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CA IOU Comments on Small Diameter Directional Lamps

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Small Diameter Directional Lamps

Codes and Standards Enhancement (CASE) Initiative
For PY 2015: Title 20 Standards Development

RESPONSE TO CEC'S EXPRESS TERMS 45 DAY LANGUAGE PROPOSAL

December 7, 2015

Prepared for:

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1 Overview

The Pacific Gas and Electric Company (PG&E), Southern California Edison (SCE), Southern California Gas (SoCal Gas), San Diego Gas & Electric (SDG&E) Codes and Standards Enhancement (CASE) Initiative Program seeks to address energy efficiency opportunities through development of new and updated Title 20 standards.

This document outlines the California Investor-Owned Utilities (IOUs) CASE team response to the California Energy Commission's (CEC) Express Terms (45 day language) published in October 2015, "Small Diameter Directional LED Lamps and General Purpose LED Lamps" (herein referred to as the 45 Day Language) and discussion in the subsequent CEC workshop on November 18, 2015. The comments in this document focus on the proposed standards for small diameter directional lamps.

We support the proposed standards, effective 2018, for small diameter directional lamps (SDDLs). There is currently a wide variety of light emitting diode (LED) SDDL products available that meet the proposed standard and LEDs in this product category are capable of replacing halogens. In fact, LED MR16s had the fastest early adoption rates of any LED lamp type – already hitting 10% market adoption in 2012.[1] This proposed standard will result in very significant savings for California, and the shift to LEDs in the SDDL market is also consistent with other LED performance standards already adopted in California (for GSLs) and Europe (directional lamps).[2]

Below is a summary of the specific comments and recommendations that are made in this document regarding the CEC's proposed SDDL standards.

1.1 Specific Comments in Support of the CEC's 45 Day Language for SDDLs

- There is a wide variety of SDDL products available today that meet the proposed standards, including products at different color temperatures, different beam angles, and from many different manufacturers. Products continue to improve at a very fast pace as well, and even more products are projected to be available by 2018.
- Compatibility between low voltage LED lamps and systems is improving and MR16 lamp designs have gotten much better at achieving backwards compatibility with existing systems.
- In cases where low voltage LEDs do not perform to expectations on existing transformers or control systems, end users have several retrofit options available. End users can switch to line voltage LED systems or they can retrofit their existing equipment to LED-compatible low voltage transformers (or LED-compatible dimming systems). We have conducted an analysis to document the expected costs associated with these retrofits and found that the life-cycle cost savings from installing LED SDDLs are so significant that the

[1] DOE, 2013. Adoption of Light-Emitting Diodes in Common Lighting Applications
http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/led-adoption-report_2013.pdf
[2] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32012R1194&from=EN

measure is still extremely cost-effective even in rare cases where existing equipment is upgraded.

1.2 Specific Recommended Changes to the CEC's 45 Day Language for SDDLs

- We recommend that CEC add a minimum CRI requirement of at least 80 or 82 for small diameter directional lamps. As written in the 45 day language, the proposal does not have any minimum CRI requirement for lamps as long as they have an efficacy above 80 lpw, meaning that manufacturers could potentially design low performing, inexpensive products that meet the efficacy requirement by reducing color rendering dramatically (for example to 50 or 60 CRI). This could result in significant consumer backlash to the implementation of this standard.
- The proposed definition of SDDL refers to "directional lamps," but this term is not defined anywhere by the standards. We recommend that the CEC specify that 'directional lamps' are those with at least 80% light output within a solid angle of π sr (corresponding to a cone with angle of 120°), which is how they are defined by European Union standards.[3]
- We recommend that CEC broaden the definition of SDDL to include all bi-pin bases with a distance between them that is greater than or equal to 4mm and less than or equal to 12mm.
- We recommend that CEC exempt lamps with light output above 900 lumens and with lamp life below 300 hours that are designed and marketed specifically for use in specialty applications such as medical equipment and projectors. We do not recommend that CEC include other exemptions based on operating voltage, or low lumens, because there is not a technical basis that would prevent LEDs from meeting these specifications.

2 Supporting Comments and Data

2.1 Product Availability and Market Trends

There is a wide variety of SDDL products available today that meet of the proposed standards, including products at different color temperatures, different beam angles, and from many different manufacturers. Figure 1 below plots the SDDL products in the ENERGY STAR qualified products list (QPL) as of October 2015. Products that meet the proposed standards levels are those to the right of the purple line. All of the products in the graph are also rated with a lifetime of 25,000 or higher. There are over 60 products that meet the proposed standards levels, available from over 20 manufacturers (the graph appears to show fewer products, because some of the data points overlap).

[3] Ibid.

Figure 1. ENERGY STAR Qualified Product List for SDDL

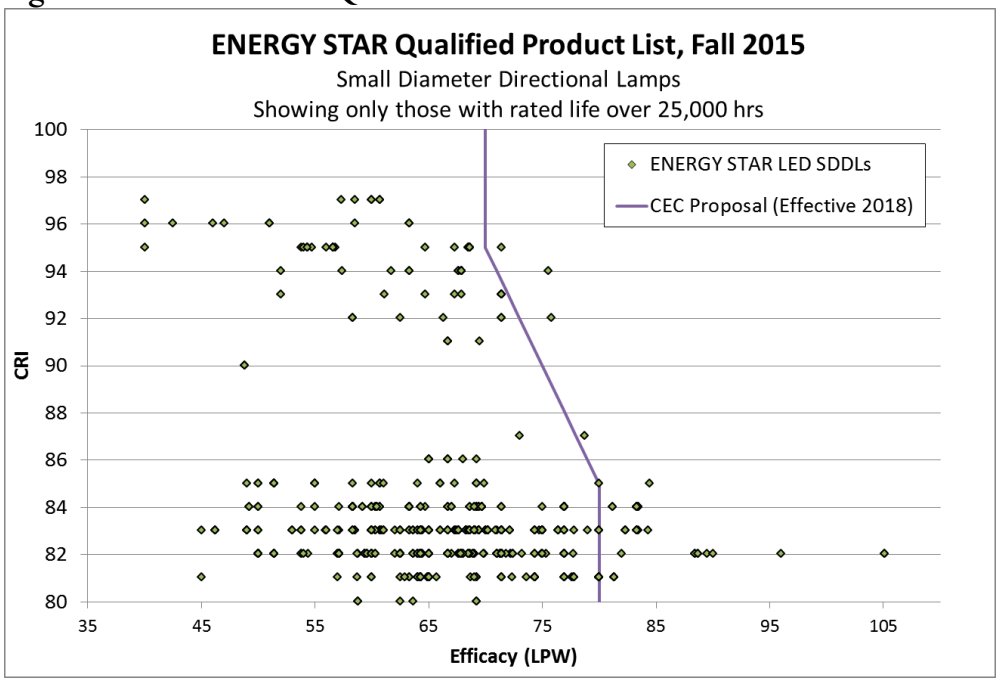


Table 1 provides more detail about some of the products in the ENERGY STAR QPL with efficacy above 80 lpw and life above 25,000 hours. This is not an exhaustive list of proposed standard-compliant products, nor an exhaustive list of the manufacturers with compliant products; rather it is a snapshot that indicates the variety of products and their performance specifications. As shown in this table, compliant products range in beam angle from 15° to 40°, they range in CCT from 2700K to 6500K, and have several different base types. They have lumen outputs up to 680 lumens (though not Energy Star certified, many other products are available that provide even higher lumen output, in the range of 700-750 lumens[4]).

[4] https://www.dmxledlights.com/IndoorLighting/MR16-LED/
http://www.lightexports.com/mr16-12w-led-dimmable-led-12v-ac-dc-700-lumens-flood/
http://www.amazon.com/SJTechon%C2%AE-Lumen-70-75-Equivalent-White/dp/B00F4IWIKS
http://www.bulbs.com/product/10MR16-F36-3000-DIM-HO?RefId=378

Table 1. Sample of qualifying SDDL products with performance specifications

Manufacturer	Model Number	Bulb Type	Base Type	Wattage Equiva-lency (watts)	Beam Angle	Light Output (lumens)	Power (watts)	Efficacy (lpw)	Life (hrs)	Color Temp-erature (Kelvin)	Power Factor	Dimmable?
Beautiful Light Technology	BLM1653M-NCW62L	MR16	GU5.3	35	25		4.5	105	25000	5000	0.9	Dimmable
Beautiful Light Technology	BLM1653M-NVW62L	MR16	GU5.3	35	25		4.6	88	25000	2700	0.9	Dimmable
Canadian Tire	052-1374-0	PAR16	GU10	50	40		7	85	25000	3000	1	Dimmable
CRS Electronics	QMR16HO30SPCW	MR16	GU5.3	75	15	650	8	81	35000	3000	0.9	Dimmable
CRS Electronics	QMR16HO40FLCW	MR16	GU5.3	75	36	670	8	83	35000	4000	0.9	Dimmable
CREATIVE LIGHTS CORP.	CL-GU10-5W	PAR16	GU10	60	38	440	5	103	25000	3000	0.6	
E2 Lighting Inc.	E2MR0740KFLAWH	MR16	GU5.3	50	38		7.1	82	25000	4000	0.9	Dimmable
Everbright Lights Inc.	EJDR710WW	PAR16	E26	50			6.5	90	25000	3000	0.8	Dimmable
Maxxima	MLB-16800SF	MR16	GU5.3	50	40	650	8	81	25000	3500	1	Dimmable
Mester LED Limited	GU0740KFLAWH	PAR16	GU10	50	38	550	7	88	25000	4000	1	Dimmable
Mester LED Limited	MR0527KSM-53	MR16	GX5.3	37	40	400	5	80	25000	2700	0.9	Dimmable
Mapled Light Inc.	MAPLEDGU10-5A(DM)	PAR16	GU10	35	38		5	81	25000	2700	1	Dimmable
Green Creative	7.5MR16G4DIM/840NF25	MR16	GU5.3	75	25	625	7.5	81	25000	4000	0.9	Dimmable
Green Creative	7.5MR16G4DIM/840FL36	MR16	GU5.3	75	36	625	7.5	81	25000	4000	0.9	Dimmable
Shenzhen Well King Lighting	WK-SL-D17	PAR16	GU10	50	30	570	6	95	25000	6500	1	Dimmable
SmartRay, Inc.	SR6MR165W-WW-D	MR16	GX5.3	25	40	422	5	84	25000	2700	0.9	Dimmable
OSRAM SYLVANIA	78206	MR16	GU5.3		36	500	7	80	25000	3000	0.9	Dimmable
OSRAM SYLVANIA	72524	MR16	GU5.3		25	500	7	80	25000	3000	0.9	Dimmable
SATCO/NUVO	S9206	MR16	GU5.3	50	40	660	8	83	25000	4000	1	Dimmable
SATCO/NUVO	S9207	MR16	GU5.3	50	40	680	8	85	25000	5000	1	Dimmable
TW Lighting	M16-05025-27	MR16	GU5.3	35	25	400	5	80	25000	2700	0.9	Dimmable
TW Lighting	M16-05036-27	MR16	GU5.3	35	36	400	5	80	25000	2700	0.9	Dimmable

It is also worth noting that there are many other available products that exceed the CEC's proposed efficiency and life requirements, but which are not currently certified to ENERGY STAR. A few examples are provided here:

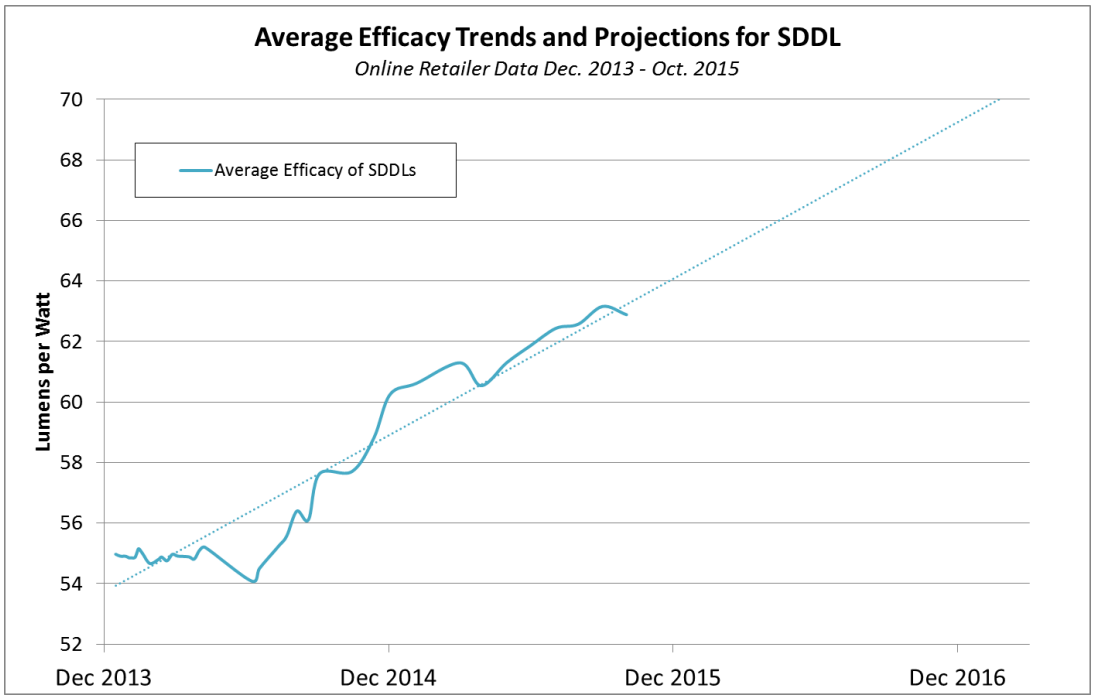
- Kobi: 90 lpw, 25,000 hours, 50W equivalent, dimmable lamp with 25 degree beam, GU5.3 base, 3000K[5]
    - Already available below $10
- Global Consumer Products: 80 lpw, 35,000 hours, dimmable lamp with 40 degree beam, GU10 base, 5000K[6]
    - Already available below $10
- MSI: 80 lpw, 50,000 hours, 50W equivalent dimmable lamp with 15 degree or 25 degree beams, GU5.3, 4000K[7]

Additionally, LED SDDL performance has been improving in recent years and all indications are that far more products will be available by 2018. For example, based on two years of monthly data collection, Figure 2 below shows average efficacy of LED SDDLs offered for sale online, improving at a rate of about 10% per year (data collection has included over 300 unique SDDL price points collected in each monthly online data pull, i.e. unique product offerings from a specific retailer). Assuming continued efficacy improvements at the current rate, *average* efficacy will be about 75

[5] https://www.1000bulbs.com/product/113270/LED-MR1640030NFL.html
[6] https://www.1000bulbs.com/product/115890/LED-566.html
[7] https://www.1000bulbs.com/product/100161/LED-XMR1640150D.html

lpw when the standards take effect, meaning that far more products will meet the proposed 70-80 lpw requirements in 2018 than at the present time. While there are a number of current products that currently fall just short of the proposed efficacy requirement (within 10%), e.g., GE, Cree, Ushio, PLT, Globe Electric, Westinghouse, EcoSmart (Home Depot brand), given ample time to prepare and current trends, these lamps should be able to meet the standards by 2018. Continued efficacy improvements will also result in increased light output capabilities.

Figure 2. Average Efficacy Trends of SDDL based on Data Collected from Online Retailers



Source: CASE Team 2015

Given the wide variety of performance characteristics among products that already meet the CEC's proposed efficacy requirements, and the projected, sustained efficacy and performance improvement in this product category, we support the efficacy and life standards as proposed.

2.2 Compatibility

Compatibility between low voltage LED lamps and existing stock of low voltage transformers and dimming systems is an important issue, and over the course of the last few years we have observed great progress on this issue. For example, we commissioned a study into compatibility issues associated with MR16s, conducted ongoing interviews with driver and lamp manufacturers, and reviewed the research on this topic conducted by United States Department of Energy (DOE). We also have significant experience from IOU incentive programs installing LED SDDLs in a variety of space types, including restaurants, retail, aquariums, and others. Several years ago, dimming MR16s was a challenge; today, most SDDLs are dimmable, and thousands of LED installations are being completed across the country without problems or call-backs. Below is a summary of findings on this issue.

In 2014, PG&E funded a research initiative at the California Lighting Technology Center (CLTC) that was designed to investigate compatibility issues between SDDLs, dimmers, and transformers.[8] Twenty LED SDDL products were tested, each with extensive combinations of components and operating conditions: transformer type, dimmer type (including no dimmer), dimming level and number of lamps, resulting in a performance data set of 600 different test scenarios. Most lamps were found to be dimmable but compatibility issues occurred in some scenarios; dimming performance was dependent on transformer type and other factors. The results of the study closely mirrored the results of a DOE study completed in early 2015. In DOE's testing of MR16 LEDs published in its most recent CALiPER report,[9] they found an array of performance levels under different conditions. For LEDs operating on electronic low voltage transformers and dimmers that were optimized for compatibility (i.e. they paired with products from the lamp manufacturer's recommend compatible transformer and dimmer lists), most of the MR16 lamps dimmed smoothly, and all but three dimmed below 10%. A third of the products actually dimmed below 2%. For lamps on electronic transformers with incandescent dimmers (not optimized for compatibility), many products had erratic dimming behavior, though some products still performed quite well – there were a number of products that dimmed below 10%. When installed on a magnetic transformer, dimming performance was good across most lamps – only a handful showed erratic behavior and all but 4 dimmed below 20%. About half the products dimmed below 10%, some below 2%. Both the CLTC study and the DOE report demonstrate that many manufacturers are having increased success in controlling MR16s; what was considered not possible 3 or 4 years ago is now being done by much of the market.

We estimate that in most cases (85-95%) low voltage LED lamps are compatible with the low voltage transformer, fixture, and wiring infrastructure specified in a lighting project. However, in cases where there are compatibility challenges (e.g., erratic behavior such as non-linear/non-smooth dimming, flicker, ghosting), one option is to replace the low-voltage transformer(s) with LED-compatible transformers. There is a cost associated with changing out transformers, but in the case of remote transformers or low voltage (mono-rail) systems, multiple lamps are driven from a single transformer, so the per lamp cost is much lower. Changing a low voltage system to a line voltage system is another potential solution that would negate compatibility challenges associated with LEDs operating on low voltage systems.

We have done an analysis to assess the most common wiring and installation scenarios for low voltage SDDLs, and to identify the retrofit options available to consumers in each scenario, should they decide to upgrade their low voltage transformers or dimming systems to LED-specific systems or to switch to line voltage LED SDDLs to improve system performance. For each of the identified SDDL configurations, we have scoped out these two options, as well as the total system retrofit costs and per lamp costs that could be expected. We have also conducted an analysis of dimming system retrofit options and costs. The aim of both of these analyses was to determine the per lamp costs associated with these retrofits, should they be needed. The matrices below, which are based on expert interviews with manufacturers and lighting designers, show the results of these analyses.

[8] http://cltc.ucdavis.edu/sites/default/files/files/publication/201505-electrical-compatibility-mr16-led-replacements.pdf
[9] http://energy.gov/sites/prod/files/2015/09/f26/caliper_22-1_mr16.pdf

Table 2. Overview of Transformer System/Fixture Designs and System Retrofits

Existing Transformer System Design Options	Est. Market Share		Retrofit Options - Each design has two retrofit options: a) retrofitting to line voltage, and b) retrofitting to LED-compatible low voltage transformer		Lamps per line /System	Fixture Cost	Labor Cost	Total Cost *(per system)*	Cost per Lamp [*5]	Comments and Remarks
	Com.	Res.								
Line Voltage track w/ low voltage (12V) lamp holders *(heads)*	**60%** 40-80%	**35%** 20-40%	a	Keep track & replace existing 12V track head with line voltage (G10) head	1 / head	$12-$125 Range *($25-$50 typical)*	$0.0 [*1]	$12-$125 Range *($25-$50 typical)*	$12-$25	Limited number of track head options/few manufactures offer this track head design
			b	Keep track & replace existing 12V track head with new 12V LED compatible track head	1 / head	$15-$175 Range *($50-$100 typical)*	$0.0 [*1]	$15-$175 Range *($50-$100 typical)*	$15-$50	Wide range of track head costs based on manufacturer and design/features
Low voltage track and/or rail	**10%** 10-20%	**20%** 15-35%	a	Replace existing low voltage track with line voltage track and either 12V heads or line volt heads [*2]	4-12 heads *(6 heads typical)*	$100-$850 Range *($200-$600 typical)*	$75-$275 Range [*4] *($100-$175 typical)*	$175-$1125 *($300-$775 typical)*	$30-$50	NOTE: Typical cost based on 6-head track
			b	Keep existing track/rail and install LED compatible low voltage transformer.[*3]	2-12 heads *(6 heads typical)*	$75-$300 Range *($100-$200 typical)*	$75-$225 Range[*4] *($100-$125 typical)*	$150-$425 Range *($200-$325 typical)*	$25-$33	NOTE: Typical cost based on 6-head track
Integrated 12V track system *(heads sold as part of system)*	**0%** 0-10%	**5%** 5-20%	a	Replace existing system with new line voltage track and LED compatible MR16 120V (G10) or 12V MR16 heads.	2-6 heads *(4 heads typical)*	$175-$650 range *($200-$400 typical)*	$75-$275 Range[*4] *($100-$175 typical)*	$250-$925 Range *($300-$575 typical)*	$62-$75	NOTE: Typical cost based on 4-head track
			b	Replace existing system with 12 volt LED MR16 lamp compatible system. [*2]	2-6 heads *(4 heads typical)*	$75-$750 range *($125-$250 typical)*	$75-$275 Range[*4] *($100-$175 typical)*	$150-$975 Range *($225-$425 typical)*	$38-$56	NOTE: Typical cost based on 4-head track
Recessed low voltage cans	**25%** 15-30%	**35%** 20-50%	a	Replace existing transformer with LED compatible 12V (likely able to keep trim associated with existing fixture). Electrician may be needed for complex / permitted projects.	1 /Socket	$8-$35 Range *($10-$20 typical)*	$75-$175 Range[*4] *($100-$125 typical)*	$83-$210 Range *($110-$135 typical)*	$83 - $110	Electrician only needed for permitted project – handy man competent for simple retrofit
			b	Replace existing MR16 down light can/trim with new 120V GU10 MR16 LED compatible down light can and trim	1 /Socket	$60-$125 Range *($75-$100 typical)*	$75-$275 Range [*4] *($100-$175 typical)*	$135-$400 Range *($175-$275 typical)*	$135-$175	NOTE: Option 2A would be to install new LED compatible 12V MR16 can with $50-$75 cost adder above option 2
Remote Transformer[*3] *(cans and track)*	**5%** 0-15%	**5%** 0-10%	a	Replace single existing transformer for can/mono-point located in separate area (adjacent space or room or on ceiling plenum or walls) with LED compatible transformer.	1 /Socket 1/Head	$8-$35 Range *($10-$20 typical)*	$125-$275 Range *($150-$225 typical)*	$133-$310 Range *($160-$245 typical)*	$133-$160	Similar to localized (in can) transformer change-out however higher cost due to remote access issues
			b	Replace existing system transformer for low voltage track located in separate area (adjacent space or room or on ceiling plenum or walls with LED compatible system transformer.	2-18 heads *(8 heads typical)*	$75-$600 Range *($150-$300 typical*	$125-$275 Range *($150-$225 typical*	$175-$825 Range *($300-$525 typical)*	$22-$38	Based on 8-head track *(cost per head $50 to $88)* Similar to localized (end of track) transformer change-out however higher cost due to remote access issues

*1: Assumes purchaser/owner and/or maintenance staff can perform required labor for change out.
*2: Low voltage track or rail system transformer *(typically services 4 to 12 lamp holders).*
*3: Low voltage system transformer may also service remote transformer locations *(when direct connect to track not feasible or desirable).*
*4: Lower install cost of $75 assumes use of qualified handy-man versus licensed electrician. *(Licensed electrician only required if building permit involved).*
*5: Cost per lamp is shown as a range, from the cheapest estimated price for the retrofit scenario modeled, to the lower end of the "typical" estimated price for the retrofit scenario.

Table 3. Overview of Dimming Replacements and System Retrofits for LED Lamp Compatibility

Existing Dimmer System Design *2	Est. Market Share		Retrofit older non LED compatible dimmers with LED compliant dimmers	Lamps per Dimmer	Dimmer Cost	Labor Cost *1	Total Cost *(per switch or system)*	Cost Per Lamp *3	Comments and Remarks
	Com.	Res.							
Localized Dimmer/switching (*single or multiple individual dimmer switches)*	**60%** 30-80%	**90%** 75-95%	New LED compatible dimmer with on/off switch	4-60 (typical 8)	$15-$75 Range *($25-$50 typical)*	$75-$250 Range *($100-$150 typical)*	$90-$325 Range *($125-$200 typical)*	$12-$16	Typical local dimmer switch controls 150 W to 1000 W max load *(3-20 halogen MR16 lamps).* 600W is common. 80% load is ideal (480W). Assuming 8W LED lamps, max # 60. However, most system will control fewer – estimate 8MR16 lamps
Lighting Control System Dimming *(dimmer modules integrated into lighting control, EM systems and or panels)*	**40%** 5%-40%	**10%** 5%-25%	New LED compatible dimming module for multi scene lighting control system *(Lutron/Vantage or similar)*	15 – 100 (typical 40)	$90-$900 Range *($125-$600 typical)*	$125-$500 Range *($175-$350 typical)*	$215-$1400 Range *($300-$900 typical)*	$6-$7	Dimmer modules for lighting control systems *(Lutron, Vantage, etc.)* controls are offered in a wide variety of wattage and number of station loads. Therefore a wide range of pricing is shown. Typically the lower price scenarios are for lower wattage loads 150W to 300W on fewer *(3 to 4 stations)* while the higher costs applies to 1000W+ loads on numerous *(8 to 12)* stations

*1: Assumes purchaser/owner uses electrician for work. However wall dimmer change outs are simple and can be performed by skilled home owner or maintenance staff which equates to $0 install or use of handy-man at $50 to $75 install. Dimming modules *(part of lighting control system)* would typically require an electrician. However, skilled handy-man could do the install at a lower cost *(typical home owner is not qualified).*
*2: While example is for dimming MR16 LED lamps same dimmer/control issue with other LED line voltage and low voltage lamps can be addressed with these option/solutions at the same costs.
*3: Cost per lamp is shown as a range, from the cheapest estimated price for the retrofit scenario modeled, to the lower end of the "typical" estimated price for the retrofit scenario.

As shown in the Cost Per Lamp columns of both tables, when the costs of these system retrofits are divided by the number of lamps being retrofitted, the per lamp cost of these retrofit scenarios is under $50 in most scenarios. In some cases, cost per lamp can exceed $100, with the most expensive retrofit scenario range estimated at $135 - $175 (the recessed low voltage can scenario where the user opts to replace existing 12V MR16 downlight cans and trim with new 120V GU10 MR16 LED compatible downlight cans and trim).

However, based on the CEC's own calculations of incremental measure cost, and measure energy cost savings, and avoided lamp replacement cost, the life-cycle cost savings per lamp from the SDDL measure is estimated at $247 (Table 4 below). This indicates that even in the rare cases where the above retrofit scenarios are needed, the SDDL measure is still extremely cost effective.

Table 4. Net Life-Cycle Cost Savings Estimates from SDDL measure

Incremental Measure Cost	Avoided Replacement Lamp Cost Change Over Design life	Total Unit Energy Cost Change over Design Life	Net Life-Cycle Cost
$4	($30)	($221.30)	($247)

2.3 Minimum CRI

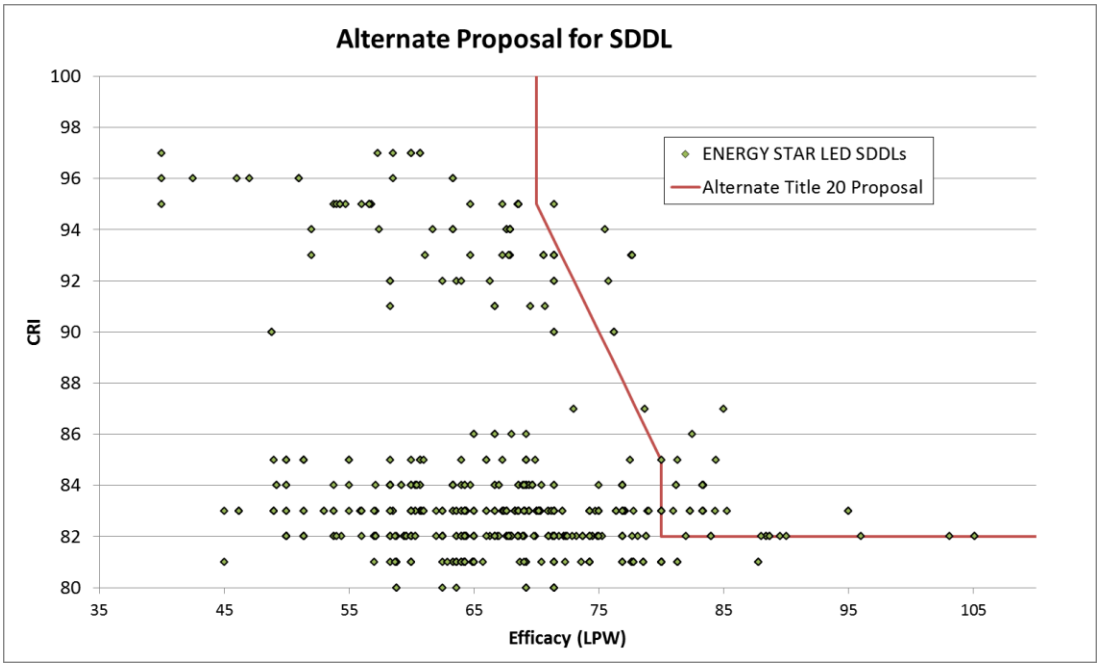
We recommend that CEC add a minimum CRI requirement for small diameter directional lamps. As written in the 45 day language, the proposal does not have any minimum CRI requirement for lamps as long as they have an efficacy above 80 lpw. This means that a manufacturer could potentially sacrifice product utility as a way to more easily meet the efficacy requirements. A manufacturer might find a lower cost way to achieve 80 lpw simply by reducing color rendering dramatically (for example to 50 or 60 CRI), which would have negative consequences. CRI is not required to be provided on SDDL packaging so consumers may not be aware that a product has such low color rendering properties. This would likely result in significant consumer disappointment with their purchase, and backlash to the implementation of this Title 20 standard.

For consistency with the LED Lamps proposal, we recommend setting a minimum CRI of at least 82 for SDDL. The simplest way to make the changes to the 45 day language would be as follows (underlined in red):

> (3) State-regulated Small Diameter Directional Lamps. State-regulated small diameter directional lamps manufactured on or after January 1, 2018 must have a CRI of at least 82, a rated life of 25,000 hours or greater as determined by the lumen maintenance and time to failure test procedure and meet one of the following requirements:
>
> (A) have luminous efficacy of ≥80 lumens per watt.
>
> (B) have a minimum luminous efficacy of 70 lumens per watt or greater and a minimum compliance score of 165 or greater, where compliance is calculated as the sum of the luminous efficacy and CRI.

This change would result in the standard line that appears in Figure 3, below.

Figure 3. Alternate Proposal for SDDLs Incorporating a Minimum CRI



Source: CASE Team 2015

2.4 Product Class Definitions and Scope

The proposed definition of SDDL refers to "directional lamps," but the term "directional lamp" is not defined anywhere by the standards. We recommend that CEC specify that 'directional lamps' are those with at least 80 % light output within a solid angle of π sr (corresponding to a cone with angle of 120°), which is how they are defined by European Union standards.[10] We believe this definition encompasses all lamps typically thought of as directional lamps (e.g. MR, R, PAR, ER, BR, etc.), and excludes other products that are not typically considered directional lamps, such as snow-cone A-lamps.

We also recommend that CEC broaden the definition of SDDL to include all bi-pin bases with a distance between them that is greater than or equal to 4mm and less than or equal to 12mm (in addition to E26 screw base lamps). The proposed definition includes a specific list of only six bi-pin base types: GU10, GU11, GU5.3, GUX5.3, GU8, GU4. However, there are many other very similar bi-pin base types that are used for MR16 lamps, or which could easily be used. For example, while the CEC's proposal includes GU5.3 and GUX5.3, it does not include GX5.3, a common MR16 base type.[11] Similarly, there are a wide array of other similar base types, many of which may be interchangeable in the same sockets. For example, our team found a socket type for sale online that is advertised as working with lamps with any of the following bases: G4, GU4, GX4, GZ4, G5.3, GX5.3, G6.35, GX6.35, GY6.35, GZ6.35.[12]

Lastly, in response to comments at the 45-day language hearing that certain specialty applications should be exempted from the SDDL requirements, we propose that CEC exempt lamps that are designed and marketed specifically for use in specialty applications and that have light output above 900 lumens and which are rated for less than 300 hours of useful life. Our research found that most of these specialty lamps designed for projectors and medical equipment are extremely high wattage, high brightness products, that tend to have very short product lives (usually 50-100 hours). We understand that LED SDDLs are not currently capable of providing the functionality required by some of these specialty applications. While LEDs in the SDDL form factor are expected to continue to get brighter than current models, they may not be capable of achieving light output above 900 lumens for several years, so this exemption is justified. However, including the maximum hours rating helps ensure that products do not get installed in general lighting applications. Products with a lifetime below 300 hours are unlikely to gain significant market share, because they would burn out in a matter of months in most general lighting applications. Including this hours limit helps to ensure that these products are only utilized in the specialty applications where short product lives are the norm. We also recommend that these exempted products be required to be labeled as such. The packaging should clearly state "Not intended for use in general lighting applications; for use in specialty equipment only." We do not recommend that CEC include any other exemptions, including those based based on operating voltage, or low lumens, because there is not technical basis that would prevent LEDs from meeting these specifications.

[10] Ibid.
[11] http://www.gelighting.com/LightingWeb/la_en/north/products/technologies/led/led-mr16-dimmable-base-gx5-3/overview/
[12] http://www.donsbulbs.com/cgi-bin/r/b.pl/socket-db-tp61.html