

FACT SHEET



CALIFORNIA ENERGY COMMISSION

Residential Lighting – JA8 Compliance For Test Laboratories 2016 Building Energy Efficiency Standards

What is the scope of the 2016 Joint Appendix JA8?

The 2016 Building Energy Efficiency Standards' (Energy Standards) Joint Appendix JA8 was updated to make it technology neutral with regard to light sources. Previously, this appendix was only applicable to LED luminaires. The changes allow for both lamps and luminaires to be considered "high efficacy" under the Energy Standards regardless of the lighting technology employed.

How does this affect testing under JA8?

JA8 now specifies a test for efficacy and color characteristics that is specific to each lighting technology. The test for LEDs remains Illuminating Engineering Society (IES) LM-79, and the tests for other lighting technologies are the applicable IES test procedures or the applicable federal test (per JA8.3.1 and JA8.3.4).

JA8 also specifies tests for start time, power factor, lumen maintenance and survival rate, audible noise, and flicker, which are the same for all light sources.

When should I test the luminaire, and when should I test the lamp or light engine?

If the light source can be easily separated from the luminaire by the end user, such as a removable screw-base or pin-base lamp, or a detachable LED light engine, then the light source must be tested separately from the luminaire.

If the light source is inseparable from the luminaire, then the entire luminaire must be tested. Inseparable means that the light source cannot be easily removed or replaced by the end user. This includes cases where wiring would need to be cut or reattached, where solder would need to be removed or reapplied, or where attempting to remove the light source could potentially damage the luminaire.

How do I determine how many models to test?

Manufacturers must test each "basic model" of the products they intend to certify. Both state and federal appliance efficiency laws use a definition of "basic model" to determine when separate testing is needed. The Energy Standards defer to these definitions to be consistent with federal law and with its references to the Title 20 Appliance Efficiency Regulations. The definition of "basic model" in Title 20 reads as follows:

“Basic model” of a federally-regulated consumer product means “basic model” as defined in 10 C.F.R. section 430.2. “Basic model” of any other appliance means all units of a given type of appliance (or class thereof) that are manufactured by one manufacturer, that have the same primary energy source, and that do not have any differing electrical, hydraulic, physical, or functional characteristics that affect energy consumption.

The following guidance regarding color temperature and color rendering also applies to lighting, and may reduce the number of models required to be tested:

- **Correlated Color Temperature**

Testing at the lowest or least efficient correlated color temperature (CCT) is acceptable for compliance with JA8, provided that the change is only due to a variation in phosphor. While a change in phosphor can affect the lumens-per-watt efficacy of a light source, this effect is small, predictable, and has consistently decreased as lighting technology has improved. Manufacturers are advised to test the warmest or otherwise worst performing CCT within a model family. This is consistent with ENERGY STAR® guidelines and ensures that off-the-shelf testing of models perform equal to or better than their certified values.

- **Color Rendering Index**

Testing at the highest color rendering index (CRI) is acceptable for compliance with JA8. JA8 requires that light sources possess a CRI of 90 or above and an R9 of 50 or above. While CRI is expressly noted in the federal basic model definition, the limited range of allowed performance will generally mean that only one model from a model family or group will perform in this range, and any solely CRI-based differences between models within this range are expected to have a negligible impact on efficiency. Manufacturers are therefore advised to test the highest CRI model within a model family. This ensures that off-the-shelf testing of models perform equal to or better than their certified values.

Can I use the ENERGY STAR [Family Groupings](#) (for luminaires) or [Allowable Variations](#) (for lamps) to determine which models to test?

Yes. The ENERGY STAR guidance lists specific elements of a lamp or luminaire that can be changed without affecting the performance of the unit. Following the ENERGY STAR guidance will result in selection of the same models as following the “basic model” definition in all but a few rare cases. Thus, laboratories are advised that they may follow this guidance, but should also keep in mind the “basic model” definitions in case of a conflict.

My client’s products include several inseparable luminaires that make use of a common, dedicated LED array for their light output. Does JA8.1 mean that each luminaire needs to be separately tested, even though they use the same array?

No. If each luminaire is designed to use the same dedicated light engine or array, and to provide the same physical and thermal conditions necessary for the performance of its engine or array, then the luminaires would not have differing characteristics that affect its performance (regardless of differences in shape or aesthetics) and only one “basic model” would need to be tested. A model with a different size or number of arrays would need a separate test, as this would affect its energy consumption.

If a light source is tested with a third-party driver, and a customer requests an equivalent, alternative driver, can the same test results apply without a complete re-test?

Yes. The test results can continue to apply provided that the rated performance of the alternate driver is at least as good as the tested driver. This ensures that off-the-shelf testing of models perform equal to or better than its certified values.

Is a sample group needed for the start time, flicker, and audible noise tests?

No. The sample size requirement in JA8.3 applies to the tests that rely on a sample group. The tests for start time, flicker, and audible noise are tests performed on a single unit, not on a sample group, and repeat performance of these tests is not required.

Does the Power Factor test need to be conducted at the highest wattage?

Yes. The power factor test must be conducted “at full light output,” which means the model will be operating at its highest wattage.

If a product uses a universal driver, do I need to conduct the Power Factor test at multiple voltages?

No. A universal driver is a driver with one large voltage range, not a driver with multiple separate ranges. The additional testing required by ANSI C82.77 2002 Section 6 only applies when a product has multiple (i.e., more than one) voltage ranges.

Where can I find more information?

The 2016 Building Energy Efficiency Standards and Reference Appendices can be downloaded at <http://www.energy.ca.gov/title24/2016standards/>. Copies of JA8 and JA10 are included with this fact sheet.

Certification of product data will be to the Modernized Appliance Efficiency Database System (MAEDBS database), the same system used for certifying regulated appliances under Title 20. Certification will be available for JA8 2016 in early October, 2016, and more information will be available at <http://www.energy.ca.gov/appliances/forms/>.

Who can I contact if I have any questions?

For assistance with the *2016 Building Energy Efficiency Standards*, contact the Energy Standards Hotline at (800) 772-3300 (toll free in California), (916) 654-5106 (outside California), or via email at title24@energy.ca.gov.

For assistance with the appliances certification process and the MAEDBS database, contact the Appliance Efficiency Hotline at (888) 838-1467 (toll free in California), (916) 651-7100 (outside California), or via email at appliances@energy.ca.gov.

Joint Appendix JA8

Appendix JA8 – Qualification Requirements for High Efficacy Light Sources

JA8.1 Purpose and Scope

Joint Appendix JA8 provides the qualification requirements for high efficacy light sources installed to comply with Section 150.0(k). For the purposes of this Section, high efficacy light sources include ballasts or drivers if needed for operation of the light source: light sources shall be certified together with a driver or ballast. If the light source is inseparable from the luminaire the entire luminaire shall meet the requirements of this section. All qualifying light sources shall be certified to the Energy Commission according to all of the requirements in this Appendix.

JA8.2 Certification of Test Labs

The light source under test shall be tested at a testing laboratory participating in the ISO/IEC 17025, by the National Voluntary Laboratory Accreditation Program (NVLAP) or other laboratory accreditation body operating in accordance with ISO/IEC 17011 and produced under an ongoing inspection program carried out by a Type A inspection body in accordance with ISO/IEC 17020.

JA 8.3 Tests to be performed

Compliance with the requirements of this Appendix shall be determined by performance of the following test procedures, as applicable to the type of light source.

Sample size for lamps with ANSI standard bases and that are not recessed downlight retrofits, shall be 10 units per model: 5 units tested base-up and 5 units tested base-down unless the manufacturer restricts specific use or position. If position is restricted, all units shall be tested in restricted position. Test units, including low voltage lamps, shall be operated at rated voltage.

Sample size for all other sources shall be 3 units, tested in accordance with manufacturer's installation instructions for intended orientation.

JA 8.3.1 Efficacy Test

Efficacy at full light output shall be determined by the following test procedures, as applicable to the type of light source:

- a) For incandescent and incandescent reflector lamps: 10CFR 430.23(r).
- b) For medium base compact fluorescent lamps: 10CFR 430.23(w).
- c) For general service fluorescent lamps: 10CFR 430.23(r).
- d) For fluorescent lamps that are not Medium base compact fluorescent lamps and general service fluorescent lamps: IES LM-9.
- e) For LED light sources, IES LM-79.
- f) For high intensity discharge lamps, IES LM-51.
- g) For induction lamps, IES LM-66.

The reported value shall be the minimum efficacy of the tested units and be rounded to the nearest tenth.

JA 8.3.2 Power Factor Test

Power factor shall be measured at full light output in accordance with ANSI C82.77, Section 6 and 7.

For lamps, the reported value shall be the average measured values of the tested units rounded to be the nearest tenth.

For all other sources, the reported value shall be the minimum power factor of the tested units rounded to the nearest tenth.

JA 8.3.3 Start Time Test

Start time shall be measured in accordance with the ENERGY STAR Program Requirements Product Specifications for Lamps 1.1: Start Time Test Method, notwithstanding the scope of the test.

For lamps the reported value shall be the average start time of the tested units rounded to the nearest millisecond.

For all other sources the reported value shall be the maximum start time of the tested units rounded to the nearest millisecond.

JA 8.3.4 Color Characteristics Tests

Correlated Color Temperature (CCT), Duv, and Color Rendering Index shall be determined by the following test procedures, as applicable to the type of light source:

- a) Incandescent and halogen reflector lamps: IES LM-20.
- b) Incandescent non-reflector lamps: IES LM-45.
- c) General service fluorescent lamps: 10CFR 430.23(r).
- d) Single ended compact fluorescent lamps: IES LM-66.
- e) Fluorescent lamps that are not single ended compact fluorescent lamps or general service fluorescent lamps: IES LM-9.
- f) Induction lamps: IES LM-66.
- g) LED light sources: IES LM 79.
- h) High intensity discharge lamps: IES LM-51.
- i) Other applicable test procedure approved by the Executive Director

Correlated Color Temperature (CCT) and Duv shall be calculated in accordance with CIE 15 (reference document ANSI C78.377). Color Rendering Index (CRI) shall be calculated in accordance with CIE 13.3.

The reported value shall be the average measured values of units tested rounded to be the nearest whole number for CCT and CRI and to 4 decimal places (closest ten thousandth) for Duv.

JA8.3.5 Ambient Temperature Life Test

The following light sources shall be tested in accordance with the ENERGY STAR Product Specification for Lamps Version 1.1: Ambient Temperature Life Testing, in an ambient temperature condition between 20°C and 35°C and satisfy the lumen maintenance and 6,000 hour survival rate criteria:

- a) Omnidirectional lamps < 10 watts, and decorative lamps for which the manufacturer has not performed an elevated temperature life test to show compliance with lumen maintenance requirements in this specification;
- b) Omnidirectional lamps labeled “not for use in enclosed fixtures” on the lamp ;
- c) LED light engines and lamps labeled “not for use in recessed fixtures” on the product ; and
- d) Inseparable SSL luminaire: Alternatively inseparable SSL luminaires may reference the in-situ measurement temperature of the LED, IES LM80 test results and TM21 projections for the light source used in the luminaire.

For lamps the reported value shall be the 9th highest measured lumen maintenance value measured (9 out of 10 units must pass life testing).

For all other sources (except those using the IES-LM80 test method and the IES-TM21 calculation method for projecting lumen maintenance) the reported value shall be the minimum measured lumen maintenance value of the 3 samples.

Inseparable SSL luminaires designed to be recessed, shall be ICAT (insulation contact air tight) rated in accordance with Section 150.0(k)1C and tested with sides and top of luminaire in direct contact of least 12" of R-38 fiberglass insulation.

For inseparable SSL luminaires referencing the in-situ measurement temperature of the LED, IES -LM80 test results and projecting lumen maintenance using the IES-TM21 calculation method for the light source used in the luminaire, ten samples for each T_s and drive current combination (refer to IES TM-21, section 4.2) must be tested. Each sample set may be composed entirely of one nominal CCT, or may be split between no more than two adjacent nominal CCT values as outlined in ANSI C78.377 (e.g. 2700 and 3000K). Passing Test: all of the conditions below shall be met.

1. In the sample luminaire, the in situ TMP_{LED} temperature is less than or equal to the temperature specified in the LM-80 test report for the corresponding or higher drive current, within the manufacturer's specified operating current range.
2. The drive current measured in the luminaire is less than or equal to the drive current specified in the LM-80 test report at the corresponding temperature or higher.
3. The TM-21 lumen maintenance life projection report projects an L70 meeting or exceeding requirements.

JA8.3.6 Elevated Temperature Life Test

The following light sources shall be tested in accordance with the ENERGY STAR Product Specification for Lamps Version 1.1: Elevated Temperature Life Testing.

- a) Omnidirectional lamps ≥ 10 Watts that are not labeled "not for use in enclosed fixtures" or "not for use in recessed fixtures"; and
- b) All other light sources that are not inseparable SSL luminaires, and that are not labeled "not for use in enclosed fixtures" or "not for use in recessed fixtures."

The Option A test method ENERGY STAR Elevated Temperature Life Test shall be modified as follows: Light source shall be tested in an ICAT (insulation contact, air-tight) recessed luminaire of the appropriate size for the source under test. The ICAT luminaire shall be listed for zero clearance insulation contact (IC) by Underwriters Laboratories or other nationally recognized testing/rating laboratory and have a label that certifies that the luminaire is airtight with air leakage less than 2.0 CFM at 75 Pascals when tested in accordance with ASTM E283. The sides and top of ICAT recessed luminaire shall be in direct contact of least 12" of R-38 fiberglass insulation.

Light sources tested in accordance with the ENERGY STAR Elevated Temperature Life Test, notwithstanding scope, shall use the modified Option A test method as described above or Option B or C with an operating temperature of:

45degC +/-5degC for omnidirectional sources between 10 and 20 Watts;

45degC +/-5degC for all sources other than omnidirectional not greater than 20 Watts;

55degC +/-5degC for all sources greater than 20 Watts.

If units are tested both base-up and base-down, the average of surviving unit measured values shall be calculated for each orientation and the reported lumen maintenance shall be the lesser of the two averages rounded to the nearest tenth of a percent if the difference between the averages is greater than 3%; if less than 3% difference, then the reported lumen maintenance shall be the average of all surviving units rounded to the nearest tenth percent. If units are tested in one orientation, the reported lumen maintenance value shall be the average of surviving unit measured values rounded to the nearest tenth percent.

For all other sources the reported value shall be the minimum measured lumen maintenance value of the three samples.

JA 8.3.7 Tests for Minimum Dimming Level, Flicker, and Audible Noise

The flicker test is performed for light sources as specified in Joint Appendix JA10 and the audible noise test as specified in the ENERGY STAR Program Requirements Product Specification for Lamps Version 1.1: Noise Recommended Practices, notwithstanding scope.

Minimum dimming level is measured by comparing the stabilized light output of the light source with the dimming control set to full light output with the dimming control being set to the manufacturer's minimum rated output. Full light output and minimum light output is measured after the light output has stabilized according to the test procedures specific to light source type in Section JA 8.3.1.

In addition to the reporting of flicker results as described in Section JA8.6, flicker test data for each combination of light source, ballast or driver (if applicable), transformer type and dimmer type claiming compliance with JA8 shall be submitted to the California Energy Commission in the format as defined in Joint Appendix JA10.

Testing for minimum dimming level, flicker, and audible noise is required for each combination of light source, ballast or driver (if applicable), transformer type and dimmer type as follows:

1. Low voltage light sources shall be tested with a representative transformer for each transformer type that the light source is claiming compatibility.
2. Light sources claimed as compatible with forward phase-cut dimmers shall be tested in combination with a NEMA SSL 7A compliant dimmer.
3. Light sources claimed as compatible with dimmers other than forward phase-cut dimmers, dimmability, low noise and low flicker operation shall be tested for each ballast or driver combination (if applicable) with at least one representative dimmer for each dimmer type for which compatibility is claimed.

JA 8.4 Qualification Requirements

The following qualification requirements must be met for the light source to be considered High Efficacy as specified in Section 150(k) and Table 150.0-A.

JA8.4.1 Luminous Efficacy

The light source shall meet the following requirements when measured in accordance with the test method of Section JA8.3.1:

The luminous efficacy of the light source shall be equal to or greater than 45 lumens/Watt when tested at its full light output.

JA8.4.2 Power Factor

The light source shall meet the following requirements when measured in accordance with the test method of Section JA8.3.2:

The light source shall have a power factor equal to or greater than 0.90 when tested at its full light output.

JA8.4.3 Start Time

The light source shall meet the following requirements when measured in accordance with the test method of Section JA8.3.3:

The light source shall have a start time no greater than 0.5 seconds.

JA8.4.4 Color Characteristics

The light source shall meet the following CCT, Duv, and color rendering requirements when measured in accordance with the test method of Section JA8.3.4:

- (a) Inseparable SSL luminaires, LED light engines, and GU24-based LED lamps shall be capable of providing a nominal Correlated Color Temperature (CCT) that is 4000 Kelvin or less and within 0.0033 Duv of the black body locus in the 1976 CIE color space.
- (b) All other light sources shall be capable of providing a nominal Correlated Color Temperature (CCT) that is 3000 Kelvin or less and within 0.0033 Duv of the black body locus in the 1976 CIE color space.
- (c) All light sources shall provide a Color Rendering Index (CRI) of 90 or higher and color rendering R9 value of 50 or higher when measured at a correlated color temperature and Duv value that comply with Section JA8.4.4.

JA8.4.5 Lumen Maintenance, Rated Life and Survival Rate

The light source shall meet the lumen maintenance, rated life, and survival rate criteria when measured in accordance with the test method of Section JA8.3.5 and JA8.3.6.

- (a) Lumen Maintenance: The percentage of initial light output after the 6,000 hour test must be equal to or greater than 86.7 percent. For inseparable SSL luminaires referencing the in-situ measurement temperature of the LED, complying products shall have IES LM-80 test results that produce an IES TM-21 projected L70 of at least 25,000 hours.
- (b) Rated Life: The light source shall have a minimum rated lifetime of 15,000 hours.
- (c) Survival Rate: 90 percent of tested units shall be operational at the completion of the 6,000 hour life test.
Exception to Section JA8.4.6(c): Inseparable SSL luminaires referencing the in-situ measurement temperature of the LED.

JA8.4.6 Dimming, Reduced Flicker Operation and Audible Noise

The light source shall meet the following dimming, reduced flicker operation, and audible noise requirements when measured in accordance with the test method of Section JA8.3.7:

- (a) The light source shall be dimmable down to 10 percent light output where 100 percent full light output is defined as operating the light source at the maximum setting provided by the control.
- (b) LED-based light sources shall meet the requirements of NEMA standard SSL 7A as Type 1 or Type 2 products.

EXCEPTION to JA8.4.6(b): LED based light sources designed to be dimmed by controls other than forward phase cut dimmers.

(c) Light source in combination with specified control shall provide "reduced flicker operation" when tested at 100 percent and 20 percent of full light output, where reduced flicker operation is defined as having percent amplitude modulation (percent flicker) less than 30 percent at frequencies less than 200Hz, tested according to the requirements in Joint Appendix JA-10.

(d) Light source shall not emit audible noise above 24dBA measured at 1 meter from the light source when tested at 100 percent and 20 percent of full light output.

JA8.5 Marking

Light sources meeting the requirements of this Appendix shall be marked with "JA8-2016" to indicate their compliance with the criteria of this Appendix. Light sources that have passed the Elevated Temperature Life Test shall instead be marked with "JA8-2016-E", to indicate that they comply with this Appendix and may additionally be installed in elevated temperature applications such as enclosed fixtures. Light sources that do not comply with this Appendix shall not be marked with "JA8-2016" or "JA8-2016-E".

JA8.6 Data Reporting

The following test data shall be submitted to the California Energy Commission in the format specified in Table JA-8. The entity submitting the filing shall keep all test data and documentation required for compliance for at least two years from the date of certification and shall provide copies of this documentation to the Energy Commission within 10 days of written request received from the Energy Commission.

TABLE JA-8. DATA TO BE RECORDED AND SUBMITTED TO THE CALIFORNIA ENERGY COMMISSION

Required Information	Permissible Answers	Compliance Threshold
Manufacturer, Model number, Description		
Light Source Type	LED, OLED, Fluorescent, HID, Incandescent, Other	
Product type	Omnidirectional lamp, Directional lamp, Decorative lamp, LED light engine, inseparable SSL luminaire, other	
Lab accredited by NVLAP or accreditation body operating in accordance with ISO/IEC 17011?	Yes/No	Yes
Initial Efficacy	Value (lumens/Watt)	≥ 45 lumens/Watt
Power Factor at Full Rated Power	0 – 1 Fraction	≥ 0.90
Start time	Value (seconds)	≤ 0.5 sec
Correlated Color Temperature (CCT)	Number Kelvin	For inseparable SSL luminaires, LED light engines and GU24 LED lamps, ≤ 4000 Kelvin. For all other sources, ≤ 3000 Kelvin.
Duv	Number Duv	≥ -0.0033 and $\leq +0.0033$
Color Rendering Index (CRI)	0-100	≥ 90
Color Rendering R9 (red)	0-100 or below 0	≥ 50
Ambient or elevated temperature test for rated life, lumen maintenance, and survival rate	Ambient or Elevated	“Ambient” allowed only for omnidirectional lamps <10W, and decorative lamps, or labeled “not for use in enclosed fixtures”, lamps and light engines that are labeled “not for use in recessed fixtures” and “inseparable SSL

Required Information	Permissible Answers	Compliance Threshold
		luminaires". All others must report "Elevated".
6,000 hour lumen maintenance	Value (percent), N/A	≥ 86.7% or NA for integral luminaires providing TM-21 L70 projections based on light source LM80 data
LM-80 and TM-21 Projected Time to L70	Value (hours), N/A	≥ 25,000 hours, or N/A for light sources providing 6,000 hour lumen maintenance testing
Rated life	Value (hours)	≥ 15,000 hours
6,000 hour survival rate	Value (percent)	≥ 90% or NA for integral luminaires whose lumen maintenance/rated life is evaluated using light source LM-80 data.
Minimum dimming level	Value (percent)	≤ 10%
Dimming control compatibility	Forward Phase cut control, reverse phase cut, powerline carrier, digital, 0-10 VDC, other.	At least one type must be listed
NEMA SSL 7A compatible?	Yes/No	If compatible with forward phase cut dimmer control, "Yes". If not, "No".
Flicker:		
See JA10 Table 10-1 for flicker data requirements and permissible answers		<30% for frequencies of 200 Hz or below, at 100% and 20% light output
Audible Noise		
100% light output: Audible Noise	Value (dBA)	≤ 24 dBA
20% light output: Audible Noise	Value (dBA)	≤ 24 dBA
Marking		
Marked in accordance with JA8.5	Yes/No	Yes. "No" allowed only for lamps and LED light engines with diameter less than 1.0" and decorative lamps with a diameter less than 2.0"

Joint Appendix JA10

Appendix JA10 – Test Method for Measuring Flicker of Lighting Systems and Reporting Requirements

JA10.1 Introduction

This test method quantifies flicker from lighting systems which may include all of the following components: lamps, light sources, transformers, ballasts or drivers, and dimming controls. This test method measures the fluctuation of light from lighting systems and processes this signal to quantify flicker as a percent amplitude modulation (percent flicker) below a given cut-off frequency. Signal processing is used to remove high frequency components above the cut off-frequency.

JA10.2 Equipment Combinations

The test results measured using this method are specific to each combination of:

- Light source and a representative dimmer; or
- Low voltage lamp together with a representative transformer and a representative dimmer (if applicable); or
- Light source and a representative dimming control (if applicable); or
- Light source together with a representative driver, and a representative dimming control (if applicable); or
- Light source together with a representative ballast, and a representative dimming control (if applicable).

If the control or transformer requires a greater load than what is provided by a single sample of the unit under test, additional load will be created by adding quantities of the identical light source, and ballast or driver if applicable on the same circuit receiving the control signal.

Flicker measurements of a phase cut dimmer controlling an incandescent line voltage lamp shall be considered representative for that dimmer with any line voltage incandescent lamp.

Flicker measurements of a phase cut dimmer controlling a transformer for low voltage incandescent lamps shall be representative only for that combination of dimmer and transformer with any incandescent lamp.

Flicker measurements of all non-incandescent lamp sources controlled by a phase cut dimmer represents only the specific combination of phase cut dimmer, ballast or driver, and lamp. These results cannot be applied to other combinations of dimmer, ballast, driver or lamp.

Flicker measurements of light sources controlled by 0-10 volt control, digital control, wireless control or powerline carrier control, the flicker measurement is specific to that combination of control type and ballast or driver and lamp. Test results of the lamp and ballast or driver combination can be applied to other systems that have another control of the same type (0-10 volt, digital, etc.) providing the control signal.

JA10.3 Test Equipment Requirements

Test Enclosure: The test enclosure does not admit stray light to ensure the light measured comes only from the UUT (unit under test). Provision shall be made so the test enclosure is able to maintain a constant temperature of 25°C ±5°C.

Device for data collection: Light output waveform shall be measured with a photodetector with a rise time of 10 microseconds or less, transimpedance amplifier and oscilloscope. An alternate measurement system providing the same accuracy and function as the specified equipment may be used.

Temporal response, amplification and filtering characteristics of the system shall be designed to capture the photometric data at intervals of 50 microseconds or less, corresponding to a data recording rate of no less than 20 kHz, and shall be capable of capturing at least 1 second of data.

JA 10.4 Flicker Test Conditions

Product wiring setup: Fluorescent ballasts shall be wired in accordance to the guidelines provided in the DOE ballast luminous efficiency test procedure in 10 CFR 430.23(q).

Product pre-conditioning: All fluorescent lamps shall be seasoned (operated at full light output) at least 100 hours before initiation of the test. Seasoning of other lamp types is not required.

Input power: Input power to UUT (unit under test), shall be provided at the rated primary voltage and frequency within 0.5 percent for both voltage and frequency. When ballasts are labeled for a range of primary voltages, the ballasts should be operated at the primary application voltage. The voltage shall have a sinusoidal wave shape and have a voltage total harmonic distortion (THD) of no greater than 3 percent.

Temperature: Temperature shall be maintained at a constant temperature of 25°C ±5°C.

Dimming levels: Measurements shall be taken within 2 percent of the following increments of full light output: 100 percent, 20 percent, and minimum dimming level where 100 percent full light output is defined as operating the light source at the maximum setting provided by the control. When the minimum light output of the systems is greater than 20 percent of full light output, then the flicker measurements are taken at the minimum light output. For dimming fluorescent ballasts, lamp arc power may be used as a proxy for light output for the purpose of setting dimming levels for collecting test measurements.

JA10.5 Test Procedure

Lamp stabilization: Lamp stabilization shall be determined in accordance with:

IES-LM9 for circleline, and U-tube fluorescent systems;

Code of Federal Regulations - 10 CFR 430.23(q) for linear fluorescent systems;

IES-LM66 for compact fluorescent systems and induction lighting systems;

IES_LM-79 for light emitting diode systems; and

IES-LM-46 for high intensity discharge systems.

Lamp light output shall be stabilized in advance of taking measurements at each dimming level. Light output shall be considered stabilized when consecutive measurements taken at one minute intervals deviate by no more than 0.5%.

Recording interval: Measured data shall be recorded to a digital file with an interval between each measurement no greater than 0.00005 sec (50 microseconds) corresponding to an equipment measurement rate of no less than 20kHz, and capture at least 1 second of data.

For each dimming level after the lamps have stabilized, record lighting measurements (in footcandles or volts) from test equipment with readings taken at intervals of no greater than 50 microseconds. These readings shall be recorded for a test period of no less than one second.

JA 10.6 Calculations

Perform the following data manipulation and calculation tasks for each dimming level (100 percent, 20 percent and minimum dimming level claimed by the manufacturer):

Calculate percent amplitude modulation (percent flicker) of unfiltered data over the duration of the test for a given dimming level using the following equation:

$$\text{Percent Amplitude Modulation} = \frac{(\text{Max} - \text{Min})}{(\text{Max} + \text{Min})} \times 100$$

Where:

Max is the maximum recorded light level or voltage from the test apparatus during the duration of the test for a given dimming level.

Min is the minimum recorded light level or voltage from the test apparatus during the duration of the test for a given dimming level.

Conduct a Fourier analysis to transform data for each dimming level into the frequency domain.

Filter frequency data to evaluate the data under four additional different conditions: frequencies under 40 Hz (data above 40 Hz is set to 0), and frequencies under 90 Hz, 200 Hz, 400 Hz, and 1,000 Hz.

Perform inverse Fourier transform to place data back in time domain.

Calculate percent amplitude modulation on resulting time domain data for each filtered dataset over the full sampling duration.

JA 10.7 Test Report and Data Format

For all systems where reporting of flicker is required, the test data shall be submitted to the California Energy Commission in the format specified in Table JA-10. For two years from the date of certification, the entity submitting the test report shall keep all documentation required for compliance, stored and shall provide copies of this documentation to the Energy Commission within 10 days of written request received from the Commission. This documentation shall also include for each measured system, a digital file containing the raw photometric data as described in Section JA10.5.

<i>TABLE JA-10-1. FLICKER DATA TO BE RECORDED AND SUBMITTED TO THE CALIFORNIA ENERGY COMMISSION</i>	
Data	Units/Format
Test Date	
Test Operator	Company Name, Contact Name, Address, Phone Number, e-mail address
Entity submitting results	Company Name, Contact Name, Address, Phone Number, e-mail address
	Manufacturer or Brand
Tested lighting system component: Dimmer	Dimmer type, Manufacturer or Brand, model number
Tested lighting system component: light source (lamp or light engine)	Light source type (lamp, light engine, etc), Manufacturer or Brand, model number
Tested lighting system component: Ballast or Driver	Ballast or Driver, Manufacturer or Brand, model number
Recording interval	seconds (no greater than 0.00005 seconds)

<i>TABLE JA-10-1. FLICKER DATA TO BE RECORDED AND SUBMITTED TO THE CALIFORNIA ENERGY COMMISSION</i>	
Data	Units/Format
Equipment Measurement Period	seconds (no less than 1 second)
Fraction of rated light output integrated over measurement period at 100%, 20% and minimum fraction of light output.	Fraction of rated light output integrated over measurement period at 100%, 20% and minimum fraction of light output.
Amplitude modulation unfiltered	calculated percent amplitude modulation unfiltered for each dimming level (100%, 20% and minimum fraction of light output)
Percent amplitude modulation with 1,000 Hz cut-off	calculated percent amplitude modulation, data filtered with a 1,000 Hz cut-off frequency for each dimming level: (100%, 20%, and minimum fraction of light output)
Percent amplitude modulation with 400 Hz cut-off	calculated percent amplitude modulation, data filtered with a 400 Hz cut-off frequency for each dimming level: (100%, 20%, and minimum fraction of light output)
Percent amplitude modulation with 200 Hz cut-off	calculated percent amplitude modulation, data filtered with a 200 Hz cut-off frequency for each dimming level: (100%, 20% and minimum fraction of light output)
Percent amplitude modulation with 90 Hz cut-off	calculated percent amplitude modulation, data filtered with a 90 Hz cut-off frequency for each dimming level: (100%, 20% and minimum fraction of light output)
Percent amplitude modulation with 40 Hz cut-off	calculated percent amplitude modulation, data filtered with a 40 Hz cut-off frequency for each dimming level: (100%, 20% and minimum fraction of light output)