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NEMA Comments to Title 20 45-day Language December 2015

Additional submitted attachment is included below.



KYLE PITSOR

Vice President, Government Relations

December 3, 2015

Submitted via email: docket@energy.ca.gov

Mr. Andrew McAllister
Commissioner
California Energy Commission
1516 Ninth Street
Sacramento, California 95814

Docket No.15-AAER-6

NEMA Comments on Proposed Amendments to Appliance Efficiency Regulations

Dear Commissioner McAllister,

The National Electrical Manufacturers Association (NEMA) appreciates the opportunity to provide the attached comments on the California Energy Commission's Proposed Amendments to Appliance Efficiency Regulations with respect to LED Lamps and Small Diameter Lamps. These comments are submitted on behalf of NEMA Lighting Division member companies.

As you may know, NEMA is the trade association of choice for the electrical manufacturing industry. Founded in 1926 and headquartered near Washington, D.C., NEMA represents nearly 400 electrical and medical imaging manufacturers. Our combined industries account for more than 400,000 American jobs and more than 7,000 facilities across the U.S. Domestic production exceeds \$117 billion per year.

Please find our detailed comments below. We look forward to working with you further on this important project. If you have any questions on these comments, please contact Alex Boesenberg of NEMA at 703-841-3268 or alex.boesenberg@nema.org.

Sincerely,

A handwritten signature in black ink that reads "Kyle Pitsor". The signature is written in a cursive, flowing style.

Kyle Pitsor
Vice President, Government Relations

NEMA Comments on Proposed Amendments to Appliance Efficiency Regulations

General Comments

1. NEMA thanks the CEC and Commissioner McAllister for their openness and interest during the November 18, 2015 Title 20 hearing in understanding the concerns presented by NEMA and its members during and immediately following the hearing. NEMA continues to have several, very significant concerns regarding the scope and feasibility of the proposal. At the same time, we believe that it is very possible, through constructive collaboration and openness, to modify the existing express terms into a regulatory package that is technologically feasible, economically justified, and more likely to result in widespread adoption and consumer satisfaction.
2. Since the release of 45-day express terms on October 15, 2015, lamp manufacturers represented by NEMA have put significant resources into investigating whether existing lamp products could comply with the proposed regulation. It was not possible for manufacturers to complete that investigation for their entire catalog during that short period, but preliminarily, as of the date of the November 18th hearing, NEMA members were finding that only a very tiny number of lamps available today could meet the proposed regulation. This outcome would not bode well for California residents or lamp manufacturers in and out of California. Conversations with CEC before, during and after the November 18th hearing indicated that there are some errors in the text of the 45-day express terms that led to this preliminary determination and we understand revisions are likely. The manufacturers' preliminary determinations raised a significant question whether the proposed regulation reflected in the 45-day express terms met the necessity, clarity and consistency requirements of California Government Code §11349.1(a). Our conclusion is that the proposed regulation did not, and our more detailed set of comments that follow our general comments is aimed at meeting those requirements, as well as other requirements of the California Government Code, §§11346.2, 11346.5, 11349 and the Warren-Alquist Act.

Today, publicly available lists of lamp product performance features do not contain information on all the parameters covered by the CEC's proposed regulatory language. This has caused a significant delay in developing comments while time was spent investigating which products might comply with the proposals. To assist stakeholders in more quickly understanding the impact of the proposed regulations with respect to product compliance and availability, we ask the CEC to publish or otherwise make available the list of lamp products the CEC staff believed were compliant in order to vet the practicality of the proposed regulation in the 45-day express terms. Sharing this list will save industry countless man hours of testing and investigative time, and allow for a more focused and useful application of industry expertise to assist the CEC in satisfying the legal requirements of necessity, clarity and consistency.

3. As written, the 45-day express terms cannot be executed across the broad scope of products covered by the proposed rule successfully and without severe financial and economic impacts. For example, the proposed rule mandates LED technology for MR and other small diameter lamps, yet there are few LED products available in the small markets for these lamps. In our detailed comments, we offer suggested scope changes to allow the market to continue expansion into those categories and prevent product unavailability during the transition. We illustrate known gaps in MR/Small Diameter

product availability in Appendix A to these comments. We are preparing additional details and will submit them as soon as possible

4. Certification Timing: Given the significant impact the proposed rule will have on current LED product offerings and the likelihood of the unavailability of significant compliant product, we urge the Commission to keep in mind the short timeline left for current LED products, which will have to be redesigned and retested or slated for removal from the market prior to the intended implementation date of January 1, 2017. Lamps must undergo lengthy 6,000 hour (nearly nine months) testing for lifetime calculations and reporting. Allowing a few weeks for administrative entry into the CEC T20 Appliance Efficiency Database means these products must enter testing in March of 2016, leaving only a few months between now and then to redesign products beginning from the anticipated adoption date of these new T20 regulations. In order to maximize product offerings for the California market and ensure market competition at the same time, the CEC must allow as many existing products as possible to comply on the day of adoption. NEMA's proposed modifications to the 45-day express terms are made with this goal in mind. The CEC's choice of 1/1/17 and 1/1/18 for the onset of the requirements for LED Lamps and MR/SDDL, respectively, indicates a one-year and two-year approach. Because the Title 20 process might become extended into January 2016 or beyond NEMA proposes CEC make the implementation dates for this proposal 12/24 months from the adoption date (depending on the category in question), rather than fixed on the first day of January. Other implementation and effective dates in the proposal should also be adjusted accordingly.
5. The proposed rule imposes unrealistically high color rendering index (CRI) requirements for R8, which will effectively force manufacturers to supply nominal CRI 90 products to the market. The result will be that the CEC is going to compel consumers to buy more expensive *and less efficient* CRI 90 lamps. Compared to consumers in the rest of the country, Californians will have to spend more and get less in terms of energy efficiency. This proposal fails to meet both the necessity and consistency requirements of California Government Code §11349.1(a). By our calculation, the CEC is sacrificing up to 20% of potential energy savings by taking this ill-advised, over-specified approach to CRI that consumers will not actually benefit from. See Part A, Comments 6 and 7, *infra*.
6. Cost Analysis: With respect to the conclusions of the Staff Analysis regarding cost, one does not need a financial feasibility analysis to conclude that raising baseline lamp performance requirements will logically raise baseline cost. By raising the cost of the baseline product available in CA today, the proposed rule will effectively reverse the market's progress in substantially driving lamp prices and costs down and making LED products affordable for consumers. Manufacturers of LED lamps have been successfully innovating and competing aggressively to develop high quality LED lamps at lower prices to advance customer acceptance and demand for the more efficient light sources. The CEC's proposed rule as expressed in the 45-day express terms will unreasonably interfere with the success that the market alone has achieved. There are other equally effective and less burdensome ways of avoiding this outcome. California Government Code §11346.2(4)(a) The staff analysis on pages 91-92/107 concludes that additional components or redesigns will be necessary for many products to remain in the market, and that there will be an associated cost with those measures. Rather than allow the market to continue its steady excellent progress on providing affordable and acceptable products to consumers, the CEC proposal will cause a rise in the prices of baseline lamps in the market along with reduced selection and availability compared

to today's offerings. Today's budget-minded California consumer, having been told again and again they should no longer buy incandescent lamp products, are left with a choice between several-dollar LED options and < \$1 CFL prices. A cost-constrained consumer will obviously gravitate toward slightly less-efficient compact fluorescent lamps (CFLs), no matter how nice or superior the LED options appear to be or how many performance parameters CEC regulates. It is irrational for the cost analysis to conclude that there will be no overall cost increase in the face of proposed requirements that will necessitate redesign and incorporation of *additional* components. The products undergoing the most cost competition today are highly desirable, consumer-accepted 80 CRI products and they will not be compliant with the CEC's proposed regulation, so the historical cost trends for 80 CRI products cited in the staff analysis are irrelevant. No reasonable person could reach the conclusion that the trend applicable to 80 CRI LED products would apply to products with CRI \geq 90, because these products are designed and behave differently than 80 CRI products. The CEC should not effectively mandate 90 CRI as the State minimum only to increase the primary obstacle to adoption, *i.e.* cost. We note that the high-end commercial SSL products which feature the color performance advanced by the CEC's proposed rule are NOT selling in large quantities because they are highly specialized and very expensive. Their higher price is NOT due to economies of scale, it is due to very expensive sub-components, mostly the Red Green Blue White (RGBW) LED chips and other features. To properly examine cost, were the CEC to decline to relax their proposal, cost analyses should focus on high-performance commercial products since they more closely align with the proposal's strict requirements. The CEC has not undertaken such an analysis and as a result has no substantial evidence for its cost impact conclusion, a conclusion that NEMA concludes is speculative and wrong. Once this proper evaluation is conducted, the CEC will no longer be able to reach the conclusion inherent in its proposed rule.

To better understand how the CEC has made their cost conclusions, NEMA requests a copy of the CEC's detailed cost analysis data *for proposal-compliant lamps* and related investigative work. As we note above, the 2015 and 2014 Staff Analyses do not examine proposal-compliant lamps, and therefore do not examine the appropriate corresponding costs.

7. Past versus Present: Time and again over the past two years, NEMA has heard from Commission staff and others the refrain "We can't repeat the CFL experience!" NEMA understands and appreciates the spirit of this remark insofar as the intent is to avoid the historical issues with market adoption of CFLs. NEMA does not understand or appreciate the refrain's application to the market's already phenomenal early-stage adoption of LED technology. The early adoption of LEDs through market forces of supply and demand has far exceeded the historical experience with CFLs. There is no parallel here, and no reasonable person could reach the conclusion that the history of CFL market adoption is relevant to LEDs. This mantra is worn out and the belief we are looking at a parallel experience is unfounded for several reasons: 1) Standards that were lacking during CFL introduction have since been developed and have influenced the development of robust LED standards, 2) surging sales in the ENERGY STAR program (nearly 80 million units in 2014)¹ refute any claim that LEDs are at risk of failing to achieve widespread adoption, and 3) the U.S. DOE in 2013 noted that LED uptake had just exceeded CFL uptake in terms of their market introduction timelines, and this 2013 trend has continued into 2015 and is expected to continue in the future. A review of the

¹ http://www.energystar.gov/ia/partners/downloads/unit_shipment_data/2014 USD Summary Report.pdf

ENERGY STAR CFL program's unit shipment information for version 1.0 of the specification shows only 21 million ENERGY STAR CFLs sold in the year 2000, twenty years after CFLs were introduced on the market. This indication of consumer interest contrasts sharply with the ENERGY STAR 2014 LED lamps shipments data for 80 million units after less than 9 years on the market. These figures directly and irrefutably contradict the Staff Analysis on page 64/107, which claims that LEDs are at risk of repeating the low consumer uptake of CFLs and that steps must be taken to prevent it. The CEC staff is not watching what is really happening in the market. To put it another way, the risk of "repeating the CFL experience" has *already been conquered* and is not a risk unless it is a self-fulfilling prophecy of the CEC attributable to restrictive LED performance requirements that drive LED lamp cost up to the point that CFLs are a more economical option for the cost-constrained consumer. This perverse prospect fails to meet the necessity and consistency requirements of California Government Code §11349.1(a).

8. We reiterate our comment made at the November 18, 2015 CEC hearing that the California Lighting Technology Center is well-suited to conduct some of the consumer studies that have yet to be pursued by the CEC in effort to better understand consumer preferences towards lamps. The CEC should fund the CLTC to conduct these studies and put to rest speculations about consumer preferences and practices.
9. As we have stated in previous comments², NEMA continues to disagree with 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 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.
10. Lastly, we suggest that some of the misunderstandings noted in these comments may stem from the use of an older regulatory model, older ways of thinking, employed in this rulemaking. Previous regulations addressed well-established technology or technology evolved from well-established components (new applications of old technology). In contrast, LED technology is cutting-edge and is still evolving rapidly. No one disputes this. This emergent nature affects all steps in sourcing, design and production. Because LED technology is still a moving target, and there is a limited data set for performance trends compared to older technologies, it is easy to draw mistaken conclusions from limited technical understanding and from limited data sets. This is why it is more important than ever for the CEC to engage manufacturer experts more heavily than before, and to grant significant weight to these expert comments on the potential impacts of proposed requirements and their potential effects on this emerging technology. While previous regulatory efforts often tried to set the minimum bar as high

² http://www.energy.ca.gov/appliances/2014-AAER-01/prerulemaking/documents/2014-09-29_workshop/comments/NEMA_Cooments_on_Staff_Analysis_of_Small_Diameter_Directional_Lamp_and_LightEmitting_Diode_Lamp_Efficiency_Opportunities_2014-11-14_TN-740012.pdf

as possible, the risk of potential strangulation of an emerging technology should require caution pursuing the older regulatory model in the case of LED lamps. We urge the CEC to establish very practical minimum requirements, within the capability of numerous products on the market, rather than seek to identify only a handful of products, set the standard there, and expect the rest of industry to catch up. It is important to note that our counter-proposals to the CEC's 45-day language DO NOT sacrifice efficiency. In fact, by allowing more-efficient 80 CRI products to remain in the marketplace, potential energy savings increase since 80 CRI lamps are more efficient than 90 CRI lamps and the CEC avoids increasing the price of LED products to the consumer that will deter market adoption.

11. In the course of our detailed comments below, we may indicate in some places that the CEC's proposed rule has reached a conclusion that "no reasonable person could have reached the same conclusion." We do not intend any disrespect to the commissioners or the CEC staff by this remark, but we note that it is a legal requirement in California that agency determinations be supported by substantial evidence and the appellate courts in California have stated that regulatory conclusions will be reversed if, based on the evidence "a reasonable person could not have reached the same conclusion." *Families Unafraid to Uphold Rural El Dorado County v. Board of Supervisors*, 62 Cal.App.4th 1332, 72 Cal.Rptr.2nd 1 (3d Dist. 1998). Key aspects of the proposed rule do not meet this requirement. We have endeavored to provide our reasoning in that regard, but we welcome dialogue with the commissioner and commission staff if further clarification is required.

Detailed comments continue on the following page

Part A: Detailed Comments Specific to the LED Lamps Proposal

1. We perceive the intent of the rulemaking to be twofold: (1) set minimum requirements both for existing LED product offerings, and (2) establish minimum requirements for lamps which are not yet offered in LED technology options. The 45 day language proposes very tight requirements on chromaticity and CRI that set the minimum bar for sale in California too high. This will have substantial unintended consequences. These requirements will effectively mandate SSL lamps with a CRI close to 90, which are significantly more expensive than the CRI 80 lamps that are currently on the market and experiencing good sales results (nearly 80 million units in 2014). This outcome reduces consumer choice, competition, and increases cost for these lamps to the average Californian. The proposed rule contains a nominal minimum 82 CRI requirement, but other requirements in the proposed rule render this nominal minimum a chimera: the true minimum is actually 90 CRI. If the CEC's real intent is to only allow nominal CRI 90 products into the market then this should be clearly stated in the proposed requirements language and the CEC should clearly take responsibility for proposing that consumers can only purchase the less-efficient CRI 90 products because that is exactly what the proposed rule is doing and this contravenes the necessity, clarity, and consistency requirements of California Government Code §11349.1(a). Our Comment Nos. 6 and 7 below (taken with our General Comment 7 above) explains why the nominal 82 CRI specification is a chimera, and therefore fails to meet the clarity requirement. It also explains why it fails to meet the necessity and consistency requirements of the Code. "'Consistency' means being in harmony with, and not in 'conflict with or contradictory to, existing statutes, court decisions, or other provisions of law.'" California Government Code §11349(d). This proposed rule is inconsistent with the Warren-Alquist Act's requirement that appliance efficiency regulations "promote the use of energy . . . efficient appliances." The proposed rule fails this requirement.

2. Scope and Specialty Lamps. The CEC's proposed definition for the General Service Lamp category is as follows:

““State-regulated Light Emitting Diode (LED) lamp” means a lamp capable of producing light with Duv between -0.012 and 0.012, and that has an E12, E17, E26, or GU-24 base, including LED lamps that are designed for retrofit within existing recessed can housings that contain one of the preceding bases. State-regulated LED lamp does not include a lamp with a brightness of more than 2,600 lumens or a lamp that cannot produce light with a correlated color temperature between 2200 K and 7000 K.”

NEMA members are very concerned that the overly broad scope of the CEC's general service LED lamp definition will stifle innovation and product development of the numerous specialty LED lamps needed to replace the wide variety of incandescent lamps available in the market today for these applications. The CEC analysis was focused on A-line general service lamps, those being the focus of research and development to date, but the proposed rule would apply the requirements to all lamps (including specialty lamp types), not just A-line lamps. The technological solutions that make A-line and PAR shape LED lamps a viable product cannot be assumed to feasibly transfer over to all other types without analysis. That is exactly what the 45-day Express Terms do with respect to these other lamps: assume without analysis. The CEC is proposing to regulate a forest of lamp products, and it is not looking at the impact of its proposed rule on the separate species of lamps within that forest. An ecologist would not take this approach to the forest, and neither should the CEC take this approach with respect to the ecology of all lighting environments and the specialty products in that

ecosystem. A separate analysis should be conducted by the CEC to examine the performance and capabilities of other lamps rather than mistakenly apply A-line and PAR lamp trends and performance information to other types which will have their own form factor, application and base/shape considerations to address. The CEC has failed to assess the form, fit, function, optical and thermal needs of specialty lamps, and as such cannot apply A-line solutions to them. In our estimation³ LED lamps that would potentially replace incandescent specialty products designed for display, appliance, and indicator lamp applications will likely not be able to meet the proposed rule's requirements due to size and performance constraints and must be exempted from the general service LED lamp proposal. NEMA members are in the process of developing an overview of the specialty lamp types that are not designed for general service applications.

Given the scant, non-existent analysis of smaller-base products, the CEC should avoid setting standards for these products until a proper analysis has been conducted. We submit that this approach is required by the Warren-Alquist Act, California Public Resources Code, §§25402, 25402.5, and 25402.5.4, and the consistency requirements of the California Government Code, §11349.1(a). While the CEC's current undertaking for general service lamps is guided by the California Public Resources Code §25402.5.4, that provision is not independent of §25402 or §25402.5. Section 25402(c) requires that efficiency standards be "feasible and attainable efficiencies or feasible improved efficiencies," and Section 25402.5(b)(1) informs that the CEC must consider "both new and replacement . . . lighting." The clear and unambiguous meaning of these words is that the CEC cannot adopt standards that would only enable compliance by products that do not yet exist and may never exist. Where there are no new replacement LED lights, the CEC should not legislate the current lamps out of existence. Furthermore, it compels the CEC to evaluate the impact of proposed efficiency standards for each of the individual products that the CEC proposes to regulate within the broad scope. A separate analysis for these specialty lamps is required in order to properly meet the Warren-Alquist requirements as well as the consistency requirement of the California Government Code.

First, NEMA proposes the E12 and E17 base be eliminated from scope until this relevant analysis has been conducted.

Second, with respect to our concerns that the definition and scope are too broad, we disagree with the lower limit of 150 lumens for general service LED lamps scope specified in the 45-day language Table K13. This level of light output equates to a 25W incandescent lamp. We note that Table K-15 in the 45-day language begins at 40W equivalency, which is consistent with the lower limit of federal lamp efficacy standards. 25W products are typically not used for general illumination because of their extremely low level of light output (lumens). These products are either in specialty applications, ex. appliance lamps where heat-tolerance is important, or in decorative applications where aesthetics are more important than general illumination to name a few. To align California's proposed regulation with national standards, to harmonize the proposed regulatory language internally between Table K-15 and clause 1602.3(k)(C), and to reduce confusion, disharmony and disruption in interpretation and enforcement of Title 20, NEMA proposes the lower limit be 310 lumens. (Please see comment #4 below for our proposed changes to the 45-day language for this topic.)

³ One must guess; given that few replacement products exist today in these categories, as evidenced from their lack of appearance in the CEC Staff Analysis and CASE studies.

3. Analysis based on the ENERGY STAR qualified products list shows that on average decorative lamps are about 9LPW less efficient than omnidirectional lamps.

	Omni	Deco	
All base types			Delta
# models	1634	705	
Average LPW – all models	81.6	73.0	8.6
Average LPW - Top 25%	97.8	96.1	1.7
<hr/>			
< 6500K			
# models	1600	660	
Average LPW	81.1	70.4	10.7
Average LPW – Top 25%	96.3	87.6	8.7
<hr/>			
>= 6500K			
# models	34	45	
Average LPW	106.7	111.5	-4.8
Average LPW – Top 25%	124.5	118.8	5.7

(We acknowledge that some filament LED decorative lamps have high efficacies but they are typically not dimmable, which is an important feature for decorative lamps in most applications.)

Our analysis indicates that in order to ensure adequate and reasonable product availability of dimmable decorative LED lamps, a separate compliance score for decorative lamps should be 267 and 287 for tier 1 and tier 2 respectively (vs. 277 and 297 for omnidirectional lamps), *i.e.* ten points lower.

NEMA Proposal: Amend Table K-14 “Standards for State-regulated LED Lamps” to add a column for “Decorative LED Lamps” with minimum compliance scores 10 points lower than those given in the 45-day terms and add the words “All Other Lamps” to the current “Minimum Compliance Score” column to differentiate them.

4. Chromaticity: The CEC’s proposed chromaticity requirements create a 2-step band of acceptability which is too restrictive: it imposes tighter binning requirements in order to meet the narrow 2-step band, and this will eliminate more than 70% of LED packages falling within the applicable ANSI standard range for LED chromaticity used today. We appreciate the spirit of the proposed correction to the upper bound, widening the band to 4-steps as articulated in the CEC’s presentation during the November 18, 2015 public hearing, but we still urge the CEC to stick with the well-established 7-step ANSI quadrangle approach. There are ANSI specification standards and regulatory certifications (ENERGY STAR and LED Lighting Facts) that specify 7 steps from the Planckian locus, as represented by the quadrangle in the ANSI standards, and this approach enjoys strong consumer satisfaction, as reflected by the 80 million unit sales in the ENERGY STAR LED lamps program. The ANSI standard dates back to 2008, has

been in use in ENERGY STAR specifications with the EPA spec since 2009, and it has not changed from +/-7 steps (Duv ± 0.006). ENERGY STAR regularly looks at making changes to this spec and none have been made so far because it is not desirable to do so. The constriction of the Duv spec from 7 to 4 steps has consequences related to economy of scale and the higher cost of manufacturing. A 4-steps approach will result in smaller economies of scale, and the resulting higher costs will be passed along to the consumer. This added cost implied by the staff analysis and 45-day express terms is in direct conflict with the number #1 factor influencing consumer adoption: acquisition cost. With respect to the feasibility of tighter binning, we note that using data from sites sources like DOE LED Lighting Facts and EPA ENERGY STAR will only show individual data points and not typical manufacturing variations. Importantly, the proposed rule's 2-step requirement, even if amended for a 4-step requirement would violate the necessity and consistency requirements of California Government Code §11349.1(a).

NEMA proposes the CEC allow a 7-step ANSI quadrangle for allowable Duv chromaticity and normatively reference ANSI C78.377-2015⁴ as the guidance for calculations. Still, we strongly urge the CEC not to adopt a 4-step requirement. In some ways, the unnecessarily tight 4-step tolerance seems to be the result of confusing the ability to measure a performance aspect to a high degree of detail with needing to regulate that aspect to a higher degree. The former does not justify the latter in this case and yields no incremental benefit to California lighting consumers. We ask the Commissioner to reconsider this decision and ask if it is truly necessary. NEMA submits it is absolutely not necessary. The strong sales evidence in the ENERGY STAR program in the rest of the United States indicates the answer is "no".⁵

With our preceding comments #2 and #4 in mind, NEMA recommends changes to the 45-day language as follows:

1602.3(k)(C)

(C) State-regulated LED lamps with lumen output of ~~450~~ 310 lumens or greater and manufactured on or after January 1, 2017 shall have a color point as described in ANSI C78.377-2015 Table 1.:

~~(i) a color point with a Duv that is:~~

~~(1) No less than 0.0033~~

~~(2) No greater than $57700 \times (1/T)^2 - 44.6 \times (1/T) + 0.00854$ where T means the measured correlated color temperature.~~

5. "White" color space: The transition from the CEC staff report to the 45-day express terms completely eliminated a class of products known for being off the black body locus, known in the DOE regulation as "modified spectrum" lamps.⁶ These are products for which there is a very strong consumer preference as demonstrated by the popularity of modified spectrum products on the market and research studies undertaken by the Lighting Research Center dating back to 2012,⁷ as well as others. The elimination of this type of high efficacy LED Lamp that the consumer prefers from the marketplace is

⁴ <http://www.nema.org/Standards/Pages/American-National-Standard-for-Electric-Lamps-Specifications-for-the-Chromaticity-of-Solid-State-Lighting-Products.aspx>

⁵ If the CEC will not allow for a 7-step ANSI quadrangle, a choice that NEMA strongly opposes, NEMA requests that CEC simply make normative reference to Table 1 Annex B of ANSI C78.377-2015 to properly reference a 4-step ANSI quadrangle. (A copy of this standard has been supplied to CEC staff.)

⁶ 10 CFR §430.2 (definition of "modified spectrum").

⁷ https://www.jstage.jst.go.jp/article/jlve/37/2_3/37_IEIJ130000501/article

inconsistent with CEC stated goals of combined consumer satisfaction and energy savings. Either the Duv requirement must be removed entirely or a full 7-step ANSI quadrangle allowed, permitting these in-demand products to continue to be sold. Our proposed change in the preceding comment rectifies this and meets the consistency requirements of the California Government Code §11349.1(a).

6. Setting Color Rendering Index (CRI) Levels in Manufacture vs. Regulations: The proposed minimum 82 CRI requirement at the lamp level is inconsistent and incompatible with how industry bins the LED packages within for CRI. LED packages in the market are not binned in stair steps of one or two CRI points. LEDs are binned and supplied to integrators in reels targeting a minimum CRI of 80 or of 90 on each reel. Some leeway for product variation is associated and needed with binning and supply. For example, a typical distribution selection on an LED reel destined for an LED integrator lamp manufacturer would be to include LEDs with a minimum CRI of 80, though more typically the LED supplier aims for a CRI of 82. This distribution ensures that no LEDs on the reel would be below 80. The lamp manufacturer needs the LEDs to have typical $R_a \geq 82$ to ensure that the lamp's color performance meets regulatory requirements. What seems to be misunderstood, in terms of reported versus measured CRI performance, is that LED lamp manufacturers rely on known component tolerances to ensure their products satisfy minimum lamp-level requirements in the mass-production environments employed to achieve the economies of scale necessary to achieve lower price points and greater consumer uptake. The limited physical product testing conducted by CEC staff and other entities for this rulemaking has not yielded adequate data to demonstrate quantities of scale and associated variations in performance. Those without an understanding of the need for manufacturing tolerances in volume production may be tempted by limited sample sets of physical testing, such as the 2014 CLTC test report where some claimed CRI 80 lamps demonstrated 82 CRI, as some indication that a minimum CRI of 82 does not represent any additional burden. This conclusion is entirely misplaced. LED technology is still in development, and the impacts of potential regulations on the practices of sourcing and design are not as well-understood. The 2 points of CRI leeway mentioned in the above example are essential to allow for variations in physical manufacture to assure the LED lamps hit 80 CRI at the lamp level reliably. This is especially critical now that the CEC intends to enforce Title 20 requirements, to include possible monetary fines. The CEC's proposal of CRI of 82 results in a requirement of minimum CRI of 84-85 at the LED package level. NEMA notes that the rest of the globe uses a minimum CRI of 80, as well as the United States' popular ENERGY STAR program. For consistency sake and to not disrupt the LED binning and sourcing market, NEMA requests that CEC require a minimum of CRI of 80, rather than 82. We note, and it is not contested, that lighting vision scientists agree that two points CRI are completely imperceptible to the lighting consumer and user. The CEC's proposed rule requiring a minimum CRI of 82 presents a potential compliance nightmare, fails the necessity and consistency requirements of the California Government Code, §11349.1(a), and the minimum CRI 80 reasonable alternative proposed by NEMA does not sacrifice efficiency or consumer satisfaction and is therefore as or more effective and less burdensome than the proposed rule. California Government Code §11346.9(4).
7. CRI and its Subcomponents:
 - a. It is clear to NEMA and its members that the CEC's treatment of CRI demonstrates some fundamental misunderstandings of the science of light. The CEC is straying from its expertise in the area of energy efficiency, and unreasonably

impairing innovation, consumer choice, and market opportunities to accelerate market adoption of LED products. Manufacturers of lighting products have been deeply engaged in the science of lighting and the confluence with consumer preference for decades. NEMA manufacturers compete and design lighting products with consumer acceptance, adoption, and preference as the primary target of their endeavor. It is a complex subject that balances important variables, and it should not ignore the importance of manufacturing tolerances and supply chain logistics that can be critical to accelerating consumer adoption.

b. In simple terms, the minimum R1 through R8 requirements that the CEC has included in its proposed rule actually requires a minimum LED lamp CRI of 90 for white LEDs based on phosphor conversion technology. The only <90 CRI products with high R8 are high color-temperature, 5000K products (see Figure 1 below). As described above, since no one is binning LEDs for CRI between 85 and 90, to fulfill this requirement at the LED lamp level would require LED packages binned for min 90 CRI. This result will seriously impair consumer adoption and acceptance of LED lamps and would fail the necessity and consistency requirements of the California Government Code §11349.1(a). It would impair California's goals under the Warren-Alquist Act.

c. While it may be possible to obtain an R8 > 72 LED lamp with adequate efficacy by using an RGBW chipset and multichannel driver, essentially a dumb smart lamp, this is a very expensive solution. See General Comment No. 6, *supra*. Alternatively, the solution proposed in the staff report, the addition of red LEDs to a white LED, increases the driver complexity, requires color mixing capabilities and increases the cost, while reducing overall lamp efficiency. This would unreasonably and unnecessarily drive up costs and impair consumer adoption.

d. Some of the conclusions in the staff analysis indicate a reliance on publicly posted information regarding LM-79 reports. However, LM79 reports may not include all the R values, leading to mistaken conclusions about R1-R8 overall scoring based on the limited information provided. Based on our members' extensive technical knowledge of LED performance, we note generally that LED lamps with very high CRI have R1 through R8 values greater than 72. LED lamps with CRIs in the 80s are deficient in one but not more than two R values. In suggesting a minimum CRI of 82, the CEC staff has reached a conclusion that no reasonable person could have reached, by implying that a CRI 82 lamp can meet the additional R1-R8 > 72 requirement. This must be corrected.

e. We have also heard the views of some that R8 scores can be inferred from publicly available R9 scores. R8 and R9 measure two very different hues. They are related, but not directly proportional. R9's relationship to R8 varies based not only on the overall value of R9 but also on the correlated color temperature of the lamp. Higher CCT lamps have a higher R8 for the same value R9. Setting a high R8 requirement in the absence of anything to balance it out may lead to CEC incentivizing the offering and sale of high CCT lamps, that is >5000K, which are not preferred by some consumers. While there are applications where high CCT levels are preferable, many if not most consumers prefer the warmer hues of 2700K-3000K in many rooms of the house. Setting overly burdensome R1-R8 score requirements could mistakenly incentivize high-CCT lamps. This would not be consistent with the goal of advancing consumer adoption of LED lamps in California sockets or the

CEC's purported goal of satisfying consumers. It would not be consistent with the EPA's ENERGY STAR program approach.

We provide the following graph of R8 and R9 versus CCT as an illustration of the above described interrelationship (R values gathered from NEMA members):

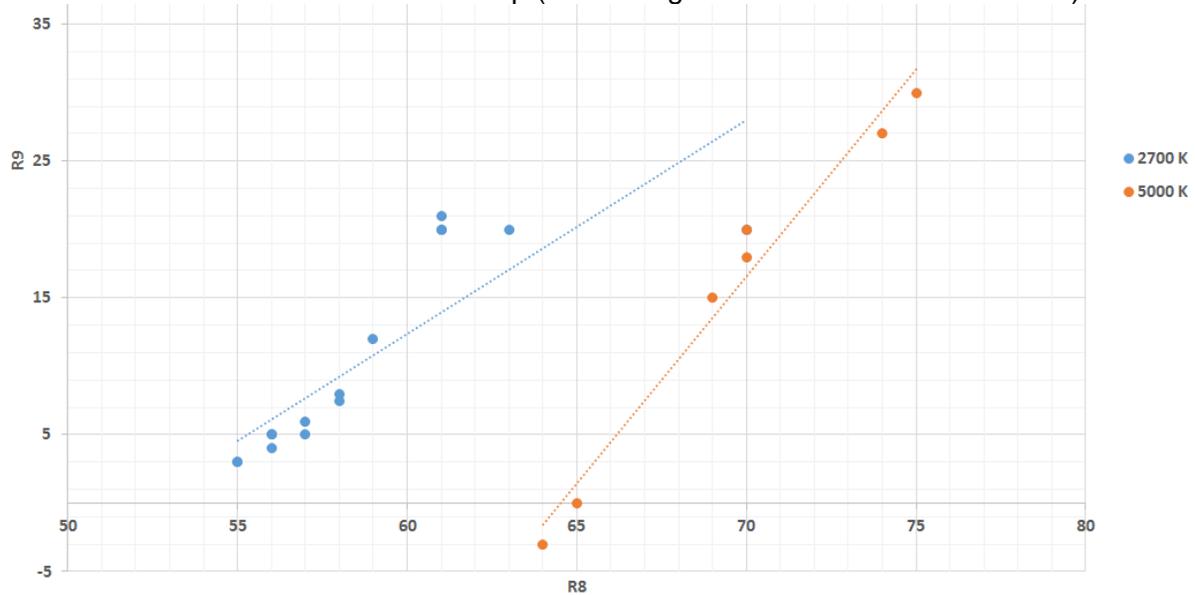


Figure 1: Comparison of R8 and R9 for 2700K products and 5000K Products

f. While NEMA shares a desire to foster good consumer acceptance in LED lamps, we disagree with the CEC's attempt to assure consumer satisfaction through stricter requirements on color, consistency and other parameters without scientific justification for these attempted quality metrics. Instead, we ask the Commission to take a step back and observe the excellent sales being enjoyed by lamps certified to meet the ENERGY STAR Lamps program specification. Without the restrictive requirements proposed by CEC, in 2014 ENERGY STAR lamp sales accounted for 75% of market share and nearly 80 million unit purchases. NEMA is undertaking a detailed examination of R1-R8 and other factors to cull the EPA's qualified products list⁸. However, our initial review of the ENERGY STAR qualified products list for lamps which might survive the CEC's proposed requirements is barely 6.8% and this poor outcome is further spread across several lamp types.

g. Also evidenced in the strong sales of the ENERGY STAR program's strong sales is the apparent consumer satisfaction with a product offering of lamps mostly landing at the 80 CRI level. Given that there is no credible consumer survey or human factors analysis which attributes increased acceptance of 90 CRI products over 80 CRI products, we propose the CEC should not make high-CRI mandatory in

⁸ http://www.energystar.gov/productfinder/product/certified-light-bulbs/results?scrollTo=2445&search_text=&technology_filter=LED&special_features_isopen=&wattage_equivalency_watts_isopen=&light_output_lumens_isopen=&bulb_life_hours_isopen=&color_rendering_index_cri_filter=91-95&color_rendering_index_cri_filter=96-100&markets_filter=United+States&zip_code_filter=&product_types=Select+a+Product+Category&sort_by=brand_name&sort_direction=asc&page_number=0&lastpage=0

California. This will not prevent high-CRI products from being offered or sold, and will allow for greater consumer choice. As the CEC staff analysis notes, the addition of red LEDs or the inclusion of more expensive Red Green Blue White (RGBW) color-tunable LED chips comes with added cost. We again refute the conclusion in the staff analysis that contends, with no justification, that prices will continue to go down despite increased material costs and design complexity demanded by the proposal. The products whose prices are going down in the national market are 80 CRI products whose performance has been engineered to deliver satisfying performance alongside acceptable initial purchase prices. While consumers have been educated on the benefits of energy efficiency, national sales trends back up the long-standing economic conclusion that cost remains the highest barrier for adoption. While California has strong rebate programs, they cannot be counted on to remain in place forever, and there are still millions of sockets carrying incandescent and compact fluorescent lamps that might find an LED substitute.

h. CRI versus efficacy: We lastly note that a reverse analysis of the CEC's proposed lm/W vs. CRI qualification equation shows a 20% difference in achievable efficiency between 80 and 90 CRI products: 90 CRI products may be up to 20% less efficient than their 80 CRI siblings. NEMA appreciates very much that the CEC allows for a tradeoff, in recognition of the limitations of the laws of physics regarding red LED efficiency, but we are deeply confused as to why CEC would write a CRI and R1-R8 proposal which effectively mandates CRI = 90, ignoring the additional energy savings that CRI 80 products bring. It makes more sense to allow consumers to choose, and take advantage of the increased energy savings and reduced operating costs that < 90 CRI products afford CA and its citizens. It is for this reason that we submit that the proposed rule's requirements on CRI fail to meet the California Government Code's requirements of necessity and consistency, and that a reasonable person could not have reached the conclusion reached by the CEC, and that NEMA's alternative proposal is as effective or more effective and less burdensome in achieving energy savings without sacrificing product acceptance and quality. California Government Code §§11349.1(a), 11346.9.

i. In conclusion: NEMA proposes that CEC restore the global minimum of CRI 80 for LED lamps in California, and if the CEC will not abandon the unnecessary R1-R8 requirements we suggest at the very least that the R8 requirement be set at R8 > 50, leaving R1-R7 > 72. This will allow well-made, high quality CRI 80 products already selling in high volume to remain competitive available in the market and to serve as lower-cost alternatives when high color rendering is not needed. This will also help compete against CFLs, which are the leading high-efficiency cost competitor and will remain so. We recommend the following change to the proposal language:

1605(k)(2)(C)

(ii) A CRI (Ra) of ~~82~~80 or greater

(iii) Individual color scores of R1, R2, R3, R4, R5, R6, and ~~and~~ R7, ~~and~~ R8 of 72 or greater, and an R8 of 50 or greater

8. Standby Power: With its proposal for standby power, the CEC should not drive too hard to reach low levels without studying what functionality might be lost. The overly restrictive proposed level for standby power ignores the growing popularity of lamps with

multiple features and with increased capabilities of communications and control within the connected household. Lamps that not only turn on and off, but are also color tunable, act as WiFi repeaters, or support some other functionality may be a critical component of Internet of Things connectivity moving forward. This is because not only is lighting popular thanks to the advent of LED technology, but also because lighting is ubiquitous – it is found in every room in the house. This presence means that strategically placed connected-capable lighting products may serve to connect rooms and floors that would otherwise require hardwired connections or the installation and commissioning of dedicated communications platforms or gateways. The CEC must recognize from their detailed work into lighting controls and into building systems that using functionally-integrated products versus dedicated platforms results in overall energy savings and increased interoperability. Thus it would be counterproductive for CEC to set the standby power maximum limits for LED Lamps so low as to preclude anything but “barely-smart” lamps that only turn on and off, such as the proposed 0.2 watts of standby power suggests. To any potential “loophole” criticism we note that connected products often cost more, so budget-minded consumers will not be tempted to buy them. Connected lamps are bought specifically because of their connect capabilities and then used for those capabilities. The balance of cost and function in these products is a self-limiting factor which will ensure that they are only purchased when specifically desired. Should the CEC wish to dig further into the energy profiles of connected products, NEMA is open to working with CEC staff to investigate levels of connectivity to see if energy-use profiles can be developed based on functionality, or the CEC could fund CLTC to study connected features and associated standby power levels. The CEC cannot set standby power requirements low and plan to raise them later if technology heads that way for two reasons, 1) CEC influences other regulators and programs, and those entities may seek to similarly restrict product functionality based on CEC’s baseless conclusions, and 2) the CEC will not be able to backtrack later on standby power limits without being accused of backsliding. It makes much more sense to set a reasonable level now, and lower it later if technology proves able to deliver the increased connectivity demanded by 21st Century consumers for fewer watts.

Until the capabilities and demands of the functionality of lamps and the associated standby power needs are more well-defined, NEMA recommends the following changes to the standby power clause in the 45-day language:

(D) In addition to the requirements in 1605.3(k)(2)(C), state-regulated LED lamps manufactured on or after January 1, 2019 shall have a standby mode power of ~~0.2 watts~~ 1.0 watt or less.

9. LED Downlight Retrofit kits: These products are a very popular high-performance option to replace incandescent and CFL downlights, but there is a limited offering that meets the proposed rule in the 45-day express terms. The specialized optical and physical requirements of LED Downlights cause them to achieve lower efficiency than simpler lamps, in part due to optical or aesthetic requirements. Additionally, many programs consider LED Downlight Retrofit products to be Luminaires due to their additional features and physical traits. ENERGY STAR defines this product class in the scope of their Luminaire program, and even CEC’s Title 24 *treats them as luminaires*. By including them in a California lamp standard will create confusion in compliance and enforcement. This class of product consists of a variety of performance options

including various aperture sizes, trim styles and directional control which results in a wide range of luminous efficacy. The proposed performance requirements in Title 20 will eliminate a significant portion of optics or trim styles for these products. Furthermore, many retrofit downlights are packaged with a screw based adapter to allow the purchaser to hard wire the luminaire or retrofit it into an existing socket. The convenience to the consumer by providing a screw based adapter unintentionally includes products in the scope of this regulation that will be installed using hardwiring. We also note that we can find no evidence that CEC staff considered the burden placed on industry due to having recently implemented Title 24 Appendix JA8 requirements for these products, only to be met with a proposed burden of implementing and redesigning to meet the proposed Title 20 requirements in the 45-day express terms. Likewise, there is no evidence in the staff analysis to suggest that the performance of existing LED Downlight Retrofit products was at any time included in the feasibility and cost analyses. As with our comments on specialty lamps (see Part A, Comment 2, *supra*), NEMA submits that a separate analysis of these lamps is required. It is unclear if these products were reasonably assessed and analyzed. NEMA requests that CEC make the analysis for this class of product publicly available prior to releasing 15-day language, and that this data be reported separately, not wrapped up with and concealed by data for dissimilar lamp types. We do not see any evidence, much less substantial evidence to support the proposed rule's application to LED Downlights. Because of the limited analysis used for this type of product, the restriction of product options which provide significant energy reductions and conflicting requirements with Title 24 JA8, we propose that CEC *remove* LED retrofits for recessed can housings from the definition of a State Regulated Light Emitting Diode (LED) Lamp and consider them when a reasonable evaluation can be conducted.

Proposed changes to regulatory language to the scope (see also item 2 above:

1605(k) Definitions

"State-regulated Light Emitting Diode (LED) lamp" means a lamp capable of producing light with Duv between -0.012 and 0.012, and that has an E12, E17, E26, or GU-24 base, ~~including LED lamps that are designed for retrofit within existing recessed can housings that contain one of the preceding bases.~~ State-regulated LED lamp does not include a lamp with a brightness of more than 2,600 lumens or a lamp that cannot produce light with a correlated color temperature between 2200 K and 7000 K."

During the development of Title 24 Appendix JA8, industry commented against including a requirement for LED downlight retrofit kits, or for any appliances, given Title 24's building-specific mission. CEC staff at the time indicated that Title 24 was the vehicle in motion, and their strong desire to implement requirements for LED technology leaned them towards putting product-specific performance requirements in the Building Energy Efficiency Regulations. The response to industry's concerns was, in effect, "we'll fix it later." We ask the Commissioner to agree that it is now "later," and it is time to address the mismatch for this technology and others in scope of Title 24 JA8 rather than push it off a year or more to the conclusion of the next Title 24 cycle. The simplest solution to

this problem, which will allow CEC staff to proceed with the Title 20 proceedings and not have to conduct an emergency rulemaking to repair Title 24, is to remove these products from the scope of the current regulatory proposal. To encourage the development and incentives for higher-performing products, the CEC could add these products to the CA Voluntary LED Quality Spec to influence their technological progression without causing them to depart the market or undergo additional burdens to remain. NEMA will also commit to addressing these products in our discussions with CEC staff for the upcoming Title 24 revision cycle planning, set to begin in January 2016. We provide a detailed comparison of the competing and conflicting requirements in Appendix B of these comments, demonstrating that this aspect of the 45-day Express Terms does not meet the consistency requirements of the California Government Code, §11349.1(a).

10. Title 20 and Title 24 Conflict: The Title 20 proposal covering LED lamps and screw-based downlight retrofit products has created a significant conflict between the mandatory Title 20 appliance standards and the Title 24 building standards in Joint Appendix JA8. Based on further discussion with CEC, there seems to be an opinion that the JA8 requirements are more stringent, and that this is justified for new construction or major renovations. However, manufacturers will be faced with additional burden to meet the most stringent requirements for both standards. Title 20 imposes more stringent requirements for the LM/W threshold and has added requirements not included in JA8 such as R8, compliance score and Duv. These differences force manufacturers to supply a product that exceeds the requirements in both Title 20 and JA8, or design and market multiple products to serve different California markets. Many retailers serve the replacement, retrofit and new construction markets and will not be willing to provide shelf space for multiple products based in conflicting standards implemented by the CEC. During the development of Title 24 Appendix JA8 industry commented against including prescriptive product requirements in the Title 24 building standard which is focused on installed performance. At that time, CEC staff indicated that Title 24 was the vehicle in motion, and their strong desire to implement requirements for LED technology leaned them towards putting product-specific performance requirements in the Building Energy Efficiency Regulations. We again submit that it is now “later” and it is time to fix this mismatch for retrofits and other “LED Light Source” lamps in scope of Title 24 JA8.
11. Regarding Test Procedures: In the 45-day language, the CEC proposes to use IES LM-84 and IES TM-28 to measure and project the lumen maintenance of integrated LED Lamps. Today manufacturers use IES LM-80 and IES TM-21 for measuring and projecting the lumen maintenance of LED lamps. LM-84 is relatively new; testing laboratories have very little experience using it and it and LM-84 has not received wide industry adoption. Changing current practice to follow LM-84 and TM-28 exclusively would place an additional financial burden on the industry and delay certification of products unnecessarily without any meaningful benefit. The net effect would be to stifle innovation. LED chip packages are typically not released until LM-80 data TM-21 data are available for a given model. The time to test against LM-84, even though the LM-80 data and TM-21 projections are known, would add months to the product introduction/certification cycle and would require end product testing of every single model which uses a particular LED, which represents an astronomical increase in testing

costs over current practice. IES LM-80/TM-21 testing has the advantage that the results for a given LED may be used for all the products which use that LED, with only an additional in-situ LED case temperature measurement for each individual lamp using that LED, to support the rated lifetime. One important item that LM-84 does not account for is the tremendous rate of change of LED development and how that in turn affects the product development life cycle. Consensus among NEMA members is that the cycle time for a lamp design is 6-8 months and manufacturers have the difficult task of keeping up with LED innovation during product development and market introduction. Manufacturers are the experts of their particular designs and need to have an option to be able to change critical components, like the LED, in a short period of time without having to conduct system level testing to 3000 or 6000 hours for every single model that uses the same LED. The ENERGY STAR Lamps program, for example, allows for product changes including LEDs which gives manufacturers needed flexibility to make changes from a high level without having to repeat all system level testing. In short, LM-84 is relatively new, at this time manufacturer experience with it is low, and it may not deliver any better results for predicting lumen maintenance than the current procedure of using LM-80 and TM-21 based on in-situ measurements. Finally, although LM-84 and TM-28 are not in common use, there may be early adopters who wish to use those standards. Thus, NEMA proposes that CEC allow manufacturers to test and certify using either LM-80/TM-21 or LM-84/TM-28, at the manufacturer's discretion, until such time as the industry has gained sufficient familiarity with the new standards so this issue can be reevaluated and a more informed decision be made regarding which standard(s) is/are best.

In conclusion: using LM-84/TM-28 exclusively will lead to: 1) Delay in product certification and subsequent introduction to the market resulting in reduced energy savings, and 2) Reduced innovation related to the additional burden and delays of additional testing, and 3) Increased burden on manufacturers via additional testing costs. Proposal: NEMA proposes the CEC not require IES LM-84/TM-28 testing until such time as the DOE standards have been completed and available for reference.

Other Comments

12. Section 1606: Table X – Under state regulated LED lamps, remove reference to 'elevated' for lifetime test temperature.
13. Section 1607:
 - (12)(A)(i) – Clarify that full light output means with or without dimmer.
 - (12)(B)(iii) – Add GU24 to minimum lumen output of 310 for medium base lamps.
 - (12)(C) – Clarify that labeling requirement shall be on lamp packaging, not the lamp itself.
 - (12)(D) – Clarify that the manufacturer shall certify ..., not the lamp itself.

Detailed comments continue on the following page

Part B: Detailed Comments Regarding Multi-faceted Reflector (MR)
and Small Diameter Directional Lamps (SDDL)

1. Scope: The scope of the proposed Title 20 regulation covering small diameter lamps needs to be narrowed. As written it covers many lamp types that have no LED equivalent at any efficiency level, and will likely not have an LED equivalent by 2018. In this regard, NEMA reiterates its comment in Part A, Comment 2 that under the Warren-Alquist Act, the CEC cannot adopt standards that would only enable compliance by products that do not yet exist and may never exist. Where there are no new replacement LED lights, the CEC should not legislate the current lamps out of existence.

The CEC's current proposed "scope" definition is: "State-regulated small diameter directional lamp" means a directional lamp with a diameter less than or equal to 2.25 inches and a GU-10, GU5.3, GUX5.3, GU8, GU4, or E26 base. Small diameter directional lamp includes incandescent filament, LED, and any other lighting technology that falls within this definition. State-regulated small diameter directional lamp does not include products that use LEDs and have an E-26 base, which are state regulated light emitting diode lamps."

Issues with the proposed definition and approach:

- a) Specialty Lamps: The definition is too broadly worded and includes many specialty MR16 lamp types for which there is no LED replacement lamp. The MR16 lamp was originally developed for specialized equipment having a *very specific focal point*. The main advantage of the halogen MR16 lamp when used in specialized equipment is its ability to use an ellipsoidal reflector to focus the majority of the light into a narrow point at a precise location in front of the lamp (the *second* focal point of the ellipse). These lamps normally are specified with a very tight focusing plane (working distance) in order to work properly in equipment that can cost many thousands of dollars such as photo, projection, fiber optic, medical, dental, enlarger, microfilm and many other applications. These lamps often have unusual operating voltages, relatively short lamp lives and very precise optical focal points. In the early 80's, use of this technology was expanded from only specialty equipment to also include accent lighting in general lighting applications. It soon became a favorite in restaurants, retail stores, and custom residential applications. We note that general lighting MR16 lamps operate at 12 volts, with less expensive versions being designed at 120 volts.

The LED technology used in LED MR16 lamps has been developed to replace halogen lamps in general lighting applications where the majority of MR lamp-associated energy is consumed. These LED MR16 lamps do not refocus the beam at a second focal point and will not work properly in specialized equipment requiring halogen MR16 lamps. Because an LED is a directional point source, while a halogen lamp is an omnidirectional point source, mandating LED technology will create a technical catch-22 to recreate the exact optics required in specialty equipment with LED technology. Lamp designers will have to increase the size of lamp reflector (and therefore the size of the lamp) to try to refocus efficiently the light through a second focal point, or live with greatly reduced lamp efficiency as only some of the light would hit the focal point. However, if the lamp size is increased, it will not fit in the equipment. We understand that some new specialty equipment is

being designed to take advantage of LED lighting technology, but this does not impact the installed base or its replacement should all halogen MR lamps be eliminated from the market as proposed by the 45-day express terms. Specialty equipment already in service will continue to require halogen MR16 replacement lamps. If those lamps are taken off the market upon the effective date of the proposed regulation then the equipment they are used in, which can cost up to tens of thousands of dollars, will become immediately obsolete. Such forced obsolescence cannot be justified as cost effective pursuant to Public Resources Code section 25402(c)(1) because CEC would not be able to demonstrate that the proposed standard “does not result in any added total costs for consumers over the designed life of the appliances concerned,” which in this case would necessarily include the cost of replacing the specialty equipment. We note that the CEC’s cost analysis does not include assessment of the impacts to specialty equipment and the small CA businesses relying on it. For all of these reasons, halogen MR16 products used in specialty applications must be excluded from the regulations by redefining the scope. This can be accomplished by limiting the lamp voltage, lamp life and lumen output currently covered by the proposed scope (some equipment uses very high lumen output specialty lamps). This is an instance where a reasonable person could not have reached the conclusion to apply the proposed rule to specialty lamp equipment, and because of the enormous cost that the proposed rule will impose on consumers, which costs have not been analyzed by the commission, it violates the necessity and consistency requirements of the California Government Code §11349.1(a) and the requirement that the proposed rule contain a statement of all cost impacts that a reasonable private person would incur. California Government Code §11346.5(a)(9). NEMA’s alternative proposal is more effective or as effective as and less burdensome than what is proposed. California Government Code §11346.9.

- b) Emergency Lighting: Life safety equipment has special requirements, standards and performance expectations that cannot reliably be met with replacement LED lamps. The CEC must clearly exempt these products so that they may continue to be served in the market. For example: along with minimum foot-candle requirements for emergency lighting, there are also max to min uniformity ratio (40:1) along the egress path. If unit equipment needs some minimum load power to operate correctly, one cannot just plug in the largest power MR16 lamp available to try and meet the minimum power requirement of the unit equipment circuitry, or one may end up with too much light output and violate the 40:1 min/max requirement. Also, LED lamps do not operate across the full environmental spectrum that traditional lamps do, for example in low temperature applications. Furthermore, such equipment is OFF until needed, so power consumption should not be a concern for these products.
NEMA proposal: exempt lamps designed for life safety equipment.
- c) Dimming: A recent DOE CALiPER Report, Report 22.1, dated August 2015⁹ documented many performance problems LED MR16 lamps used on dimming systems. We note that, for reasons that are unclear to NEMA and its members, the older 2009 CALiPER report¹⁰ was used by CEC staff in the staff analysis, not the more recent report. In some ways this may be moot, because BOTH reports cited notable challenges in MR product offerings and cautioned against widespread use

⁹ http://energy.gov/sites/prod/files/2015/09/f26/CALiPER_22-1_mr16.pdf

¹⁰ http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/CALiPER_22_summary.pdf

until they are sorted out. In most cases, the transformer and dimming system had to be replaced for the user to get full dimming performance with these lamps. While this outcome may be cost-effective in some simple dimming applications, it would not be cost-effective for advanced dimming systems used in restaurants and other commercial and custom residential applications. Some of these advanced dimming systems can cost tens of thousands of dollars, some over \$100,000 to purchase and install. Even when replacing the components, the system will be unable achieve the deep dimming performance of halogen MR16 lamps required in certain applications such as home theatre applications. The following issues documented in the 2015 CALiPER report illustrate these problems:

- i. Although many LED MR16 lamps claim to be equivalent to halogen MR16 lamps, MR16 lamps tested by the DOE CALiPER program demonstrated systemic inaccuracy in equivalency claims.
- ii. Claims about lamp performance based on laboratory power supplies can result in misleading flicker and power quality performance characterizations. Performance on actual transformers demonstrated substantial variation and clearly indicated the difficulty in retrofitting LED lamps into existing systems intended for use on Halogen MR16 lamps.
- iii. The MR16 form factor and system requirements pose substantial challenges for LED technology compared to line voltage products. The small size poses unique driver design challenges and trade-offs including *greatly increased thermal challenges*. Lamps that have thermal issues will have significantly shortened lamp lives.
- iv. The system requirements often require an electronic driver, an electronic transformer and an electronic dimmer, all designed by different manufacturers, to work together. This can lead to unwieldy compatibility issues and result in complications before, during and after installation as well as unacceptable performance. CALiPER determined that most LED MR16 lamps are only compatible with certain combinations of equipment. In particular, the flicker performance for all LED MR16 lamp models was poor and all had much higher flicker index values than Halogen MR16 lamps when dimmed. In addition, LED lamps have very low power factors when dimmed. In many cases, MR16 LED lamps exhibited undesirable dimming behavior, such as dead travel or erratic dimming performance due to incompatible electronic circuits in the driver, transformer and/or dimmer.
- v. When testing an electronic transformer on an incandescent dimmer most products did not dim in a reasonable manner even though they were marketed as dimmable. Some products dimmed in a non-monotonic manner, meaning light levels could go higher when they were dimmed lower, and many did not dim below 60% light output. The presence of audible noise greatly increased when dimming. In addition, the overall flicker index was quite poor with lamps exhibiting objectionable flicker when dimmed. The MR16 LED lamps demonstrated irregular or unpredictable dimming, essentially showing a high level of incompatibility with the transformer-dimmer system. None of the LED products matched the dimming curve of the halogen benchmarks, and the flicker performance of most of the lamps was very poor.
- vi. In retrofit situations, where other system components are unknown, a significant investment in time and new equipment may be required to achieve acceptable system compatibility and performance. The likelihood that a combination of a new LED MR16 lamp, an unknown transformer, and an unknown dimmer will

operate smoothly and meet halogen performance expectations is extremely low and highly unlikely.

- vii. To address these issues, the CEC must allow some types of Halogen MR16 lamps to remain on the market to be used on advanced dimming systems and in specialty equipment. Replacing systems that can cost over \$10,000, which would be necessary to preserve product efficacy, would not be cost-effective pursuant to Public Resources Code section 25402(c)(1). This is especially true because the lamps used in these applications draw very little power when dimmed. The CEC should also note that halogen MR16 lamp life is greatly increased when dimmed to low levels. Commercial MR16 lamps used at full power, up to 16 hours a day, 7 days a week, require a long lamp life of 3000 to 6000 hours to make their use practical. These applications also use the most power and are well suited to LED conversion in terms of maintenance and product cost. We propose that if the CEC allowed continued use of shorter-life halogen MR16 lamps these systems and specialty equipment could continue to be used, but those using MR systems at full-power for long hours would be naturally incentivized to convert to LED systems due to sooner halogen lamp failure.

- d) Lumens: As stated in the aforementioned CALiPER report: “The MR16 form factor and system requirements pose substantial challenges for LED technology. The small size poses unique driver design challenges and trade-offs including greatly increased thermal challenges.” The lumen output of a small LED MR16 lamp is limited by the need to dissipate heat generation during lamp operation. It is easier to match center beam candlepower than to match lumens, which is acceptable in applications which have a secondary general lighting system. However, in applications that also rely on the lumen output to provide general illumination to the surrounding area as well as accent light matching lumens is necessary. Whether the LED replacement MR16 lamp is acceptable ultimately depends on the application. As no LED MR16 lamp has been demonstrated to achieve more than approximately 800 lumens due to the above noted technology limitations, the scope of the CEC standard must therefore be limited by total lumen output. There is simply no LED lamp available today that can achieve the 1200+ lumens produced by some halogen MR16 lamps and no technological breakthroughs that will change this limitation are currently anticipated. In NEMA member experience, sales of these high lumen Halogen MR 16 lamps are very small compared to sales of 50 watt, 35 watt and 20 watt Halogen MR16 lamps. Narrowing the scope in this way will have no impact on energy savings given there are no high lumen LED MR 16 products available or expected to be available. Moreover, the scope of the proposed standard must exclude these higher lumen products because replacement LED lamps simply do not exist for such applications.

- e) To address these serious concerns, and to ensure products are available that work in all applications after the regulation is takes effect, the proposed definition must be changed.

NEMA proposes the following changes to the proposed scope for MR/SDDL:
“State-regulated small diameter directional lamp” means a directional lamp with a diameter less than or equal to 2.25 inches and a GU-10, GU5.3, GUX5.3, GU8, GU4, or E26 base that is capable of meeting performance specifications when operated within a voltage range of 11 to 13 volts, or, 110 to 130 volts, has a rated life of more

than 2000 hours, and has a lumen output greater than 150 lumens and less than 825 lumens. Small diameter directional lamp includes incandescent filament, LED, and any other lighting technology that falls within this definition. State-regulated small diameter directional lamp does not include products that use LEDs and have an E-26 base, which are state regulated light emitting diode lamps.”

Rationale for proposed changes:

- i. Limiting the voltage range to 12 volt and 120 volt products, or products close to these voltages, will appropriately focus the standard on lamps typical to general lighting applications. Specialty lamps made at other voltages (e.g., 6, 8, 10.8, 13.8, 14.5, 17, 19, 20, 21, 24, 30, 36, 68, and 82 volts) will not be affected as there is no possible LED replacement lamp that provides the *proper optical performance for specialized equipment*. Specialty Halogen MR lamps include products used in airport, airplane, photo, projection, fiber optic, medical, dental, emergency, enlarger, microfilm and many other applications.
- ii. Limiting Halogen lamp life to 2000 hours or less will ensure that these products are only used in dimming applications. It will also ensure that specialty products designed at 12 volts or 120 volts, but which have limited durations of use, are not affected.
- iii. Limiting the scope only to lamps rated for less than 825 lumens ensures that there will be MR16 lamps available for all appropriate applications, and that LED MR16 lamps will be deployed where those LED lamps are viable replacements for halogen MR16 lamps. It ensures that specialty MR16 lamp products designed at 12 volts or 120 volts, which have very high lumen output and no known LED MR16 replacements to take their place, are not affected. Placing a floor of 150 lumens aligns the MR/SDDL proposal with the CA LED Lamps proposal and avoids the complexity of the disparate market offerings in the low-lumens category, of which none are effective replacements for higher-lumen products and thus not prone to being abused as replacements for larger halogen products.

This too is an instance where a reasonable person could not have reached the conclusion to apply the proposed rule to certain MR16 LED lamps, and because of the enormous cost that the proposed rule will impose on consumers, which costs have not been analyzed by the commission, it violates the necessity and consistency requirements of the California Government Code §11349.1(a) and the requirement that the proposed rule contain a statement of all cost impacts that a reasonable private person would incur. California Government Code §11346.5(a)(9). NEMA's alternative proposal is more effective or as effective as and less burdensome than what is proposed. California Government Code §11346.9.

2. We note that the CEC did not propose a minimum Color Rendering Index for MR/SDDL products, and NEMA proposes CEC set a minimum score for CRI at 80 for MR/SDDL products.
3. Beam Angle and Center Beam Candlepower (CBCP): Not all manufacturers test for or report these parameters. Although the CEC does not propose to regulate these parameters, we note that the CEC has proposed they be reported per the line item in

Table X, row K on page 17/21 of the 45-day express terms. Rather than make reporting Beam Angle and CBCP mandatory, we propose the CEC make it optional by adding a superscript “2” to the rows, as given in Table K for other parameters such as R9, start time and warranty. The testing burden will arise because of CEC’s use of the DOE’s additional guidance (80 FR 39666) in the Supplemental Notice of Proposed Rulemaking for the Energy Conservation Program: Test Procedures for Integrated Light-Emitting Diode Lamps, and as noted on slide 19 of the CEC’s November 18th 2015 hearing presentation. In the DOE’s guidance, Sections 3.2.6, 3.2.7, and 3.2.8 clearly state “Do not use goniophotometers.” However, to ascertain CBCP a goniophotometer is required, and the CEC’s reporting requirements also stipulate that a test lab be certified by the CEC, another added burden with respect to testing costs if a goniophotometer is required. This means that CEC-listed SDDLs must be tested for the regulated parameters and then re-tested using a goniophotometer to obtain measurements for Beam Angle and Center Beam Candle Power. Such goniophotometer measurements take a minimum of 30 minutes per lamp and represent a significant test burden for manufacturers. We note that larger diameter Federally-regulated directional sources do not have beam angle or CBCP reporting requirements. Again, we ask the CEC to strike these two reporting requirements to reduce testing burden.

Proposed change to Table K regulatory language:

Beam Angle ²
Center Beam Candle Power (CBCP) ²

4. NEMA appreciates the recognition that higher CRI lamps will have inherently lower efficacy and agrees that high CRI lamps should have a lower efficacy limit such as allowed by the proposed CRI vs. lm/W equation. However, instead of proposing a “minimum” efficacy level that will ensure MR16 products are available in 2018 for all general service applications – a hallmark of previous Title 20 appliance efficiency standards – the CEC has instead proposed an efficacy level that will only be achievable by a small number of specialty LED MR16 lamps in a narrow range of applications.
5. While we recognize that large efficiency gains have been achieved in LED technology in the past 5 years, the rate of progress is, comparatively speaking, beginning to slow. Moreover, as noted in our preceding comments, opportunities for future efficiency gains in MR16 lamps are limited relative to general service lamps due to their small size and particular performance requirements. The average efficacy of LED MR16 lamps sold in California today is approximately 56 lm/W according to a recent Navigant report¹¹. Even if one assumes an ambitious 10% increase in efficacy in each of the next two years, the average will only reach a little over 65 lumens per watt by 2018. The vast majority of the LED MR16 lamps being sold in the USA in 2018 would still be well below the proposed 80 lm/W standard.
6. An Australia E3 study was released in August 2015,¹² which evaluated performance characteristics of LED MR16 lamps on a global basis. Figure 46 on page 79 of the

¹¹

http://www.energydataweb.com/cpucFiles/pdaDocs/1365/LED%20Study_Draft%20Final%20Report_20150828_Clean.pdf see page 98 of 102

¹² <http://www.energyrating.gov.au/files/product-profile-light-emitting-diodes-ledsdocx>

Australian study illustrates that the average worldwide efficacy today of LED MR16 lamps is less than 45 lm/W. Only one lamp in this study reached an 800 lumen output, and its efficacy was less than 50 lm/W. Only two lamps out of over 100 evaluated for this study were over 80 lm/W. Only 6 lamps (or less than 5%) were over 70 lm/W, and these lamps represented a very narrow lumen range of between 340 and 620 lumens. The highest average efficiency of lamps in all lumen ranges between 150 and 825 lumens was approximately 50 lm/W. Thus, even if one assumes aggressive efficiency gains moving forward, available market data indicates that CEC's proposed efficacy levels are at least 10 lm/W too high to ensure that products will be available for all lumen ranges and for all applications.

7. If CEC's current proposal is adopted without further modification, very few products would qualify at any lumen range. The proposal would set an optimal performance goal rather than a floor designed to ensure a minimum level of performance that meets consumer expectations, achieves additional energy efficiency gains and preserves product availability at a reasonable price. Only a few LED products would be available from a limited number of suppliers. This must be corrected. If desired, the CEC could also move some of this product scope into the California Voluntary LED Lamp Quality Spec, rather than attempt a risky and aggressive once-and-done approach.
8. NEMA Proposal for MR/SDDL Performance Requirements
If the state wishes to have many manufacturers competing with high quality (above average) products widely available for consumers, CEC should lower the proposed levels by at least 15 lm/W, which would still eliminate over 20% of today's ENERGY STAR products from the market.

1605.3(k) (3)

(A) have luminous efficacy of ~~≥80~~60 lumens per watt.

(B) have a minimum luminous efficacy of ~~70~~55 lumens per watt or greater and a minimum compliance score of ~~165~~150 or greater, where compliance is calculated as the sum of the luminous efficacy and CRI.

(C) a CRI (Ra) of 80 or greater

Appendix B: Comparison of Title 20 and Title 24 Requirements for Lamps

	CA T20 Proposed	JA8 2016 Requirements	
		Requirements based on an inseparable luminaire	Requirements based on an LED light source
CCT	2000-7000K covered	>=4000	>=3000
Lumens	< 2600 covered	N/A	N/A
lm/W	65	45	45
CRI (Ra)	82	90	90
Compliance score	277	N/A	N/A
Duv lower limit	-0.0033	-0.0033	-0.0033
Duv upper limit*	= 57700 x (1/T)^2 - 44.6 x (1/T)+0.00854	0.0033	0.0033
Life (hrs)	10000	15000	15000
PF	0.7	0.9	0.9
Standby W	<0.2w (eff 1/1/19)	N/A	N/A
R1	72	N/A	N/A
R2	72	N/A	N/A
R3	72	N/A	N/A
R4	72	N/A	N/A
R5	72	N/A	N/A
R6	72	N/A	N/A
R7	72	N/A	N/A
R8	72	N/A	N/A
R9	N/A	50	50

Start Time (sec)	N/A	0.5	0.5
Lumen Maint (after 6000 hrs)	N/A	0.867	0.867
LM80 and TM21 hours to L70 (if 6000 testing is not provided)	N/A	25000	25000
Survival Rate (after 600 hrs)	N/A	0.9	0.9
Dimming level (minimum)	N/A	0.1	0.1
Meet SSL7A Type I or Type 2	N/A	YES	YES
Max % flicker at >2000hz	N/A	0.3	0.3
Noise dBA (at 100% and 20% light output 1 meter)	N/A	24	24
Marking	??	JA8-2016 or JA8-2016-E (elevated temp)	JA8-2016 or JA8-2016-E (elevated temp)

* We note the 11/18/2015 hearing presentation changed the factor of 0.00854 to 0.01184

Executive Summary of Proposals and Requests

List of NEMA Proposals

- Use the well-established 7-step ANSI quadrangle for allowable Duv chromaticity and normatively reference ANSI C78.377-2015¹⁴ as the guidance for calculations.
1602(k) Definitions
(C) State-regulated LED lamps with lumen output of ~~450~~ 310 lumens or greater and manufactured on or after January 1, 2017 shall have a color point as described in ANSI C78.377-2015 Table 1.:
(i) ~~a color point with a Duv that is:~~
(1) ~~No less than 0.0033~~
(2) ~~No greater than $57700 \times (1/T)^2 - 44.6 \times (1/T) + 0.00854$ where T means the measured correlated color temperature.~~
- 1605(k)(2)(C)
(ii) A CRI (Ra) of ~~8280~~ or greater
(iii) Individual color scores of R1, R2, R3, R4, R5, R6, and R7, and R8 of 72 or greater, and an R8 of 50 or greater
- (D) In addition to the requirements in 1605.3(k)(2)(C), state-regulated LED lamps manufactured on or after January 1, 2019 shall have a standby mode power of ~~0.2 watts~~ 1.0 watt or less.
- 1602(k) “State-regulated small diameter directional lamp” means a directional lamp with a diameter less than or equal to 2.25 inches and a GU-10, GU5.3, GUX5.3, GU8, GU4, or E26 base that is capable of meeting performance specifications when operated within a voltage range of 11 to 13 volts, or, 110 to 130 volts, has a rated life of more than 2000 hours, and has a lumen output greater than 150 lumens and less than 825 lumens. Small diameter directional lamp includes incandescent filament, LED, and any other lighting technology that falls within this definition. State-regulated small diameter directional lamp does not include products that use LEDs and have an E-26 base, which are state regulated light emitting diode lamps.”
- Table K:

Beam Angle ²
Center Beam Candle Power (CBCP) ²
- 1605.3(k)(3)
(A) have luminous efficacy of ~~≥8060~~ lumens per watt.
(B) have a minimum luminous efficacy of ~~7055~~ lumens per watt or greater and a minimum compliance score of ~~465150~~ or greater, where compliance is calculated as the sum of the luminous efficacy and CRI.
(C) a CRI (Ra) of 80 or greater
- 1602(k) “State-regulated Light Emitting Diode (LED) lamp” means a lamp capable of producing light with Duv between -0.012 and 0.012, and that has an ~~E12, E17, E26, or GU-24 base, including LED lamps that are designed for retrofit within existing recessed can housings that contain one of the preceding bases.~~ State-regulated LED lamp does not include a lamp with a brightness of more than 2,600 lumens or a lamp that cannot produce light with a correlated color temperature between 2200 K and 7000 K.”
- Do not require IES LM-84/TM-28 testing until such time as the DOE standards have been completed and available for reference.

¹⁴ <http://www.nema.org/Standards/Pages/American-National-Standard-for-Electric-Lamps-Specifications-for-the-Chromaticity-of-Solid-State-Lighting-Products.aspx>

- Make the implementation dates for this regulation 12-24 months from the adoption date, rather than fixed at 1/1/17, etc.
- Set a separate compliance score for decorative lamps be 267 and 287 for tier 1 and tier 2 respectively (vs. 277 and 297 for omnidirectional lamps), i.e. ten points lower.
- Change the minimum CRI for LED lamps to 80, rather than 82.
- Address the requirements mismatch between the Title 20 proposal and existing Title 24 Appendix JA8 requirements for “LED Light Source” lamps rather than postpone it.
- Remove LED Downlight Retrofit Kits from scope
- Do not require IES LM-84/TM-28 testing until such time as the DOE standards have been completed and available for reference.
- Allow for the continued sale of “modified spectrum” lamps.
- Exempt lamps designed for life safety equipment.
- Move lamp types/shapes not analyzed separately during the proposal development to the California Voluntary LED Quality Specification as a way to incentivize development and investment in their LED alternatives rather than apply analysis from A-line and PAR lamp data to them inappropriately.
- Do not mandate State-specific labeling requirements.

Summary of NEMA Requests

- Publish or otherwise make available the internal list of compliant products made by CEC staff in order to vet the practicality of the proposals, to assist the public in understanding the impacts on product availability.
- To better understand how the CEC has made their cost conclusions, NEMA requests a copy of the CEC’s detailed cost analysis data and investigative work.
- Fund the CLTC to conduct studies about consumer acceptance and put to rest speculations about consumer preferences and practices.
- If the CEC’s real intent is to only allow nominal CRI 90 products into the market then this should be clearly stated in the proposed requirements language and the CEC should clearly take responsibility for proposing that consumers can only purchase the less efficient CRI 90 products.
- NEMA requests that CEC make the analysis for LED Downlight Retrofit Kits publicly available prior to releasing 15-day language, and that this data be packaged alone, not wrapped up with and clouded by data for dissimilar lamp types.