Small Diameter Directional Lamps

Codes and Standards Enhancement (CASE) Initiative
For PY 2014: Title 20 Standards Development

RESPONSE TO CEC'S DRAFT STAFF REPORT AND SEPTEMBER 29, 2014 STAKEHOLDER WORKSHOP

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Executive Summary

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 improvement opportunities through development of new and updated Title 20 standards. Individual reports document information and data helpful to the California Energy Commission (CEC), and other stakeholders in the development of these new and updated standards. The objective of this Program is to develop CASE Reports that provide comprehensive technical, economic, market, and infrastructure information on each of the potential appliance standards.

This document outlines the California investor-owned utility (IOU) CASE team response to the CEC's Draft Staff Report published in September 2014 ("Analysis of Small Diameter Directional Lamp and Light Emmiting Diode Lamp Efficiency Opportunities" and discussion in the subsequent CEC workshop on September 29, 2014, with respect to three main points indicated below.

1) CA IOU Proposal for Labeling
2) Additional Information on Backward Compatibility
3) Response to CEC Proposal

The CASE team further investigated label designs for small diameter directional lamps (SDDLs), and has revised a proposal that addresses stakeholder interests and concerns regarding label uniformity across markets. The CASE team is proposing mandatory labeling requirements for Light Emitting Diode (LED) SDDLs sold in California, to help ensure successful market transformation of the SDDL market as it transitions from a stock of primarily filament-based lamps to LEDs with the CEC proposed standard. For the label, we are recommending the use of the Department of Energy's (DOE) LED Lighting Facts Program (LFP) label, which is a free and voluntary program that already has significant industry support. In addition to this label, we are recommending that wattage equivalency date of manufactur (in the format MM/YYYY) also be listed on LED SDDL packaging.

The CASE team also further investigated backward compatibility in response to stakeholder concerns about LED SDDL replacement on existing magnetic and electronic low voltage transformers (MLVTs and ELVTs) and dimming systems. In this document, the CASE team outlines technical solutions that manufacturers are working on to address these issues.

Finally, the CASE team would like to reiterate its support for a high efficacy standard that will move the market to LEDs in 2018, paired with minimum color rendering requirements consistent with those being adopted for other types of LED lamps as part of the LED Quality measure, and a mandatory consumer-facing labeling. Research findings and analyses suggest that the LED SDDL market will be fully capable of providing equivalent utility to filament-based lamps by 2018 since there are already commercially available products that provide equivalent utility in terms of beam angle, center beam candle power, lumen output, color rendering index, and correlated color temperature.

1 Labeling for Small Diameter Directional Lamps

1.1 CA IOU Proposal for Labeling

We believe that a label for LED SDDLs, paired with a wattage equivalency designation, can greatly facilitate successful market transformation to LEDs by providing a straightforward, reliable means for comparison, as well as lead to additional energy savings. We recommend that the CEC require the proposed label on LED SDDL packaging one year after this measure's adoption.

We recommend that the CEC require that packaging for LED SDDLs sold in California have an official DOE LED Lighting Facts® Program (LFP) label. The label should be placed on a consumer-facing package side (i.e., on the exterior of the package as opposed to interior). Additionally, we propose that the CEC require that wattage equivalency be indicated somewhere consumer-facing on the packaging as well, utilizing the ENERGY STAR© Center Beam Candle Power (CBCP) tool for wattage equivalency, as well as the values for CBCP and beam angle reported to the DOE LED LFP. DOE LED LFP offers two labels (i.e., a standard label and a standard label with optional metrics) either of which, we recommend, would meet the labeling requirement. Figure 1 below provides an overview of the Standard DOE LED LFP label. As a reminder, wattage equivalency is not included on the label, but we recommend that it be indicated elsewhere on the package.

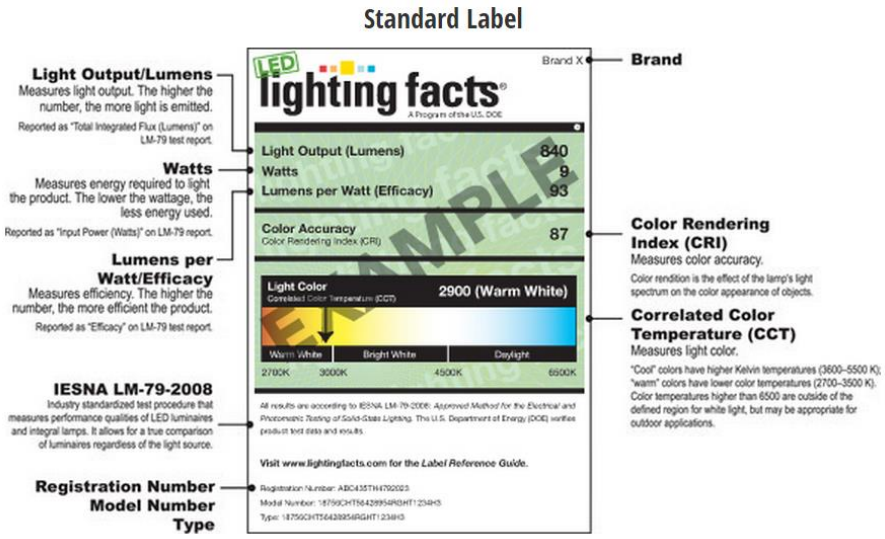

FIGURE 1.1 DOE LED LIGHTING FACTS PROGRAM LABEL

The CA IOUs provide further information and justification for this labeling proposal in the sections below.

1.2 Background on Labeling Efforts

Labels can have a positive impact on market transformation efforts by providing consumers with information that supports informed purchasing decisions. This information can lead to increased energy savings, particularly when uniform design requirements for the label are specified, making comparisons across products straight-forward. Additionally, labels that are paired with testing and

verification requirements can yield a more level playing field for manufacturers with regard to unchecked and/or overstated claims about product performance. This can also help ensure that consumers have a favorable experience with their LED product purchases since testing, verification and penalties for overstating product performance should reduce the number of misrepresented products in the market.

Labeling at the Federal level is typically regulated by the Federal Trade Commission (FTC), which prescribes mandatory labeling requirements on a manufacturer-reported basis for some lighting categories. However, SDDLs are not covered by the FTC and no other labeling for lamp performance for lumen output, color quality, and correlated color temperature exist for SDDLs at the Federal or state level.

The DOE LED Lighting Facts Program[1] consists of verification and testing, a maintained database of products and their performance across various metrics, and a certified voluntary label. There are no minimum performance requirements or eligibility criteria for participation, other than to submit LM-79 test data and pass random testing and verification requirements. DOE created the Program in 2008 in a coordinated effort with the lighting industry to improve transparency and authenticity of reporting. Thus unlike labeling regulated by the Federal Trade Commission (FTC),the DOE LED LFP closely monitors product testing, while the FTC depends solely on manufacturer assurance for the data listed on the its label. Moreover, the uptake of the program by LED manufacturers is almost ubiquitous at this point. With respect to the LED SDDL market, there are over 70 unique manufacturers participating in the Program with over 300 unique SDDL models.

During the workshop, industry provided feedback that any label proposed in California, to the extent possible, should align with existing, industry-backed labeling initiatives. We agree with industry, and as such are recommending the use of the DOE LED Lighting Facts Program label.

1.3 Cost-Effectiveness Analysis for Label

Results from the CA IOU cost-effectiveness analysis of including a label on SDDL product packaging indicate that labeling will only cost an additional $0.02 per label for the entire stock of SDDLs in California. Before labeling costs, the net present value (NPV) of benefits less costs is $164 and $94 per lamp for the commercial and residential markets, respectively. We assert that it is cost-effective to include a label on SDDL packages, with the details of our analysis outlined below.

There is minimal to no additional cost to participate in the DOE LED Lighting Facts Program. Manufacturers participate by signing a pledge and submitting LM-79 test report data. While the LM-79 test is about $300 for an integrating sphere test and $500 for a goniophotometer test, manufacturers have indicated that completing these tests is regular practice, regardless of their decision to participate in the program.[2] Additionally, to remove manufacturer burden, the Program accepts LM-79 test data on products from ENERGY STAR, further reducing any additional cost to provide test data. DOE reserves to right to conduct random verification testing of off-the-shelf

[1] http://www.lightingfacts.com/
[2] Conversation with DOE LED Lighting Facts Program Administrator on 10/17/2014

products, which is paid for by the manufacturer. DOE indicated that the cost for this testing can vary; one estimate provided was $2,000 for either a product or family of products.[3] The label is free to manufacturers who participate.

There would be a cost to the manufacturer in redesigning product packaging to accommodate a wattage equivalency marking (if it is not already on the package) and the DOE LED LFP label that has already been designed and provided by the DOE LED LFP. We are exploring ways in which the current label could be customized to fit different package sizes for SDDLs, which would further reduce product package re-design time. It would be left to the manufacturer's discretion on where wattage equivalency would be placed on the package; at a minimum the metric must be consumer-facing. We do not anticipate the need for any retooling of the manufacturing since the material printed on packaging is digitally transferred to printers. Table 1.2 below provides an overview of these assumptions and the final estimated cost to include a label ($0.02/label).

TABLE 1.2 ESTIMATED COSTS TO INCLUDE A LABEL ON SDDL PACKAGING

One Time Set-Up Costs		Units	Source
Engineer/ Designer Time	100	Hours	Federal Trade Commission. 2013. http://www.reginfo.gov/public/do/PRAViewICR?ref_nbr=201302-3084-001
Engineer/ Designer Hourly Wage	$44.36	Dollars/hour	
Set-Up Cost to each Manufacturer	$4,436	Dollars	
Number of LED SDDL Manufacturers	71	Manufacturers	DOE LED Lighting Facts
Total Set-Up Cost Statewide	$314,956	Dollars	
Material Cost			
Additional Printing Costs	$0.00	Per Label	The manufacturer will print information on the product package with or without a labeling mandate.
Total printing costs to label stock	$0	Dollars	
Total Cost to Label Stock	$314,956	Dollars	Sum of Setup, Material, and Labor Costs (in reality manufacturers may choose to adopt the label for all SDDL product packaging and thus the cost would decrease significantly as stock increases.
SDDL Stock in California in 2018	16,000,000	lamps	Estimates based on CASE Analysis of stock and shipment data for SDDL.
Label Cost per unit	$ 0.02	Dollars/ Label	

2 Additional Information on Backward Compatibility

In response to concerns raised during the September 29th 2014 stakeholder meeting concerning LED SDDL backward compatibility with existing dimmers and low voltage transformers, the CA IOUs conducted numerous interviews with LED and driver manufacturers to understand the challenges and design solutions. We found that there continues to be considerable investment and innovation in technologies to help overcome issues associated with backward compatibility, such as flicker, inoperability, or shorter life, and under most circumstances we do not expect to see any incompatibility issues. Nonetheless, in some instances a system retrofit, in which the transformer or dimmer is replaced, may be warranted. The large majority of these issues are only applicable to

[3] http://www.lightingfacts.com/About/Content/VTPolicy

the low voltage market, which we estimate to be largely within the commercial sector (or about 6 precent of the SDDL market). Moreover, these issues appear to be confined to specific installation configurations and equipment with specific load requirement limitations, as discussed further in this section.

Ultimately, given the numerous design cycles between now and the proposed effective date in 2018, we anticipate that the market will further resolve any remaining issues associated with dimming and transformer compatibility. We expand on these research findings below.

2.1 Characterization of Technical Solutions to Backward Compatibility

The CA IOUs have engaged in a test effort with the California Lighting Technology Center (CLTC) to evaluate backward compatibility of lamps on magnetic and electronic low voltage transformers and dimming systems; the effort entails a tear down analysis of 20 unique LED MR16 replacements and testing on electronic and magnetic low voltage transformers (ELVT and MLVT) as well as reverse and forward phase control dimmers. While testing is still underway, the team analyzed three main driver topologies used by lamp manufacturer in their tear-down analyses, including buck, boost, and buck-boost converters. Some manufacturers we spoke with indicated that there were additional topologies and lamp designs that they were actively working on to address compatibility with transformers and dimmers as well.

Driving some of these designs are chip and driver manufacturers that are invested in improving LED compatibility with transformers and dimmers to reduce the issues of flicker, shorter life, or inoperability. Jade Sky Technologies is one such California-based manufacturer that has partnered with the CLTC to develop integrated driver solutions specifically designed to enable smooth dimming from 100 percent down to 0 percent with all commercially available dimmers and occupancy sensors.[4] Their initial focus has been on larger omnidirectional and directional lamps, where their technology has been highly successful. However, Jade Sky is actively working to address similar design challenges in the SDDL market as well. Power Integrations is another driver California-based manufacturer invested in addressing compatibility issues for low voltage LED applications. The LYTSwitch-2 family of drivers utilizes a control technique to provide tight output current regulation, compensating for transformer and external component variations, as well as device parameter tolerances for input voltage variations.[5] The LYTSwitch-4 family of drivers is designed to be compatible with TRIAC dimming applications, resulting in wide dimming range.[6]

2.2 Evaluation of the Prevalence of Issues Associated with Backward Compatibility

Backward compatibility is complicated by the fact that LED SDDLs are often replacing lamps that operate on existing transformer and dimming systems with minimum load requirements. The transformer is necessary in low voltage lamp systems, to step the main AC Voltage, typically 120 V

[4] http://jadeskytech.com/home/news-press/press-release/24-press-releases
[5] http://www.powerint.com/products/lytswitch-family/lytswitch-2
[6] http://www.powerint.com/products/lytswitch-family/lytswitch-4

down to 12 VAC, the typical operating voltage of many filament-based MR16s. The dimmer, while not used in all applications, serves to provide adjustable light output, which may be important in applications where occupants desire ambient lighting.

The minimum load requirements can vary across different transformer and dimming systems. Our interviews with manufacturers revealed that some transformers need 5 to 20 watts (W) of resistive load on the system to operate correctly; 20 W is the equivalent power draw of two 10 W LED SDDLs, or three 7 W LED SDDLs (common wattages for LED SDDLs). The majority of residential and commercial dimming systems control more than one lamp, and thus incompatibility with dimmers is likely to be uncommon. Our market and technical research indicates that backward compatibility issues are generally confined to the relatively rare situation in which there is one lamp operating on one dimmer. Installation configurations in which one transformer per lamp is common include recessed can applications and track systems with low-voltage track heads (which have one power supply per lamp). These one to one lamp-transformer-dimmer configurations are both used in commercial and residential applications, and in some instances may warrant retrofit of the transformer or dimmer.

3 Response to CEC Proposal

The CA IOU CASE team is highly supportive of the CEC proposal of a high efficacy standard for SDDLs, effective in 2018. The savings at stake are significant. In total, the proposed approach would yield a net savings of 1,486 gigawatt-hours (GWh) after stock turnover and a reduction of 552 megawatts (MW), as discussed during the CA IOU presentation at the recent CEC Stakeholder Workshop.

To ensure that California rate-payers have the most successful transition to LED replacement lamps, we strongly recommend that this efficacy standard be paired with the labeling proposal outlined in this response, as well as minimum color rendering requirements, equivalent to those being considered for other LED lamp types. Moreover, our research findings and analyses indicate that the market will be fully capable of delivering LED products that are equivalent in utility to filament based options by 2018 since the market is already able to deliver across all major benchmarks (e.g., beam angle, wattage equivalency, CRI, correlated color temperature, power factor). Cost-effectiveness remains justified under both residential and commercial applications, even when a system retrofit may be warranted for those limited configurations where there are issues with one to one dimmer-transformer-lamp configurations. Finally, our preliminary investigation into backward compatibility suggests that the market will also be able to overcome these challenges by 2018, as numerous market players are already working to address these issues. Based on 6 month design cycles, we estimate that there would be at least 6 design cycles to iterate on these approaches between 2014 and 2018, when the proposed standard would become effective. The CA IOUs are committed to monitoring these issues and facilitating information-sharing among stakeholders and interested parties, wherever possible.