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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

<i>TABLE JA-10-1. FLICKER DATA TO BE RECORDED AND SUBMITTED TO THE CALIFORNIA ENERGY COMMISSION</i>	
<i>Data</i>	<i>Units/Format</i>
Recording interval	seconds (no greater than 0.00005 seconds)
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)