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SUPPLEMENTAL INITIAL STATEMENT OF REASONS (ISOR) ATTACHMENT A PROPOSED AMENDMENTS TO APPLIANCE EFFICIENCY REGULATIONS

CALIFORNIA CODE OF REGULATIONS, TITLE 20:

SECTIONS 1601-1609: APPLIANCE EFFICIENCY REGULATIONS

CALIFORNIA ENERGY COMMISSION

DOCKET NUMBER 15-AAER-6

California Energy Commission
Edmund G. Brown Jr., Governor

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ATTACHMENT A

Specific Purpose, Rational, and Necessity:

Proposed new regulatory language appears as underline (example) and proposed deletions appear as strikeout (~~example~~). Existing language appears as plain text.

This document is supplemental to the original Initial Statement of Reasons. Note that only the original 45-day language is presented in this Supplemental Initial Statement of Reasons. Subsequent changes to the regulations will be addressed in the Final Statement of Reasons.

1601 Scope.

(k) Lamps, which are federally-regulated general service fluorescent lamps, federally-regulated incandescent reflector lamps, state-regulated general service incandescent lamps, general service lamps, state-regulated light-emitting diode (LED) lamps, state-regulated small-diameter directional lamps, and includes GU-24 base lamps.

Purpose and Rationale: The scope section identifies the energy using products or classes of products that are subject to the Commission's jurisdiction and which have an energy efficiency standard or testing standards. Because the Commission is proposing standards which will cover LED lamps and small diameter directional lamps new language has been added to section 1601 Scope.

Necessity: To ensure clarity as to the lighting products covered under the Commission's regulations, it is necessary to add descriptions for LED lamps and small diameter directional lamps to the regulations.

1602 Definitions.

(k) Lamps

"Beam angle" means the angle within which the lamp produces 50% of the maximum luminous intensity.

Purpose and Rationale: Definitions are being added to the regulations to address new terms that have been incorporated into the regulatory language. Precise technical language helps to ensure regulatory clarity and common understanding of requirements and to set forth a frame work for the Scope section.

Necessity: The technical nature of the regulations generally requires corresponding definitions to be added to the regulations when the scope expands to cover new product classes, in this case, small diameter directional lamps and certain types of LED lamps. Without the definitions there could be ambiguity as to exactly what products may be covered or what product features are subject to the standards or what metrics are being used to assess compliance. Beam angle definition is based on the work of expert technical staff as discussed in the following report on page 10: Harinder Singh, Ken Rider, 2015. *Analysis of Small Diameter Directional Lamp and General Service Light-Emitting Diode Lamp Efficiency Opportunities,* California Energy Commission. Publication Number: CEC-400-2015-034.

"Center beam candle power" means luminous intensity at the center of the beam of a reflector lamp, measured in candelas (cd).

Purpose and Rationale: Definitions are being added to the regulations to address new terms that have been incorporated into the regulatory language. Precise technical language helps to ensure regulatory clarity and common understanding of requirements and to set forth a frame work for the Scope section.

Necessity: The technical nature of the regulations generally requires corresponding definitions to be added to the regulations when the scope expands to cover new product classes, in this case, small diameter directional lamps and certain types of LED lamps. Without the definitions there could be ambiguity as to exactly what products may be covered or what product features are subject to the standards or what metrics are being used to assess compliance. Center beam candle power definition is based on the work of expert technical staff as discussed in the following report on page 10: Harinder Singh, Ken Rider, 2015. *Analysis of Small Diameter Directional Lamp and General Service Light-Emitting Diode Lamp Efficiency Opportunities,* California Energy Commission. Publication Number: CEC-400-2015-034.

"Connected LED lamp" means an LED lamp capable of changing its lumen output or spectral power distribution in response to an external control signal other than a change

in RMS AC supply voltage or a 0-10 volt DC control signal. Connected LED lamp includes lamps that can be controlled wirelessly and through power line carrier digital communication.

Purpose and Rationale: Definitions are being added to the regulations to address new terms that have been incorporated into the regulatory language. Precise technical language helps to ensure regulatory clarity and common understanding of requirements and to set forth a frame work for the Scope section.

Necessity: The technical nature of the regulations generally requires corresponding definitions to be added to the regulations when the scope expands to cover new product classes, in this case, small diameter directional lamps and certain types of LED lamps. Without the definitions there could be ambiguity as to exactly what products may be covered or what product features are subject to the standards or what metrics are being used to assess compliance. This definition was drafted by staff after input from stakeholders, to ensure that relatively new product lines, LED lamps that can be controlled through the web, are covered products. Specifically the definition is based on the work of expert technical staff as discussed in the following report on pages 54-55: Harinder Singh, Ken Rider, 2015. *Analysis of Small Diameter Directional Lamp and General Service Light-Emitting Diode Lamp Efficiency Opportunities,* California Energy Commission. Publication Number: CEC-400-2015-034.

"Duv" means the closest distance from the chromaticity coordinate of the light source to the Planckian locus on the International Commission on Illumination (CIE) (u', 2/3 v') coordinates with "+" sign for above and "-" sign for below the Planckian locus.

Purpose and Rationale: Definitions are being added to the regulations to address new terms that have been incorporated into the regulatory language. Precise technical language helps to ensure regulatory clarity and common understanding of requirements and to set forth a frame work for the Scope section.

Necessity: The technical nature of the regulations generally requires corresponding definitions to be added to the regulations when the scope expands to cover new product classes, in this case, small diameter directional lamps and certain types of LED lamps. Without the definitions there could be ambiguity as to exactly what products may be covered or what product features are subject to the standards or what metrics are being used to assess compliance. This definition was drafted by staff after input from stakeholders, to address a very technical area of lighting physics and color perception. Specifically the definition is based on the work of expert technical staff as discussed in the following report on pages 58-59: Harinder Singh, Ken Rider, 2015. *Analysis of Small Diameter Directional Lamp and General Service Light-Emitting Diode Lamp Efficiency Opportunities,* California Energy Commission. Publication Number: CEC-400-2015-034.

"Lumen output" means the brightness of the lamp at full output, measured in Lumens.

Purpose and Rationale: Definitions are being added to the regulations to address new terms that have been incorporated into the regulatory language. Precise technical language helps to ensure regulatory clarity and common understanding of requirements and to set forth a frame work for the Scope section.

Necessity: The technical nature of the regulations generally requires corresponding definitions to be added to the regulations when the scope expands to cover new product classes, in this case, small diameter directional lamps and certain types of LED lamps. Without the definitions there could be ambiguity as to exactly what products may be covered or what product features are subject to the standards or what metrics are being used to assess compliance. The definition of "Lumen output" is a standard industry accepted description of the term.

"Power" means the total amount of electric power required, measured in Watts, to operate the lamp, as measured at the base of the lamp.

Purpose and Rationale: Definitions are being added to the regulations to address new terms that have been incorporated into the regulatory language. Precise technical language helps to ensure regulatory clarity and common understanding of requirements and to set forth a frame work for the Scope section.

Necessity: The technical nature of the regulations generally requires corresponding definitions to be added to the regulations when the scope expands to cover new product classes, in this case, small diameter directional lamps and certain types of LED lamps. Without the definitions there could be ambiguity as to exactly what products may be covered or what product features are subject to the standards or what metrics are being used to assess compliance. The definition of "Power output" is a standard industry accepted description of the term.

"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.

Purpose and Rationale: Definitions are being added to the regulations to address new terms that have been incorporated into the regulatory language. Precise technical language helps to ensure regulatory clarity and common understanding of requirements and to set forth a frame work for the Scope section.

Necessity: The technical nature of the regulations generally requires corresponding definitions to be added to the regulations when the scope expands to cover new product classes, in this case, small diameter directional lamps and certain types of LED lamps.

Without the definitions there could be ambiguity as to exactly what products may be covered or what product features are subject to the standards or what metrics are being used to assess compliance. This definition has been carefully crafted by expert technical staff working with stakeholders to ensure the targeted products are covered by the proposed regulations while avoiding accidently covering other types of lamps. Detailed discussion of the definition can be in the following report on page 56: Harinder Singh, Ken Rider, 2015. *Analysis of Small Diameter Directional Lamp and General Service Light-Emitting Diode Lamp Efficiency Opportunities,* California Energy Commission. Publication Number: CEC-400-2015-034

"State-regulated small diameter directional lamp" means a directional lamp with a diameter of less than or equal to 2.25 inches and a GU10, GU11, 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 E26 base, which are state-regulated light emitting diode lamps.

Purpose and Rationale: Definitions are being added to the regulations to address new terms that have been incorporated into the regulatory language. Precise technical language helps to ensure regulatory clarity and common understanding of requirements and to set forth a frame work for the Scope section.

Necessity: The technical nature of the regulations generally requires corresponding definitions to be added to the regulations when the scope expands to cover new product classes, in this case, small diameter directional lamps and certain types of LED lamps. Without the definitions there could be ambiguity as to exactly what products may be covered or what product features are subject to the standards or what metrics are being used to assess compliance. This definition has been carefully crafted by expert technical staff working with stakeholders to ensure the targeted products are covered by the proposed regulations while avoiding accidently covering other types of lamps. Detailed discussion of the definition can be in the following report on pages 7-10: Harinder Singh, Ken Rider, 2015. *Analysis of Small Diameter Directional Lamp and General Service Light-Emitting Diode Lamp Efficiency Opportunities,* California Energy Commission. Publication Number: CEC-400-2015-034

Section 1604 Test Methods for Specific Appliances

(k) Lamps

(2) The test method for state-regulated general service incandescent lamps~~, and~~ state regulated incandescent reflector lamps, and state-regulated small diameter directional lamps that use incandescent filament technology is 10 C.F.R. section 430.23(r) (Appendix R to Subpart B of part 430).

(4) The test methods for LED state-regulated small diameter directional lamps and state-regulated LED lamps ~~is IES LM-79-08~~ are contained in Table K-1.

Table K-1
Test Methods for State-Regulated LED Lamps and LED State--Regulated Small Diameter Directional Lamps

Measurement	Test Procedure	Required or Optional*
Input power, Lumen output, Lumens per Watt, Correlated Color Temperature, Duv, Color Rendering Index, Power Factor	IES LM-79 (2008) with additional guidance provided in 80 Fed. Reg. 39665-39666 (July 9, 2015), §430.23(dd) and Appendix BB to Subpart B of Part 430.	Required
Lumen Maintenance and Time to Failure	IES LM-84 (2014) and TM-28 (2014) with additional guidance provided in 80 Fed. Reg. 39665-39667 (July 9, 2015), §430.23(dd) and Appendix BB to Subpart B of Part 430.	Required
Standby Power	IEC 62301 (2011) with additional guidance provided in 80 Fed. Reg. 39667 and with the following additional guidance for connected LED lamps: (A) Ensure that the lamp is connected to only one network type and the lamp is in Network Mode (i) If lamp has ability to connect to multiple networks, only one network shall be tested, and the network selected for testing shall be selected using the following prioritization:	Required

	1. Wi-Fi 2. ZigBee 3. ANT 4. Bluetooth 5. RF 6. Wired 7. Other (B) Measure standby power as described in section 5.3.2 of IEC 62301 (2011) for a total period of no less than 60 minutes. (i) Standby power should be measured at a lamp that is a distance of 10 meters (+/- 0.5 meters) from the hub, or wireless controller if no hub exists. If connection is not possible at this distance, conduct testing within 1 meter of the maximum connection distance. (C) To calculate standby power, divide the accumulated energy consumption in watt-hours by the duration of the test in hours. Record this value as the average Network Standby Power. For lamps that are not connected LED lamps, record this value as "not applicable."	
Flicker	Title 24, part 6, Joint Appendix 10 (2015), tested at both 100% and 20% output. Lamps with a percent amplitude modulation (percent flicker) less than 30 percent at frequencies less than 200Hz shall report "yes" for "reduced flicker operation" described in section 1606, otherwise report "no."	Optional
Lumen Maintenance, Rated Life, and Survival Rate for Compliance with Title 24 Joint Appendix 8 and minimum dimming level.	Cal. Code Regs., tit. 24, part 6, Joint Appendix 8.	Optional
Audible Noise	ENERGY STAR Recommended Practice – Noise (2013) with the following modification:	Optional

	measurements shall be taken at 100 percent output as well as at 20 percent output if dimmable.	

* Required test procedures must be conducted per section 1603(a) for each basic model of lamp. Option test procedures are conditionally required depending on manufacturer claims of performance as described in sections 1607(d)(12) and 1606 table X.

Purpose and Rationale: This section identifies the test methods related to LED and small diameter directional lamps that will allow manufacturers to show product compliance. Test methods are standardized industry developed procedures that describe the testing protocol. Many test methods are also utilized by the Department of Energy and are identified in the Code of Federal Regulations.

Necessity: In order to have energy efficiency standards there must be corresponding standardized test methods identified that manufacturers can use to assess product performance. Several of the test methods identified are existing state test methods, such as Joint Appendix 8 and 10, which were adopted as part of the California Building Energy Code. Other test methods are as proposed by the U.S. Department of Energy in its Supplemental Notice of Proposed Rulemaking for Test Procedures for Integrated Light-Emitting Diode Lamps (80 Fed. Reg. 39643 (July 9, 2015). The U.S. Department of Energy test procedures are expected to be finalized and preempt the Energy Commission test methods before the Energy Commission standards go into effect (see 42 U.S.C. § 6297(a); reginfo.gov (U.S. Department of Energy publication of final rule expected in December 2015)), making it important to align with them as early as possible. The U.S. Department of Energy test methods are in turn based on industry-developed test procedures. The ENERGY STAR test method is well understood by industry and achieves the necessary testing for the proposed standards.

The following documents are incorporated by reference in Section 1604.

CALIFORNIA ENERGY COMMISSION TEST METHODS

California Title 24, Part 6, Joint Appendix 8 JA-8 -- 2015	Qualification Requirements for High Efficacy Light Sources
California Title 24, Part 6, Joint Appendix 10 JA-10 -- 2015	Test Method for Measuring Flicker of Lighting Systems and Reporting Requirements

Copies available from:

California Energy Commission
Energy Hotline
1516 Ninth Street, MS-25
Sacramento, California 95814
Phone: (916) 654-5106
FAX: (916) 654-4304

FEDERAL TEST METHODS

ENERGY STAR Recommended Practice – Noise (2013)	EPA ENERGY STAR Program Requirements Product Specification for Lamps (Light Bulbs) Version 1.1 (August 2014)
Copies available from:	US EPA Climate Protection Partnership Energy Star Programs Hotline & Distribution (Ms-6202j) 1200 Pennsylvania Ave NW Washington, DC 20460 WWW.ENERGY.Gov
80 Federal Register 39665-39667 (July 9, 2015)	Energy Conservation Program: Test Procedures for Integrated Light-Emitting Diode Lamps, Proposed Rule
Copies available from:	Office of the Federal Register 800 North Capitol Street, NW Suite 700 Washington, DC 20001 Phone: (202) 741-6000 Fax: (202) 741-6012 www.federalregister.gov

ILLUMINATING ENGINGEERING SOCIETY (IES)

IES LM-84-14	Measuring Luminous Flux and Color Maintenance of LED Lamps, Light Engines, and Luminaries.
TM-28 (2014)	Projecting Long-Term Luminous Flux Maintenance of LED Lamps and Luminaires
IES LM-49 (2011)	Life Testing of General Lighting Incandescent Filament Lamps
Copies available from:	Illuminating Engineering Society 120 Wall Street, 17th Floor New York, NY 10005-4001 www.ies.org Phone: (212) 248-5000 FAX: (212) 248-5017/18

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 62301 (2011) (E)	Household electrical appliances - Measurement of standby power
Copies available from:	IEC Central Office 3, rue de Varembé P.O. Box 131 CH – 1211 GENEVA 20 Switzerland

Purpose and Rationale: This section identifies the sources of selected test methods related to LED and small diameter directional lamps that will allow manufacturers to show product compliance. Test methods are standardized industry developed procedures that describe the testing protocol. Many test methods are also utilized by the U.S. Department of Energy and are identified in the Code of Federal Regulations.

Necessity: In order to have energy efficiency standards there must be corresponding standardized test methods identified that manufacturers can use to assess product performance. Several of the test methods identified are existing state test methods, such as Joint Appendix 8 and 10, which were adopted as part of the California Building Energy Code. Other test methods are as proposed by the U.S. Department of Energy in its Supplemental Notice of Proposed Rulemaking for Test Procedures for Integrated Light-Emitting Diode Lamps (80 Fed. Reg. 39643 (July 9, 2015). The U.S. Department of Energy test procedures are expected to be finalized and preempt the Energy Commission test methods before the Energy Commission standards go into effect (see 42 U.S.C. § 6297(a); reginfo.gov (U.S. Department of Energy publication of final rule expected in December 2015)), making it important to align with them as early as possible. The U.S. Department of Energy test methods are in turn based on industry-developed test procedures. The ENERGY STAR test method is well understood by industry and achieves the necessary testing for the proposed standards.

1605.1 Federal and State Standards for Federally-Regulated Appliances

(k) Lamps

(1) Federally-Regulated General Service Fluorescent Lamps.

(A) General Service Fluorescent Lamps Manufactured Before July 15, 2012. The average lamp efficacy and the color rendering index of federally-regulated general service fluorescent lamps manufactured before July 15, 2012, shall be not less than the applicable values shown in Table K-~~1~~2.

Table K-~~1~~2
Standards for Federally-Regulated General Service Fluorescent Lamps Manufactured Before July 15, 2012

Purpose, Rationale and Necessity: Because a new table K-1 was added, all subsequent K tables need to be renumbered.

(B) General Service Fluorescent Lamps Manufactured On or After July 15, 2012. The correlated color temperature and minimum average lamp efficacy (LPW) of federally-regulated general service fluorescent lamps shall be not less than the applicable values shown in Table K-~~2~~3.

Purpose, Rationale and Necessity: Because a new table K-1 was added, all subsequent K tables need to be renumbered.

Table K-~~2~~3
Standards for Federally-Regulated General Service Fluorescent Lamps Manufactured On or After July 15, 2012

(2) Federally-Regulated Incandescent Reflector Lamps. ~~The average lamp efficacy of federally-regulated incandescent reflector lamps shall not be less than the applicable values shown in Table K-2, subject to the following.~~

Purpose and Rationale: The sentence being removed represents a publishing error which resulted in the duplication of an earlier version of subsection **(A) Incandescent Reflector Lamps Manufactured Before July 15, 2012,** below. Specifically during the last rulemaking updates to federal language, dates were added to the text in subsection (A) along with new table numbers. The old (A) language was then transposed during publication to subsection (2) which should only be a heading now.

Necessity: In order to show the correct language the stricken text needs to be removed otherwise subsection (2) and (2)(A) contain overlapping language.

(A) Incandescent Reflector Lamps Manufactured Before July 15, 2012. The average lamp efficacy of federally-regulated incandescent reflector lamps manufactured on or after November 2, 1995 and manufactured before July 15, 2012 shall be not less than the applicable values shown in Table K-~~3~~4, subject to the following.

(1) The standards specified in Table K-~~3~~4 shall apply with respect to:

a. ER incandescent reflector lamps, BR incandescent reflector lamps, BPAR incandescent reflector lamps, and similar bulb shapes on and after January 1, 2008; and

b. Incandescent reflector lamps with a diameter of more than 2.25 inches, but not more than 2.75 inches, on and after June 15, 2008.

(2) The standards specified in Table K-~~3~~4 shall not apply to the following types of incandescent reflector lamps:

a. Lamps rated at 50 watts or less that are ER30, BR30, BR40, or ER40;

b. Lamps rated at 65 watts that are BR30, BR40, or ER40 lamps; and

c. R20 incandescent reflector lamps rated 45 watts or less.

Purpose, Rationale and Necessity: Because a new table K-1 was added, all subsequent K tables need to be renumbered.

Table K-~~3~~4
Standards for Federally-Regulated Incandescent Reflector Lamps Manufactured Before July 15, 2012

Purpose, Rationale and Necessity: Because a new table K-1 was added, all subsequent K tables need to be renumbered.

(B) Incandescent Reflector Lamps Manufactured on or After July 15, 2012. The average lamp efficacy of federally-regulated incandescent reflector lamps with rated lamp wattage between 40 – 205 watts, and manufactured on or after July 15, 2012, shall be not less than the applicable values shown in Table K-~~4~~5.

Table K-~~4~~5
Standards for Federally-Regulated Incandescent Reflector Lamps Manufactured On or After July 15, 2012

Purpose, Rationale and Necessity: Because a new table K-1 was added, all subsequent K tables need to be renumbered.

(3) Medium Base Compact Fluorescent Lamps. A bare lamp and covered lamp (no reflector) medium base compact fluorescent lamp manufactured on or after January 8, 2007, shall meet the requirements set forth in Table K-~~5~~6.

Table K-~~5~~6
Standards for Medium Base Compact Fluorescent Lamps

Purpose, Rationale and Necessity: Because a new table K-1 was added, all subsequent K tables need to be renumbered.

(4) Federally-Regulated General Service Incandescent Lamps and Modified Spectrum General Service Incandescent Lamps. The energy consumption rate of federally regulated general service incandescent lamps and modified spectrum general service incandescent lamps, manufactured on or after the effective dates shown, shall be no greater than the maximum rated wattage shown in Tables K-~~6~~7 and K-~~7~~8.

Table K-~~6~~7
Standards for Federally-Regulated General Service Incandescent Lamps

Table K-~~7~~8
Standards for Federally-Regulated Modified Spectrum General Service Incandescent Lamps

Purpose, Rationale and Necessity: Because a new table K-1 was added, all subsequent K tables need to be renumbered.

(5) Candelabra Base Incandescent Lamps and Intermediate Base Incandescent Lamps. The energy consumption rate of federally regulated candelabra base incandescent lamps and intermediate base incandescent lamps, manufactured on or after January 1, 2012, shall be no greater than the maximum rated wattage shown in Tables K-~~8~~9.

Table K-~~8~~9
Standards for Federally Regulated Candelabra Base Incandescent Lamps and Intermediate Base Incandescent Lamps

Purpose, Rationale and Necessity: Because a new table K-1 was added, all subsequent K tables need to be renumbered.

1605.3 State Standards for Non-Federally-Regulated Appliances

(k) Lamps

(1) **State-Regulated Incandescent Reflector Lamps.** The average lamp efficacy of state-regulated incandescent reflector lamps manufactured on or after January 1, 2008, shall be not less than the applicable values shown in Table K-~~9~~10.

Table K-~~9~~10
Standards for State-Regulated Incandescent Reflector Lamps

Purpose, Rationale and Necessity: Because a new table K-1 was added, all subsequent K tables need to be renumbered.

(2) Standards for State-Regulated General Service Incandescent Lamps, General Service Lamps, ~~and~~ Modified Spectrum Incandescent Lamps, and State-Regulated LED Lamps. The energy consumption rate of state-regulated general service incandescent lamps, general service lamps, ~~and~~ modified spectrum general service incandescent lamps, and state-regulated LED lamps manufactured on or after the effective dates shown in Tables K-1~~0~~1, K-1~~1~~2, ~~and~~ K-1~~2~~3, and K-14 shall meet the standards shown in these Tables.

Purpose and Rationale: State-regulated LED lamps are being added to the regulations to address coverage of a new product line that have been incorporated into the regulatory language. Setting forth the scope of state covered products helps to ensure regulatory clarity and common understanding of what products are covered by efficiency standards.

Necessity: The clearest means of identifying the new products covered by state efficiency regulations is to identify the product type directly in the regulatory language. The specific discussion regarding the product lines being added is based on the work of expert technical staff in the following report, on pages 46-49: Harinder Singh, Ken Rider, 2015. *Analysis of Small Diameter Directional Lamp and General Service Light-Emitting Diode Lamp Efficiency Opportunities,* California Energy Commission. Publication Number: CEC-400-2015-034

Table K- 1~~0~~1
Standards for State-Regulated General Service Incandescent Lamps - Tier I

Table K- 1~~1~~2
Standards for State-Regulated General Service Lamps -Tier II

Table K- 1~~2~~3
Standards for State-Regulated Modified Spectrum General Service Incandescent Lamps - Tier I

Purpose, Rationale and Necessity: Because a new table K-1 was added, all subsequent K tables need to be renumbered.

(C) State-regulated LED lamps with lumen output of 150 lumens or greater and manufactured on or after January 1, 2017 shall have:

(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.

Purpose and Rationale: The proposed standards represent product characteristics that will ensure the state meets its energy efficiency goals and consumers save money with a product that does not sacrifice quality to meet the efficiency goals.

Necessity: The color point (chromaticity) requirement was determined based on technical input during the rulemaking proceeding from a number of stakeholders on desirable lamp chromaticity, to ensure that two lamps, held side by side, look similar in color. The exact levels are designed to balance cost and benefit of the proposed standard, ensuring that the standard is cost-effective to the consumer while being technologically feasible as required by Public Resources Code section 25402(c)(1). Detailed discussion of the chromaticity requirements (also called "MacAdam steps") can be found in the following report on pages 58-59: Harinder Singh, Ken Rider, 2015. *Analysis of Small Diameter Directional Lamp and General Service Light-Emitting Diode Lamp Efficiency Opportunities,* California Energy Commission. Publication Number: CEC-400-2015-034.

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

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

Purpose and Rationale: The proposed standards represent product characteristics that will ensure the state meets its energy efficiency goals and consumers save money with a product that does not sacrifice quality to meet the efficiency goals.

Necessity: The color rendering requirements (in terms of color rendering index or CRI, and individual color scores) was determined based on technical input during the rulemaking proceeding from a number of stakeholders on the ability of a lamp to light a room with accurate color fidelity. The exact levels for CRI and R1-R8 were chosen to

balance cost and benefit of the proposed standard, to ensure that the standard was still cost-effective to the consumer while being technologically feasible as required by Public Resources Code section 25402(c)(1). Detailed discussion of the color rendering requirements can be found in the following report on pages 57-58: Harinder Singh, Ken Rider, 2015. *Analysis of Small Diameter Directional Lamp and General Service Light-Emitting Diode Lamp Efficiency Opportunities,* California Energy Commission. Publication Number: CEC-400-2015-034.

(iv) A power factor of 0.7 or greater

Purpose and Rationale: The proposed standard represents product characteristics that will ensure the energy efficiency of the product does not come at the cost of impacts to the utility grid that could ultimately raise consumer costs.

Necessity: The power factor requirement was determined based on technical input during the rulemaking proceeding from a number of stakeholders on the need to ensure against harmonics in the grid that can cause power quality to be reduced. A power factor of 1 is ideal, although lesser levels have shown to be acceptable. The exact levels are designed to balance cost and benefit of the proposed standard, ensuring that the standard is cost-effective to the consumer while being technologically feasible as required by Public Resources Code section 25402(c)(1). Detailed discussion of the power factor requirement can be found in the following report on pages 40-41: Harinder Singh, Ken Rider, 2015. *Analysis of Small Diameter Directional Lamp and General Service Light-Emitting Diode Lamp Efficiency Opportunities,* California Energy Commission. Publication Number: CEC-400-2015-034.

(v) A lifetime of 10,000 hours or greater as determined by the lumen maintenance and time to failure test procedure.

Purpose and Rationale: The proposed standard represents product characteristics that will ensure that the energy efficiency standards for the product do not come at the cost of shortened product life, which itself provides consumer benefits through not having to buy as many light bulbs over time, and reducing environmental waste.

Necessity: The lifetime requirement was determined based on technical input during the rulemaking proceeding from a number of stakeholders on the lifetime that LEDs are expected to achieve and the lifetime necessary to ensure that consumers receive a significant payback on their investment in the technology. 10,000 hours, or 10 years, is on the low end of expected lifetime for LEDs, and presents a floor to ensure that manufacturers do not shorten lamp life simply to reduce costs, which would lead to fewer energy savings to consumers. The exact lifetime chosen was designed to balance cost and benefit of the proposed standard, ensuring that the standard is cost-effective to the consumer while being technologically feasible as required by Public Resources Code section 25402(c)(1). Detailed discussion of the lifetime requirement can be found in the

following report on page 67: Harinder Singh, Ken Rider, 2015. *Analysis of Small Diameter Directional Lamp and General Service Light-Emitting Diode Lamp Efficiency Opportunities,* California Energy Commission. Publication Number: CEC-400-2015-034.

(vi) State-regulated LED lamps that have an ANSI standard lamp shape of A shall meet the omnidirectional light distribution requirements of ENERGY STAR's Product Specification for Lamps Version 1.1. State-regulated LED lamps that have an ANSI standard lamp shape of B, BA, C, CA, F, or G shall meet the decorative light distribution requirements of ENERGY STAR's Product Specification for Lamps Version 1.1

Purpose and Rationale: The proposed standard represents product characteristics that will ensure the energy efficiency of the product does not come at the cost of other quality characteristics, such as the light distribution of the lamp.

Necessity: The light distribution requirements were determined based on technical input during the rulemaking proceeding from a number of stakeholders on the desirable light distribution from a lamp. For example, a lamp that looks like a traditional incandescent A-shaped lamp should produce light in all directions like that lamp, and not just in one-direction, as some of the early "snow-cone" LED lamps produced. Reducing the light distribution of the lamp can reduce the lamp cost, but at a cost of quality. The light distribution requirement chosen is based on ENERGY STAR, which is a standard developed with industry input and represents general consensus on feasibility and cost. Detailed discussion of the light distribution requirements can be found in the following report on pages 59 and 65-66: Harinder Singh, Ken Rider, 2015. *Analysis of Small Diameter Directional Lamp and General Service Light-Emitting Diode Lamp Efficiency Opportunities,* California Energy Commission. Publication Number: CEC-400-2015-034.

(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 or less.

Purpose and Rationale: The proposed standard represents the energy efficiency and characteristics that will ensure the state meets its energy efficiency goals and consumers save money.

Necessity: The connected standby requirement has been carefully crafted by expert technical staff working with stakeholders to ensure the most cost effective technically feasible energy savings are met as required by Public Resources Code section 25402(c)(1). Lamps with internet-communication capability consume significant energy, offsetting any benefits from using efficient LED technologies. Detailed discussion of the exact level chosen can be found in the following report on pages 66-67: Harinder Singh, Ken Rider, 2015. *Analysis of Small Diameter Directional Lamp and General Service*

Light-Emitting Diode Lamp Efficiency Opportunities, California Energy Commission. Publication Number: CEC-400-2015-034.

Table K-14
Standards for State-regulated LED Lamps

Effective Date	*Minimum Compliance Score*	*Minimum Efficacy Lumens Per Watt*
January 1, 2017	277	65
January 1, 2019	297	80
The compliance score shall be calculated as the sum of the efficacy and 2.3 times the CRI of a lamp.		

Purpose and Rationale: The proposed standard represents the most cost-effective and technologically feasible energy efficiency levels that state-regulated LED lamps can achieve, ensuring that California saves energy and consumers save money.

Necessity: The specific compliance scores, effective dates, and use of a "tradeoff approach," where high CRI lamps are allowed to be slightly less efficacious, were the result of technical input during the rulemaking proceeding from a number of stakeholders on the highest cost-effective levels of efficiency that could be achieved by this technology. The first effective date is to be one year from the adoption of the proposed standards, the minimum required by Public Resources Code § 25402(c)(1). The second effective date is set based on the timing expected from improvements in energy efficiency and manufacturer cost scaling as a result of the standard. The two tiers of standards are based on the expected improvements in lamp efficiency over that period. Detailed discussion of the tradeoff equation, efficacy levels, and effective dates can be found in the following report on page 57: Harinder Singh, Ken Rider, 2015. *Analysis of Small Diameter Directional Lamp and General Service Light-Emitting Diode Lamp Efficiency Opportunities*, California Energy Commission. Publication Number: CEC-400-2015-034.

(3) State-regulated Small Diameter Directional Lamps. State-regulated small diameter directional lamps manufactured on or after January 1, 2018 must have 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.

Purpose and Rationale: The proposed standards represent the energy efficiency and related product characteristics that will ensure the state meets its energy efficiency goals and consumer save money.

Necessity: This selected language has been carefully crafted by expert technical staff working with stakeholders to ensure the most cost effective technically feasible energy savings are met as required by Public Resources Code section 25402(c)(1). The effective date of January 1, 2018 was chosen to meet the minimum requirement of one-year from adoption under Public Resources Code § 25402(c)(1) and to give additional time for manufacturers to meet the proposed requirements for a smaller market (compared to general service LED lamps, which are rapidly growing in marketshare). The minimum lifetime requirement is designed to ensure that manufacturers do not decrease product lifetime simply to reduce costs, as this would cause consumers to save less money. For this product, 25,000 hours is about average for lifetime. Detailed discussion of the chosen efficiency levels and minimum lifetime requirement can be found in the following report on pages 32-33 and 38-40: Harinder Singh, Ken Rider, 2015. *Analysis of Small Diameter Directional Lamp and General Service Light-Emitting Diode Lamp Efficiency Opportunities,* California Energy Commission. Publication Number: CEC-400-2015-034.

(4) **GU-24 Base Lamps.** GU-24 base lamps shall not be incandescent lamps.

(5) See Section 1605.1(k) for energy efficiency standards for federally-regulated lamps.

(n) Luminaires and Torchieres.

(1) Energy Efficiency Standard for Metal Halide Luminaires. Metal halide luminaires rated at least partially within the range of 150 to 500 watts shall not have probe-start ballasts and shall comply with Section 1605.3(n)(1)(A) as applicable:

(3) **Portable Luminaires.**

(A) Portable luminaires manufactured on or after January 1, 2010 shall meet one or more of the following requirements:

(3) Be an LED luminaire or a portable luminaire with an LED light engine with integral heat sink, and comply with the minimum requirements shown in Table N-~~3~~2;

Table N-2
Minimum Requirements for Portable LED Luminaires and Portable Luminaires with LED Light Engines with Integral Heat Sink

Criteria	Requirement
Light Output	≥ 200 lumens (initial)
Minimum LED Luminaire Efficacy	29 lumens/W
Minimum LED Light Engine Efficacy	40 lumens/W
Color Correlated Temperature (CCT)	2700 K through 5000 K
Minimum Color Rendering Index (CRI)	75
Power Factor (for luminaires labeled or sold for residential use)	≥ 0.70

(4) Be equipped with an E12, E17, or E26 screw-based socket and be prepackaged and sold together with one screw-based compact fluorescent lamp or screw-based LED lamp for each screw-based socket on the portable luminaire. The compact fluorescent or LED lamps which are prepackaged with the portable luminaire shall be fully compatible with the luminaire controls, meaning that portable luminaires having a dimmer control shall be prepackaged with dimmable compact fluorescent or LED lamps, and portable luminaires having 3-way controls shall be prepackaged with 3-way compact fluorescent or LED lamps. The compact fluorescent lamps which are prepackaged with the luminaires shall also meet the minimum energy efficiency levels established by ENERGY STAR® for compact fluorescent lamps in effect on December 31, 2008. The LED lamps required to be packaged with the luminaire shall comply with the minimum requirements ~~shown in Table N-2~~ for state-regulated LED lamps in sections 1601 through 1607 of this article;

Purpose and Rationale: Existing law requires screw-base portable luminaires be packaged together with either an LED or CFL lamp. It also requires LED lamps that are packaged with the portable luminaire meet a minimum set of standards. The proposed regulations also require the same set of screw base lamps meet even higher standards. The proposed changes to the portable luminaire language in 1605.3(n)(3) aligns the requirements of LED lamps to the new proposed performance standards.

Necessity: Because the proposed standards in 1605.3(k) for screw-base LED lamps would require all such lamps sold in the state to meet new requirements that are more stringent than the levels required in 1605.3(n)(3), the change is necessary to avoid conflicting requirements within section 1605.3 and add clarity to the regulations.

The following documents are incorporated by reference in Section 1605.3.

EPA ENERGY STAR Program Requirements Product Specification for Lamps (Light Bulbs) Version 1.1 (August 2014)

Copies available from:

US EPA
Climate Protection Partnership
ENERGY STAR Programs Hotline & Distribution
(MS-6202J)
1200 Pennsylvania Ave NW
Washington, DC 20460
WWW.ENERGYSTAR.GOV

Copies available from:

Superintendent of Documents
U.S. Government Printing Office
Washington, DC 20402
http://ecfr.gpoaccess.gov

Purpose and Rationale: This section incorporates by reference the relevant provisions of the ENERGY STAR specification for light distribution. Including the entire ENERGY STAR light distribution requirements would cause more confusion and could lead to translation errors when the intent is to align with this existing voluntary standard.

Necessity: The U.S. Department of Energy's ENERGY STAR v. 1.1 requirements for light distribution for general service light-emitting diode lamps are based on industry input and represent an accepted level of light distribution for these types of lamps. Detailed discussion of the light distribution requirements can be found in the following report on pages 59 and 65-66: Harinder Singh, Ken Rider, 2015. *Analysis of Small Diameter Directional Lamp and General Service Light-Emitting Diode Lamp Efficiency Opportunities,* California Energy Commission. Publication Number: CEC-400-2015-034.

Section 1606. Filing by Manufacturers; Listing of Appliances in Database.

Table X Continued - Data Submittal Requirements

	Appliance	Required Information	Permissible Answers
	All Appliances	* Manufacturer's Name	
		* Brand Name	
		* Model Number	
		Regulatory Status	Federally-regulated consumer product, federally-regulated commercial and industrial equipment, non-federally-regulated
		…	
K	State-regulated small diameter directional lamps	Base Type	GU 11, GU 5.3, GUX 5.3, GU8, GU 4 and medium screw base
		Lamp Type (examples PAR-16, MR-11, MR-16, or R)	
		Lamp Power (Watts)	
		Lamp Output (Lumens)	
		Beam Angle	
		Center Beam Candle Power (CBCP)	
		Lumens Per Watt	
		Minimum lamp efficacy (LPW)	
		Color Rendering Index (CRI)	
		Combined CRI + Efficacy	
		Correlated Color Temperature	
		Rated Life (hours)	
	State-regulated medium screw base general service ~~Light Emitting Diode (LED) lamps, and~~ Organic LED (OLED) lamps	Rated lumens	
		Rated lamp wattage	
		Average lamp efficacy	
	State-regulated Light Emitting Diode (LED) lamps	Base Type	E12, E17, E26, GU-24, retrofit kit
		Lamp Shape	
		Light Distribution	Directional, Omnidirectional, Decorative, Spot, Recessed Can
		Dimmable	Yes, no
		Minimum dimming level (%)	
		Reduced Flicker Operation	Yes, no
		Correlated Color Temperature	

		Duv	
		Rated Lifetime (hours)	
		Lifetime test environment temperature	Ambient, Elevated
		Lamp Power (Watts)	
		Luminous Flux (Lumens)	
		Efficacy (Lumens per watt)	
		Color Rendering Index (R_a)	
		Compliance Score	
		Power Factor	
		Standby Power (watts)	
		R_1	
		R_2	
		R_3	
		R_4	
		R_5	
		R_6	
		R_7	
		R_8	
		R_9 [2]	
		Meets applicable luminous intensity distribution requirement	ENERGY STAR Omnidirectional, ENERGY STAR Decorative, California Quality Specification Recessed Can Housing Retrofit Kit, California Quality Specification Spotlight, California Quality Specification Floodlight, none.
		Warranty Length (years) [2]	
		Audible Noise at 100% output (decibels)	
		Audible Noise at 20% output (decibels)	
		Start Time [2]	
		6000 hour lumen maintenance [2]	
		6000 hour survival rate [2]	
		Projected time to L70?[2]	
		Dimming Control Compatibility	Forward, Phase cut control, reverse phase cut, powerline carrier, digital, 0-10 VDC, other.
		NEMA SSL 7A Compatible? [2] (If compatible with forward phase cut dimmer control answer "Yes," If not answer "No.")	Yes, no
		Marked in accordance with Title 24 JA-8 [2]	Yes, no
		Meets the Voluntary California Quality Specification 2.0 requirements applicable to the lamp type	Yes, no

* "Identifier" information as described in Section 1602(a).

1 = Voluntary for federally-regulated appliances

2 = Voluntary for state-regulated appliances

The following documents are incorporated by reference into section 1606.

CALIFORNIA ENERGY COMMISSION

California Energy Commission Voluntary California Quality Light-Emitting Diode (LED) Lamp Specification (December 2014)

California Title 24, Part 6, Joint Appendix 8 JA-8 -- 2015	Qualification Requirements for High Efficacy Light Sources
Copies available from:	California Energy Commission Energy Hotline 1516 Ninth Street, MS-25 Sacramento, California 95814 Phone: (916) 654-5106 FAX: (916) 654-4304

NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION (NEMA)

NEMA SSL 7A (2013)	Qualification Requirements for High Efficacy Light Sources
Copies available from:	National Electric Manufacturers Association 1300 N. 17th Street, Suite 1847 Rosslyn, VA 22209 www.nema.org Phone: (703) 841-3200 Fax: (703) 841-3300

Purpose and Rationale: This regulatory language identifies the data required for the Commission to be able to verify the LED and small diameter directional lamps meet the new standards. Without the data Commission staff would not be able to determine if a product meets the standards and therefore if the product can be listed in the Commission's database as an item which can be sold or offered for sale in the state.

Necessity: All product certifications require data submissions. As new products become regulated data is necessary to evidence compliance with efficiency standards to ensure the state goals of energy efficiency and consumer savings are being met. Each of the data submittal requirements were determined based on the need for the information to confirm that the product meets the efficiency standard, and on the need to provide

information to consumers and researchers about the desirable characteristics provided by the product.

Under current law, manufacturers who wish to certify that their lamps meet the Voluntary California Quality Light-Emitting Diode (LED) Lamp Specification are unable to do so, because no data collection mechanism exists. Similarly, there is no system in place yet to certify lamps as meeting the Title 24, Joint Appendix 8 requirements that will allow them to qualify as "high efficacy" lighting for new residential construction. Some of the data fields identified above are therefore to provide a single database where manufacturers can certify that they meet either or both of these requirements, on a voluntary basis.

1607 Marking of Lamps.

(d) Energy Performance Information

(12) State regulated LED lamps shall meet the criteria below before making any of the relevant claims in marketing materials, including retail packaging or on the lamp itself.

(A) The following shall be demonstrated before making a claim of being "dimmable."

(i) The lamp shall be dimmable to 10 percent of its full light output.

(ii) The lamp shall be reduced flicker operation;

(iii) Shall not produce noise in excess of 24 A-weighted decibels at 100 percent and 20 percent of full light output.

(iv) If the product cannot be reduced flicker operation using a standard phase-cut dimmer, but can be reduced flicker operation using another type of dimmer, references to dimmability shall be qualified with the phrase "dimmable with LED dimmer." These lamps shall include instructions on or inside the retail packaging that describe, or contain an internet link to a description of, the type of dimmers that are compatible or recommended for use with the lamp.

Purpose and Rationale: This section identifies basic labeling requirements that will ensure product performance matches manufacturer claims and reduce consumer confusion. The language covers labeling for LED lamps the manufacturer claims to be dimmable.

Necessity: In order to reduce consumer confusion and to ensure labeled claims meet performance expectations, the labeling standards are necessary. The requirements for manufacturers who wish to label their lamps as "dimmable" have been carefully crafted by expert technical staff working with stakeholders to ensure that a "dimmable" lamp meets consumer expectations. These levels are consistent with similar discussion that has happened with staff working on the recently adopted lighting requirements for the 2016 California Building Energy Code (Joint Appendix 8). Detailed discussion on dimmability labeling and the levels selected can be found in the following staff report on pages 60-61: Harinder Singh, Ken Rider, 2015. *Analysis of Small Diameter Directional Lamp and General Service Light-Emitting Diode Lamp Efficiency Opportunities,* California Energy Commission. Publication Number: CEC-400-2015-034.

(B) State regulated LED lamps shall meet all of the following requirements before including comparisons to incandescent lamps, including wattage equivalencies:

(i) The lamp shall have a color correlated temperature of 3000k or less.

(ii) The lamp shall be "dimmable" as described in 1607(d)(12)(A).

(iii) The lamp shall have a lumen output of 310 lumens or greater for medium-screw base lamps or 150 lumens or greater for intermediate and candelabra bases.

(iv) Claims of incandescent wattage equivalence shall have lumen outputs in the respective ranges contained in Table K-15.

Table K-15
Incandescent Equivalences for State-regulated LED Lamps

Incandescent equivalence	Lumen minimum
Medium screw-base and GU-24 base omnidirectional lamps	
40 W	310
60 W	750
75 W	1050
100 W	1490
150 W	2500

Purpose and Rationale: This section identifies basic labeling requirements that will ensure product performance matches manufacturer claims and reduce consumer confusion. The language covers LED lamps the manufacturer claims to be equivalent to an incandescent lamp.

Necessity: In order to reduce consumer confusion and to ensure labeled claims meet performance expectations, the labeling standards are necessary. The requirements for manufacturers who wish to label their lamps as equivalent to an incandescent lamp have been carefully crafted by expert technical staff working with stakeholders to ensure that a lamp that claims to be just like an incandescent lamp meets consumer expectations in that it is dimmable, not unusually dim, has a certain color temperature associated with incandescent lamps, and has the same brightness as an incandescent lamp of a certain wattage. Detailed discussion on dimmability labeling and the levels selected can be found in the following staff report, on pages 60-61: Harinder Singh, Ken Rider, 2015. *Analysis of Small Diameter Directional Lamp and General Service Light-Emitting Diode Lamp Efficiency Opportunities,* California Energy Commission. Publication Number: CEC-400-2015-034.

(C) A lamp that is certified with a light output of less than 150 lumens for candelabra bases, or less than 200 lumens for other bases, shall be labeled as "for decorative purposes."

Purpose and Rationale: This section identifies basic labeling requirements that will ensure product performance matches manufacturer claims and reduce consumer

confusion. The language ensures that lamps that are very dim (less than 150 lumens) are labeled as "for decorative purposes."

Necessity: In order to reduce consumer confusion and to ensure labeled claims meet performance expectations, the labeling standards are necessary. The requirement for manufacturers who produce very dim lamps (under 150 lumens) was developed by expert technical staff working with stakeholders to ensure that the lamp meets consumer expectations. Detailed discussion on labeling can be found in the following staff report, on pages 60-61: Harinder Singh, Ken Rider, 2015. *Analysis of Small Diameter Directional Lamp and General Service Light-Emitting Diode Lamp Efficiency Opportunities,* California Energy Commission. Publication Number: CEC-400-2015-034.

(D) Lamps shall certify that each and every portion of the California Quality LED Lamp Specification is met before making any marketing, label, or mark regarding a model's qualification for the specification.

Purpose and Rationale: This section identifies basic labeling requirements that will ensure product performance matches manufacturer claims and reduce consumer confusion. The language covers labeling for LED lamps the manufacturer claims to meet the California Quality LED Lamp performance metrics.

Necessity: In order to reduce consumer confusion and to ensure labeled claims meet performance expectations, the labeling standards are necessary. This selected labeling language will ensure that lamps that claim to meet the California Quality LED Lamp Specification actually do meet the specification, by appearing in the Energy Commission's database through certification. This will in turn provide a list of certified products that utilities can consider for rebates in their own programs, and prevents lamps that do not meet the California Quality LED Lamp Specification from receiving the benefit of rebates while not providing the necessary quality and efficiency benefits to consumers.