using these types of fixtures in high rise residential occupancies?

### **Cooper Comment 8**

We ask that the Commission also consider the requirement for minimum rated life and warranty. This is a financial decision made by the manufacture and is not appropriate in an energy standard.

### **CASE Team Response to Cooper Comment 8**

The CEC has removed the requirement for warranty. However, lifetime requirements have significant implications for consumer utility, persistence of savings, and life cycle cost analysis – providing a minimum level of performance in these metrics is not just a financial decision impacting the manufacturer.

### **Cooper Comment 9**

The .03 required start time will add cost to a product when we have no data to substantiate that start time is an issue. We ask that this requirement be removed or changed to a more reasonable value. With our experiences with dimmers offered in the market, driver technology, and potential nuisances; we recommend to make this 1 second so flicker is avoided and the product is capable to dim to 10% or less.

### **CASE Team Response to Cooper Comment 9**

The CEC reduced the stringency of the start time requirement to 0.5 seconds. The majority of LED products meet this requirement. The commenter has not provided any specifics around reasons to further drop this to a lower value.

### **Cooper Comment 10**

Please clarify that you have allowed an exception for both Correlated Color Temperature (CCT) and Color Rendering Index (CRI) requirements for residential outdoor lighting. (i.e., equal to or less than 3000K and 90 CRI)

### **CASE Team Response to Cooper Comment 10**

Initially the CEC's draft proposal did not treat outdoor luminaire separately, but we agree that dedicated outdoor luminaires should not have to meet JA8 and should be listed in the left hand column of table 150.0(A).

# PHILIPS COMMENT: NOVEMBER 19, 2014 (POSTED NOVEMBER 19, 2014)

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## Philips Comment 1

### *Screw base luminaires*

We applaud CEC's proposal in Section 130.0 to allow screw base luminaires to qualify as high efficacy. The concern that people will purchase a high-efficacy luminaire, perhaps with a rebate, and then convert it to low-efficacy, by replacing the lamp with an incandescent, is fading, as LED Lamp prices decrease, acceptance and adoption increase, and incandescents are disappearing from the market. Also, as efficacy increases, the need for heatsinking with strong thermal contact from light source to luminaire, is decreasing. Allowing screw bases will reduce the multiplication of products, allowing higher volumes and lower cost for manufacturers and customers, and enable easy replacement of failed light sources without having to replace the entire luminaire.

By the argument in the previous paragraph, we do not believe that CEC should require that recessed luminaires not have screw bases. There are plenty of LED lamps that are designed to handle elevated temperatures and function well in recessed luminaires. Some accomplish this with larger heatsinks or lower power and others, such as the smaller MR16 lamps, accomplish it with integrated fans. In any case, efficacy will continue to increase and thermal concerns to decrease. There is no need to exclude screw-base options. We believe that removing the exception will also help to simplify the code.

## CASE Team Response to Philips Comment 1

NEMA, Cooper and other stakeholders have expressed their support for the CEC not to compromise on the requirements for screw based sockets in recessed downlights. The rationale for this ban of screw based sockets in recessed downlights is to increase retention of high efficacy light sources. In addition, both recessed luminaires and other luminaires with screw bases are required to have JA8 light sources. This also renders it less likely that the consumer will want to revert to a low efficacy source by keeping the amenity of the initial light source high.

The commenter appears to be under the impression that MR16s would not be allowed to be installed in recessed luminaires. Most MR16s do not have screw bases, but rather Gu5.3 or GU10 pin bases, and as such they will be allowed to be installed in recessed downlights. The prohibition only applies to screw bases.

## Philips Comment 2

### ***Over-specified performance parameters***

Philips continues its opposition to requirements for CRI >90, SDCM<4, CCT <3000K and PF>0.9 as minimum requirements in code. The 2016 proposal widens the requirement for these over-specified parameters, by its extended reliance on Appendix JA8. We will not restate the rationale for our objections here, but refer the reader to comments submitted recently by Philips, both to Title 20 and the CA Quality LED Lamp Specification. If CEC desires additional elaboration on the Philips position, please contact Keith Cook or Richard Haring.

## CASE Team Response to Philips Comment 2

The proposed high quality requirements are cost-effective when compared to the current code. A wide variety of products are available that meet these specifications. The code does not require CCT<3000K; GU24 and other pin based and legacy high efficacy sources can be installed at any color temperature. Further, color changing products are also allowed by JA8, provided that they are *capable* of generating warm CCT light. The color consistency requirement is taken from the ANSI color consistency specification ANSI C77.378, which is an industry standard document. We do not believe the requirement is aggressive or represents any undue burden. The goal of the 90CRI requirement is to ensure that light sources provide accurate color rendition and do not distort colors relative to the way colors are rendered by incandescent light sources.

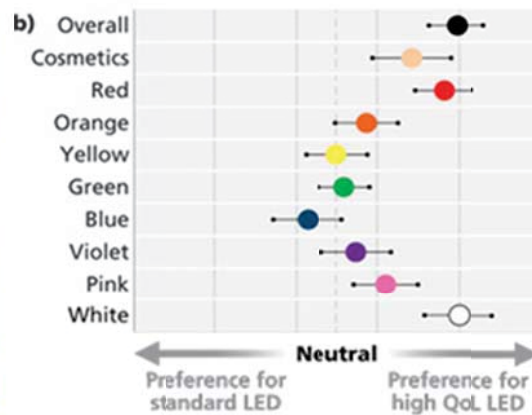
A consumer preference study published in 2014 by Pennsylvania State University and lighting manufacturer Soraal isolates the difference between lower CRI and higher CRI. The executive summary states:

Here we investigate perceptual responses under illumination from two sources, a blue-pumped LED with a colour rendering index of 85 (BLED85), and a violet-pumped LED with colour rendering index of 97 (VLED97). Forty-eight participants completed three experiments. Neutral, red, and pink were preferred under VLED97. Skin rendition was preferred by Caucasians under VLED97; Asians had no preference. Teeth and a white shirt were whiter and more preferred under VLED97. We conclude that the colour and whiteness rendition must be considered on a par with luminous efficacy.<sup>10</sup>

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<sup>10</sup> <http://lrt.sagepub.com/content/early/2014/08/22/1477153514548089.abstract> <http://www.soraa.com/public/docs/News/LRT-14-0060-20140729%20Soraa%20formatted.pdf>





## Philips Comment 3a

### **Flicker**

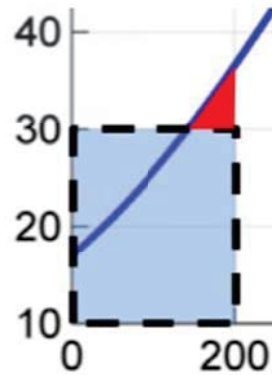
The Title 20 specification on flicker is overly restrictive for some frequencies and too lax for others. It states:

“Dimmer controls that can directly control lamps shall provide electrical outputs to lamps for reduced flicker operation through the dimming range so that the light output has an amplitude modulation of less than 30 percent for frequencies less than 200 Hz without causing premature lamp failure.”

This specification makes no allowance for the dependence of human flicker sensitivity either on frequency or on wave shape. For sine wave modulation, the visibility threshold for stroboscopic effects<sup>1</sup>, expressed in terms of modulation depth, is shown in the figure below. At a particular frequency, modulation depths above the curve can be detected by most people. Below the curve, they are not detected by most people. The threshold changes for different wave shapes, in a way that depends on the Fourier components of the light output waveform. A full Fourier approach would take account of both frequency and wave shape effects<sup>2</sup>. Sensitivity to flicker also depends on the application. Flicker in outdoor street lighting or in stairwells is more tolerated than in indoor offices, for instance. Therefore, a curve of *acceptability* may be above the *visibility threshold* curve. Different curves may be needed for different applications.



Zooming in on the region from 0 to 200 Hz in the figure above, the shaded rectangular region with dashed outline represents the conditions allowed by the Title 20 specification. The red triangle is forbidden by the Title 20 specification, but flicker in this region is not visible to most observers. Title 20, as a MINIMUM specification, should not exclude acceptable regions where flicker is not even be detected.



The Title 20 specification does a poor job of defining acceptable flicker levels, and the test procedure in Title 24 does a poor job of determining flicker acceptability. Specifications on flicker and test procedures should wait until the experts (in IEEE and in IEC) conclude their work on this topic and produce a solid standard. Energy Star is also collecting data on flicker and should complete their work and make recommendations before California produces its own specification.

If CEC is unwilling to remove the flicker specification and wait for agreement in standards organizations, then CEC should at the very least modify the present specification to allow use of

the acceptable flicker region denoted by the red triangle in the figure above. We suggest modifying the specification to allow flicker in the region shown in the figure below. The specification would then be:

“Dimmer controls that can directly control lamps shall provide electrical outputs to lamps for reduced flicker operation through the dimming range so that the light output has an amplitude modulation of:

- less than 30 percent for frequencies less than 100 Hz,
  - below the line: Modulation Depth =  $20\% + \text{Frequency}/10$ , for frequencies from 100 to 200 Hz,
- without causing premature lamp failure.”

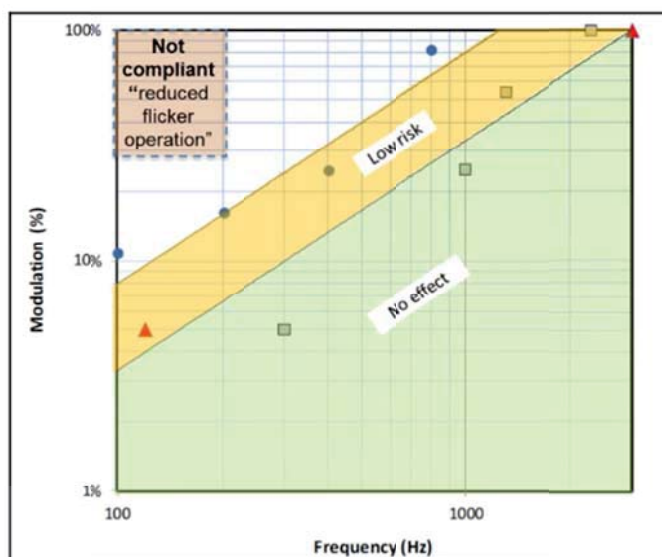


## CASE Team Response to Philips Comment 3a

First, Title 24 has had the same requirements for “low flicker operation” of dimming controls since the 2008 Standards. This requirement pertains to dimming sources controlled by dimming controls that have less than 30% amplitude modulation for frequencies less than 200 Hz. Thus, the current proposal does not require more stringent flicker requirements than what have been in place for years. However, the proposal does recognize that flicker is not just a function of the control but also of the light source and its driver or ballast.

Second, the Philips comment seems to be conflicted. On the one hand, the comment suggests that the proposed flicker standard is too stringent, and that it should be relaxed between the frequencies of 100 – 200 Hz to allow products that produce some visible flicker. On the other hand, the comment encourages CEC to coordinate with the IEEE “experts” who are working on a flicker standard currently. In fact, the CASE Team has worked quite closely with several members of the IEEE PAR 1789 committee who are working on a flicker standard for LEDs currently. The standard being developed by that committee is actually far more stringent than the standard being proposed in California. Members of the IEEE PAR 1789 committee have submitted comments to the CEC urging California to adopt a *more* stringent standard level.

As described in the Residential Lighting CASE Report and shown in the figure below, the requirement being proposed now would only prohibit levels of flicker that are the most offensive. Levels of flicker that are considered “low risk” (the yellow area) would be allowed by the current proposal, as would a great deal of flicker that has some higher level of risk (the white area).



**Figure 3: Low risk and no observable effect regions for flicker (Lehman et .a 2014) overlaid with region of graph not compliant with "reduced flicker operation" requirement**

Philips also suggests in its comments that the proposed test procedure does a poor job of determining flicker acceptability. First, the role of the test procedure is not to determine acceptability, the role of the test procedure is simply to measure levels of flicker. Second, the proposed JA10 test procedure has received support from multiple stakeholders, including other manufacturers and two members of the IEEE PAR 1789 committee, for whom Philips would like the CEC to wait.

Commenters include the following:

- Cree, a NEMA member and one of the largest LED manufacturers in the U.S., specifically supported the CEC’s proposed flicker requirements and the JA10 test procedure in a comment letter dated November 24, 2014.
- AccurIC, a manufacturer of LED drivers, and a member of the IEEE committee developing flicker standard PAR1789, also supported the CEC’s efforts in a comment letter dated January 5, 2015. AccurIC actually recommended that flicker requirements should be significantly stronger than what was proposed by the CASE Team and CEC, but specified that the proposed JA10 test procedure would be suitable in testing LED lamps for adherence to the proposed flicker standard.
- Jade Sky, a California driver IC manufacturer, specifically supported CEC’s flicker proposal in comments docketed September 9, 2014.
- Professor Arnold Wilkins, University of Essex, a member of the IEEE committee developing flicker standard PAR1789, commented to the docket on February 4, 2015 recommending that flicker requirements should be significantly stronger than what was proposed by the CASE Team and CEC. He also stated that it was a “major innovation” to at least begin requiring the collection of flicker test data.

### **Philips Comment 3b**

We propose that any flicker specification should be moved from Title 20 to Title 24, where the testing procedure is defined. Having the specification in one document and the test procedure in another is unnecessarily complicated.

### **CASE Team Response to Philips Comment 3b**

We agree that for the purposes of complying with Title 24, the flicker test procedure and the flicker specifications should all be contained within Title 24. Both the test procedure and the proposed standard were included in the CEC’s Title 24 45-day language, so it appears that CEC has accepted this recommendation.

### **Philips Comment 3c**

The draft language in Section JA10.2 is confusing and should be clarified. For example, it is unclear which dimmer(s) are to be used, if the test is supposed to be repeated *for every dimmer/lamp combination*, and the number of lamps are to be used (1, 2, 3, 4,... up to the maximum number supportable by the dimmer?). Should the testing be done with sensors in the circuit as well? The point is that there is a huge amount of testing that *could* be done, to confirm compatibility. That testing will rapidly become burdensome, and will never ensure 100% compatibility. CA should simply require manufacturers to maintain compatibility lists for dimmer/lamp combinations (as is now done in Energy Star).

### **CASE Team Response to Philips Comment 3c**

The CASE Team agrees that some edits would benefit this section of the 45 day language and the Team is working with the CEC to further clarify these items in the test procedure. The intent of the proposal was only to require testing with one dimmer of each dimmer type being claimed as compatible with light source. The proposal only requires one test, so it is up to the manufacturer to decide how many lamps / sources to be wired in the circuit during the test.

### **Philips Comment 3d:**

We believe the number of measurements as defined in JA10.5 and the subsequent data analysis and reporting as defined in JA10.6 and JA10.7, respectively, are overly prescriptive and complex and, as such, will impose an undue burden on manufacturers.

The test procedure, if CEC insists on adding it, should be no more complicated than the procedure presently in use by Energy Star. We see no reason to require testing/calculation with 5 different frequency cutoffs (1000, 400, 200, 90, 50 Hz), when the specification only requires one value (200 Hz), and see no reason to complicate testing by requiring additional dimmer set points as compared to the Energy Star requirements.

### **CASE Team Response to Philips Commend 3d**

The flicker test procedure requires only 2 seconds of measured data for each level of light output. Only three levels of light output are being proposed 100% (dimmer set to full output) 20% and the minimum dimming level claimed by the manufacturer. ENERGY STAR is requiring 100% and minimum light output as they wish to show good performance across the entire dimming range. We think this is a good idea as well but have relaxed the standard for this first implementation. Setting the flicker requirement at 20% rather than at minimum light output results in more products passing the flicker criteria. Some products have higher levels of flicker at 100% (full light output) but most have higher levels of flicker at 20% light output and flicker increases at minimum light output.

Filtering of data is conducted mathematically and does not increase the test effort but provides useful data on the performance of products now and how they might perform under a future more stringent standard that is more closely aligned with IEEE PAR 1789 “Recommended Practice for Modulating Current in High-Brightness LEDs for Mitigating Health Risks to Viewers.” Amplitude modulation has less impact on human health and performance at higher frequencies and thus any measurement of flicker should be accounting for this. Mr. Bannister of AccurIC has indicated how a future standard might be applying the amplitude modulation data at different frequencies. Summarizing this data in a public database will provide the appropriate market information to encourage a reduction in flicker below the minimal limits proposed for the 2016 standard.

As discussed earlier in Philips comment, human sensitivity to flicker is heavily dependent on frequency. The current proposed standard only applies to frequencies less than 200 Hz, but it would be hugely valuable to the lighting industry to understand how products are performing in terms of flicker at a number of different cutoff frequencies. This information will be helpful to specifiers, and in the future the CEC may wish to consider a more nuanced approach that would establish a variety of different flicker requirements at different cut off frequencies. Indeed, the flicker standard proposed by Philips in its comments utilizes a sloped line for maximum percent flicker, an approach that requires filtering raw flicker data at different cut off frequencies. The first step is for California to collect this data.

Secondly, there is no added test burden associated with providing these additional data points. Manufacturers simply have to upload their raw flicker data into the Fourier transform that will be available on the CEC site and it will automatically generate levels of flicker at each of the cut off required frequencies. The CASE team has discussed this approach with other stakeholders and test labs and confirmed that there would be minimal added burden beyond increasing the file size for eventual submission to CEC.

## **Philips Comment 4**

### ***Labeling***

We continue to disagree with the IOU proposals that a State-specific label or labeling requirements be established. The additional costs and difficulty of assuring proper distribution are not justified in the intangible benefits pursued by the proposals. CEC has routinely stated their intent to set a trend for other States to follow, and should keep in mind that a State-specific label is not in keeping with their attempts to set a standard that can be adopted at the national level. This also respects manufacturer's tendencies to produce and label products for sale in multiple regions. It is costly to produce lamp packaging for sale in a single State and challenging to assure proper distribution therein. Additionally, existing labeling is strictly challenged to meet Federal and other disclosure and marking requirements while being simple to read and understand. A State label only complicates this situation.

## **CASE Team Response to Philips Comment 4**

CASE Team Response: The "CA T-24 JA8 compliant" marking on the light source is critical to the success of this measure because it enables building inspectors to quickly confirm that luminaires have JA8 compliant products installed in them. Other forms of showing compliance would be more cumbersome, less definitive and more costly for the building industry and building departments. Marking lamp with their lumens, CRI, and CCT have also been proposed so that consumers will be able to identify replacement lamps/products when these products eventually fail. A review of existing products indicates there is a fair amount of product information already on lamps and luminaires but with available "real estate" for the T-24 JA8 compliant marking to be accommodated on those intended for sale in new California homes – a market that is in excess of 3 Million lamps or luminaires per year.

The author is correct in thinking that it is desirable that more entities make use of high quality high efficacy sources bearing the T-24 JA8 label, there is no reason that products distributed outside of California could not also be marked with the JA8 required markings. The existence of the JA8 label will help builders, retailers, consumers and utility efficiency incentive programs around the country to identify these quality products. Some companies may find that obtaining a rating and marking their product as T-24 JA8 compliant is an investment that opens access to more markets than just the California new home construction market.