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March 5, 2018

Commissioner McAllister
California Energy Commission
Attention: Docket No. 17-BSTD-02
Docket@energy.ca.gov

Re: Docket No. 17-BSTD-02 – Flicker Reporting in Reference Appendix JA8

Dear Commissioner McAllister, CEC Staff and other Stakeholders,

I am writing **in support of the 45 day proposal to keep the JA8-2016 flicker standard intact and collecting JA10 formatted data.** This data is critical to supporting a data-driven update of the flicker standard in the 2022 Title 24 code cycle.

When major controversial changes are made to the building standards, they should be broadly discussed during the pre-rulemaking and a detailed justification of the proposal made. As an interested party I was surprised that the detailed flicker requirements and reporting from the 2016 T-24 standards in Reference Joint Appendix JA8 were changed in the draft express terms without warning during the pre-rulemaking. The changes to the flicker requirements would have allowed manufacturers to report flicker performance in terms of the NEMA 77 metrics of Pst and SVM, instead of the reference appendix JA10 formatted data. This may have been seen as a minor clean-up and alignment as was the case for other specifications that instead rely on ENERGY STAR test methods.

For flicker this has definitely not been the case; there have been numerous submitted comments to the docket, from 10 organizations with half supporting and half opposing the changes to the Appendix JA8. An appendix to this letter itemizes most of the comment record to date for easy retrieval. Proponents for using NEMA 77 as the basis for the revised JA8 standard have not submitted a public proposal in alignment the Building Energy Efficiency Measure Proposal Template[1] and not along a timeline that would allow careful review of such a proposal.

For the other proposed changes to JA8 that more closely harmonize the JA8 requirements with the ENERGY STAR requirements that they are based on, these changes have met a uniformly positive response with some minor tweaks being recommended. Thus the comments here are about the changes to the flicker requirements should not be overgeneralized to the non-controversial changes to JA8 in regards to lumen depreciation, start time and the like.

[1] This template is available on the *Public Participation in the Energy Efficiency Standards Update* web page. http://www.energy.ca.gov/title24/participation.html

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Why is a Flicker Standard Important?

For those of us who have operated lighting efficiency programs back in the days of magnetically ballasted fluorescent lighting we realize the importance of avoiding light sources that have comparable flicker of these poorly performing devices with amplitude modulation (percent flicker) of around 30% at 100-120 Hz. The flicker from these magnetic sources was imperceptible or barely perceptible. Some people were more sensitive to these magnetic sources and in one study, around 20% of building occupants would have regular headaches under magnetic ballasts that would go away when replaced by electronically ballasted fluorescent lighting operating at 10,000+ Hz. [2]

The transition to electronic ballasts for fluorescent lighting was welcomed, not only for the increased energy savings but also because this simultaneously reduced complaints about flicker and headaches. McHugh Energy participated in an LED testing program that included flicker measurements of LED lamps. This research found a wide range of flicker performance from 79% percent flicker (worse than magnetically ballasted fluorescent lamps, around 30% flicker) to less than 1% flicker for filtered data with a cut-off frequency of 200 Hz (better than incandescent lamps with flicker around 10%).[3] These results were for LED lamps at full light output. Thus the need for flicker reporting is not limited to dimming light sources only but for all LED light sources.

Consumers benefit from testing that identifies which combinations of lamps and dimmers do not result in visible flicker. But what is most valuable for the consumer, the specifier and for future regulations, is the flicker performance of products with waveforms that are not directly perceivable as visible flicker but which have physiological impacts over the long term, as outlined in IEEE PAR 1789.

Key to achieving the AB1109 goal of reducing residential indoor lighting energy consumption by 2018 is a negotiated agreement between California and the US Congress which allows California to require a minimum 45 lm/W efficacy for all general service lamps by 2018, effectively eliminating about 75% of the incandescent lamp market. The energy impact of the **EISA general service lamp standard is around 10,600 GWh/yr** by time of stock turn-over in California alone.[4] This savings is about **5 times**

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[2] Wilkins, A. J., I. Nimmo-Smith, A. I. Slater, and L. Bedocs, 1989. *"Fluorescent lighting, headaches, and eyestrain,"* Lighting Research and Technology, vol. 21, p. 11-18. The measured percent flicker or percent amplitude modulation of magnetic ballasts in this study is between 27% and 33%. This has been missed by some reviewers that did not recognize that modulation was presented in terms of peak-to-trough modulation. *"Most lamps were cool white (Thorne Cool White) and gave a light modulation of 49-50% of maximum. The remainder were white and (Wotan 23) and gave a modulation of 43-47%."* This uses a "peak-to-trough" metric of modulation, where PT = (Max – Min)/Max. Percent flicker or percent amplitude modulation is AM = (Max-Min)/(Max + Min). AM = PT/(2-PT). The resulting range of percent flicker in the Wilkens et al paper is between 27% and 33%. This calculation was confirmed with Dr. Wilkins.

[3] Note that modulation percent, percent amplitude modulation, and percent flicker refer to the same metric which is given by the AM (percent amplitude modulation) equation above.

[4] Calculated from 2010 US Lighting Market Characterization (Navigant 2012). Conservatively assuming 75% savings (60 lm/W vs 15 lm/W) for LED replacement of halogen incandescent lamps, with US stock of 2 Billion General Service A-lamps at 64 W/ea operating 1.9 h/day on average and 1 Billion GS Ornamental lamps at 44 W/ea

the savings of the energy efficiency measures in the 2019 Title 24 standards over the entire 3 year code cycle. These savings are not realized if there is a backlash against lights that flicker, cause a general state of unease and headaches. Spillover of low flicker products from the JA8 standards into the rest of the LED market due to products designed to meet the moderate "reduced flicker operation," requirements or from specifier awareness of flicker performance posted in the appliance database, these effects improve the amenity of LEDs and support the transition to an all LED lighting environment.

What are the Key Features of the 2016 Title 24 Residential Flicker Standard?

The Joint Appendix sets the flicker requirements for all JA8 sources so that at full light output and at 20% output the product provides "reduced flicker operation which is defined as *"percent amplitude modulation (percent flicker) less than 30 percent at frequencies less than 200Hz, tested according to the requirements in Joint Appendix JA-10."*[5] Additionally the JA8 standard requires that flicker data is reported as described in JA10, *"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."* [6]

The "reduced flicker operation" requirement for dimmers has been in Title 24 since the 1992 standard when percent amplitude modulation was required to be no more than 30% regardless of frequency. Starting with the 2008 standard, the frequency limitation, *"for frequencies less than 200 Hz,"* was inserted into the standard to account for pulse width modulation dimming. Starting in 2016, the flicker requirement was applied to all JA8 light sources with a test method (JA10) to clearly define how percent amplitude would be measured and how it would be filtered for frequencies less than 200 Hz.

The JA10 test method is widely used as it is required for California's Title 24, JA8-2016 certification of high quality efficacious light sources. The JA10 test method also supports the "low flicker operation requirement" in the Title 20 appliance standard for dimmable state regulated LEDs. JA8 certified light sources are required for most luminaires and lamps installed in new California residential construction permitted since January 1, 2017. A recent review of the data in the JA8-2016 MAEDBS appliance efficiency database[7] indicated the database now contains over 15,000 inseparable luminaires and 656 light engines. This database in the JA10 format is a key feature for developing an effective flicker standard in the future.

Around the same time as the development of the 2016 Title 24 standards, the Institute of Electrical and Electronics Engineers was finalizing IEEE PAR 1789-2015 Standard, "Recommended Practices for Modulating Current in High-Brightness LEDs for Mitigating Health Risks to Viewers." This standard has helped the lighting industry understand that the effect of flicker on the human organism varies by both

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operating 1.8 h/day. California's portion is about 12% of the United States stock. http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/2010-lmc-final-jan-2012.pdf

[5] Section JA8.4.6(c).

[6] Section JA8.3.7(c)

[7] Modernized Appliance Efficiency Database System (MAEDBS). http://www.energy.ca.gov/appliances/forms/index.html

depth of modulation and frequency. This standard has synthesized the various studies that indicate that there are physiological impacts of modulating light associated with direct perception of flicker (including seizures for some people) but that there are also physiological impacts beyond the range of frequencies that are associated with direct perception of flicker. This is the only flicker standard that has undertaken the rigorous ANSI standard development process that not only includes public review but also requires that the committee membership is balanced among different interest groups.

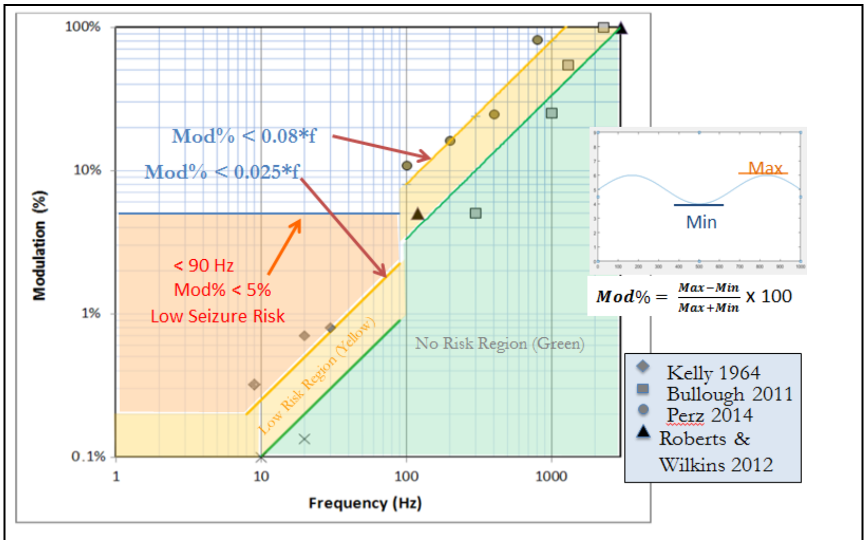

Figure 1: IEEE PAR 1789-2015 Low Risk and No Risk Regions

A key outcome of this synthesis of the research to date was a recommendation document that included a two dimensional risk map of frequencies and modulation (%) as shown **Figure 1**, with three primary regions: 1) No Risk Region (Green) where there is little expectation of any physiological effect, also known as the "No Observable Effect Level" (NOEL). This is where physiological response so far is not measureable. 2) Low Risk Region (Yellow) where a physiological response is detected but the response is small and deemed to be unlikely to be damaging and 3) Not Low Risk Region (White) where there may be a range of risk from not much risk to the severe risk associated with triggering epileptic seizures or vertigo with relatively modest amplitude modulation at low frequencies. If it turns out that designing LED drivers to meet the IEEE standard is relatively inexpensive and does not have other deleterious effects on performance, this would seem to be the prudent thing to do.

McHugh Energy Recommends Maintaining Test and List Standard for Flicker in JA8 using JA10 data

McHugh Energy recommends retaining the JA8/JA10 test and list standard to provide the data necessary for informed consumer choice and product differentiation. A test and list standard, provides a market signal for manufacturers to differentiate themselves and compete on the basis of their flicker performance, similar to the market signal that the HERS rating provides for whole home energy efficiency.

The California's Title 24 Reference Joint Appendix JA10, *Test Method for Measuring Flicker of Lighting Systems*,[8] is well suited for comparing product performance with the recommendations in IEEE PAR

[8]Pages JA10-1 to JA10-4 (electronic pages 271-274). http://www.energy.ca.gov/2015publications/CEC-400-2015-038/CEC-400-2015-038-CMF.pdf

1789. The data collected in California's Title 24 JA10 are broadband representations of percent flicker (percent amplitude modulation), for all frequencies below the cut-off frequencies of 1,000, 400, 200, 90 and 40 Hz in addition to unfiltered percent flicker. The benefit is that one can plot these data points on the IEEE PAR 1789 risk map for modulation percent versus frequency and have a good understanding of flicker performance below each of these cut-off frequencies.

If only one flicker test metric is going to be used, using the JA10 metric is preferable. This desire to have a test method and a flicker metric that can be directly compared to the IEEE PAR 1789 standard is not a criticism of NEMA 77. NEMA 77-2017, *Standard for Temporal Light Artifacts: Test Methods and Guidance for Acceptance Criteria,* proposes a test method and metrics that addresses directly observed visible flicker (Pst, short term flicker indicator) and directly observed stroboscopic effect (SVM, stroboscopic visibility metric). It is similar to IEEE PAR 1789 in that the impact of flicker is a function of frequency, but the metrics Pst and SVM are complex weighted functions cannot be directly assessed against the IEEE PAR 1789 standard. That is, products tested for Pst and SVM cannot easily be plotted on the low risk / no risk graph to see if they meet the recommended levels of flicker. Additionally Pst and SVM do not address other types of flicker such as phantom array effects. Reporting Pst and SVM in addition to the JA10 values would be a good outcome. The same test data can be used to generate the SVM and JA10 values.

NEMA 77 Recommended SVM levels is not Sufficiently Protective

In addition to reporting flicker in terms NEMA-77 metrics of Pst and SVM, both Philips and NEMA have recommended that the NEMA 77 guideline acceptance criteria of Pst ≤ 1.0 and SVM ≤ 1.6 be used for defining JA8 flicker compliance. Using these criteria instead of the "low flicker operation" definition of less than 30% amplitude modulation for frequencies less than 200 Hz would be a weakening of the standards at the 120 Hz frequency where much of light modulation is introduced. At 120 Hz, a device with a sinusoidal waveform having an amplitude modulation of 44% would meet NEMA's maximum SVM metric of 1.6. This is about 50% higher amplitude modulation than the magnetically ballasted fluorescent luminaires linked to headaches in the Wilkins et al. study described earlier and 50% higher than the current JA8 criteria. In comparison, the recommended percent flicker at the boundary between the low risk region and the not low risk region of the IEEE recommendations is 9.6% modulation at 120 Hz. For 120 Hz flicker, and a desire to more closely align with IEEE PAR 17890, the allowable modulation percent should be dropping not increasing.

It is worth repeating what is said in the NEMA 77 standard about the recommended limits in this industry document (underline added for emphasis): *"Attempts by regulators and others to specify universal TLA parameters may result in either extremely long and expensive testing programs (as well as overdesigned products) or the risk that TLA, for certain applications and operating conditions, although endorsed by the regulating or other body, will be unacceptably high*.

IES has formed a working group that will address limits on Pst and SVM for different applications. NEMA defers to the greater application expertise in IES. Until IES has completed their work, the general guidelines of Table 6 for broad application areas are suggested."

McHugh Energy recommends that the **CEC and their consultants participate in the IES standard development process** to assure that California's public interest is represented and to better evaluate if this IES standard would be suitable for use in a future Title 24 and Title 20 standard.

Example: How IEEE PAR 1789 and Current Market Data from California's JA8 Database can be used to Set Future Flicker Criteria

Table 1: Maximum Amplitude Modulation Limits for Compliance with "Low Risk" Recommendations of IEEE PAR 1789 using data collected by 2016 Title 24, part 6, Joint Appendix JA10

Cut-off frequency	Max % Amplitude Modulation 1 x IEEE 1789
40 Hz	1.0%
90 Hz	2.3%
200 Hz	16%
400 Hz	32%
1,000 Hz	80%

Many people agree that IEEE PAR 1789 is the standard of care for flicker. If the JA10 data were collected and evaluated over time, a conservative metric of compliance may be one that is at the boundary between the low risk region (yellow) and the not low risk region (white) in Table 1:

Products that comply with the maximum percent amplitude modulation in **Table 1** would reflect equipment performance below the red boxes shown in **Figure 2**. In other words products with amplitude modulation above the limits listed when plotted would be in one of the red boxes in the upper left-hand corner of Figure 2 that are labelled "Not Compliant."

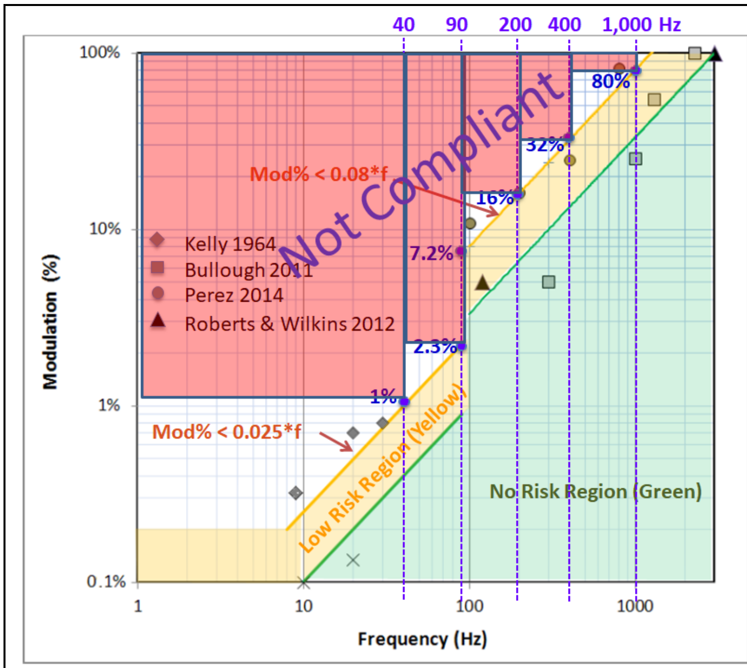

Figure 2: JA10 broadband modulation data for showing compliance with IEEE PAR 1789 guidelines for low risk

The 16% modulation limit for the low-pass filtered results with 200 Hz cut-off frequency is around 0.58 SVM for a 120 Hz sinusoidal waveform. This is significantly less than the 1.6 SVM proposed criteria in NEMA 77. The JA10 metric evaluates percent modulation of the waveform of the light output with all the frequency components above the cut-off frequency removed.

There may be some disagreement about whether these requirements are reasonable for setting the minimum qualifications to be considered a high quality, high efficacy light source for use in new residential construction. That is why it is so important to collect this information in a repeatable, useful manner for all manufacturers providing products into California's new

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residential home construction market and to publish the data into the MAEDBS appliance efficiency database. From this data one can evaluate the trade-off between cost, performance and amenity in this protective standard.

The performance is markedly different for these light sources when at full light output and dimmed to 20%. It raises the question whether there should be different requirements when dimmed as compared to full light output. As shown in **Table 2,** the third column indicates what fraction of JA8-2016 compliant luminaires would comply with the IEEE PAR 1789 recommendations at full light output. The fourth column indicates what fraction would comply with the IEEE limits if dimmed to 20%. As shown in the fourth column, when dimmed a little more than half of inseparable luminaires and decorative lamps would comply but less than one third omnidirectional lamps, directional lamps and light engines would meet this recommended maximum flicker criteria.

Table 2: MAEDBS JA8-2016 database: Luminaire Compliance with IEEE PAR 1789 at Full Light Output and Dimmed to 20% Light Output

	Dimming Level ->	Full Output	20% Output	20% Output	Full AND 20%
Light Source Type	Metrics	Comply with 1 x IEEE 1789	Comply with 1 x IEEE 1789	1 x IEEE 1789 except 1.4 x IEEE 1789 @ 90 & 200 Hz	Full - 1 x IEEE AND 20% 1.4 x IEEE
Decorative Lamp	Total	46	46	46	46
Decorative Lamp	Comply with PAR 1789	40	33	33	33
Decorative Lamp	**% comply with PAR 1789**	**87%**	**72%**	**72%**	**72%**
Directional Lamp	Total	215	215	215	215
Directional Lamp	Comply with PAR 1789	70	38	118	62
Directional Lamp	**% comply with PAR 1789**	**33%**	**18%**	**55%**	**29%**
Inseparable Luminaire	Total	8749	8749	8749	8749
Inseparable Luminaire	Comply with PAR 1789	5920	4444	5623	4855
Inseparable Luminaire	**% comply with PAR 1789**	**68%**	**51%**	**64%**	**55%**
Light Engine	Total	410	410	410	410
Light Engine	Comply with PAR 1789	366	124	376	359
Light Engine	**% comply with PAR 1789**	**89%**	**30%**	**92%**	**88%**
Omnidirectional Lamp	Total	313	313	313	313
Omnidirectional Lamp	Comply with PAR 1789	238	34	211	197
Omnidirectional Lamp	**% comply with PAR 1789**	**76%**	**11%**	**67%**	**63%**

This finding of less than a third of many light sources complying when tested in their dimmed state led to evaluating a moderate relaxation of the IEEE requirements at 90 and 200 Hz for dimmed state compliance. The amplitude magnitude limits for the 90 Hz and 200 Hz cut-off frequencies were adjusted to 1.4 times the IEEE limits but the rest of the amplitude modulation limits were left alone for the other frequencies (40, 400 and 1,000 Hz). These are the amplitude modulation limits posted in Table 3. Column 5 displays that with this relaxation of requirements 92% of JA8 certified light engines would comply.

The sixth and last column identifies what fraction of lamps would meet BOTH the requirements in column 3 AND in column 5.

Table 3: California Market-Based JA10 Amplitude Modulation Limits Approaching IEEE 1789 but with Relaxation of 90 Hz and 200 Hz for 20% Dimmed State

	Full Output	20% Dimming
Cut-off frequency	Max % Amplitude Modulation 1 x IEEE 1789	Max % Amp Modulation 1.4 x IEEE 1789 @90 & 200 Hz
40 Hz	1.0%	1.0%
90 Hz	2.3%	3.2%
200 Hz	16%	22%
400 Hz	32%	32%
1,000 Hz	80%	100%

The first two columns of this table would reflect equipment performance below the red boxes shown in Figure 2. As discussed above, the third column represents some relief when dimmed to 20% by requiring the IEEE standard for most of the frequencies, but for the data where the virtual low pass filter has a 90 and 200 Hz cut-off frequency, the maximum amplitude values are equivalent to 1.4 times the IEEE PAR 1789 recommended values. These increased values are in the shaded cells in the third column. Note when dimmed to 20%, the 22% maximum amplitude modulation value for the 200 Hz cut-off frequency is comparable to a SVM = 0.78 for a 120 Hz sinusoidal waveform. This would address all the light sources except directional lamps. A similar approach could be used to evaluate what are reasonable flicker limits for directional lamps. To be clear this is an example and is not being proposed for the 2019 standards as significantly more research would need to be evaluated on feasibility, cost-effectiveness, use of proprietary technology etc. However his analysis does indicate that more closely approaching the recommendations of the IEEE standard is feasible.

Concluding Remarks

McHugh Energy recommends that the CEC retain the current flicker requirements in JA8 and continue to collect the data in the JA10 format for the 2019 code cycle. The CEC should start a deliberative process for setting the flicker limits for the 2022 code cycle. I am also supportive of processing the data so that the NEMA 77 metrics of Pst and SVM are also collected and posted in a public database. The cross-comparison the JA10 and NEMA 77 metrics would be desirable and require only a little extra processing of the same data. I also recommend that EPIC program consider research on the effects of different modulation depths and frequencies of light on human physiology, health and performance.

This letter contains my thoughts on flicker in the Title 24 standards. They do not necessarily represent the position of any other entity besides McHugh Energy.

Sincerely,

Jon McHugh, PE

Principal

Appendix: Documents submitted to the Docket on Flicker in JA8

Arnold Wilkins - - University of Essex http://docketpublic.energy.ca.gov/PublicDocuments/17-BSTD-02/TN222839_20180304T132609_Arnold_Wilkins_Comments_Comment_on_recent_submission_from_Phili.pdf

Dave Bannister - AccurIC. Importance of collecting at least JA10 flicker data but full waveform data would be even better.. http://docketpublic.energy.ca.gov/PublicDocuments/17-BSTD-02/TN222845_20180305T105747_Dave_Bannister_Comments_Appropriate_Photometric_Flicker_metrics.pdf

Arnold Wilkins - University of Essex. http://docketpublic.energy.ca.gov/PublicDocuments/17-BSTD-01/TN221720_20171113T093624_Arnold_J_Wilken_Comments_17BSTD01_Draft_2019_Building_Energy_Ef.pdf

Luke Price - Public Health England - http://docketpublic.energy.ca.gov/PublicDocuments/17-BSTD-02/TN222625_20180221T055741_Luke_Price_Comments_Simpler_alternative_to_NEMA_77_to_implement.pdf

Luke Price - Public Health England - http://docketpublic.energy.ca.gov/PublicDocuments/17-BSTD-01/TN221892_20171204T090812_Luke_Price_Comments_17BSTD01_Draft_2019_Building_Energy_Efficie.pdf

Dave Bannister AccurIC - Driver Manufacturer - http://docketpublic.energy.ca.gov/PublicDocuments/17-BSTD-01/TN221851_20171122T123607_Dave_Bannister_Comments_Response_to_California_Energy_Commissio.pdf

Dave Bannister AccurIC - Driver Manufacturer - http://docketpublic.energy.ca.gov/PublicDocuments/17-BSTD-02/TN222606_20180220T021028_Dave_Bannister_Comments_Additional_Comments_on_the_Title_24_Fli.pdf

Arnold Wilkins - University of Essex http://docketpublic.energy.ca.gov/PublicDocuments/17-BSTD-02/TN222595_20180217T045026_Prof_Arnold_Wilkins_Comments_Re_submission_by_NEMA_and_Philips.pdf

Gayathri Unnikrishnan - International Well Building Standard - http://docketpublic.energy.ca.gov/PublicDocuments/17-BSTD-01/TN221879_20171201T092450_Gayathri_Unnikrishnan_Comments_International_WELL_Building_Inst.pdf

Edward Moreno - Sierra Club. http://docketpublic.energy.ca.gov/PublicDocuments/17-BSTD-01/TN221872_20171130T094945_Edward_Moreno_Comments_Re_17BSTD01_Sierra_Club_Comments_on_the.pdf

Statewide IOU team - http://docketpublic.energy.ca.gov/PublicDocuments/17-BSTD-01/TN221679_20171103T170734_Statewide_Utility_Codes_and_Standards_Team_Comments_Statewide_U.pdf

Support NEMA 77 and/or a less stringent flicker standard

Kelly Seeger, Philips March 2, 2018 Comments: http://docketpublic.energy.ca.gov/PublicDocuments/17-BSTD-02/TN222823_20180302T105129_Kelly_Seeger_Comments_Philips_Lighting_additional_comments_on_N.pdf

Jim Gaines, Philips - http://docketpublic.energy.ca.gov/PublicDocuments/17-BSTD-01/TN221584_20171020T165301_James_Matthew_Gaines_Comments_Philips_additional_comments_on_th.pdf

Alex Boesenberg, NEMA - http://docketpublic.energy.ca.gov/PublicDocuments/17-BSTD-02/TN222648_20180221T123000_Alex_Boesenberg_Comments_NEMA_Response_to_Comments_on_NEMA_Stan.pdf

Alex Boesenberg, NEMA - http://docketpublic.energy.ca.gov/PublicDocuments/17-BSTD-01/TN221594_20171023T134804_Alex_Boesenberg_Comments_NEMA_Comments_on_CEC_Title_24_Draft_Pr.pdf

Kelly Seeger, Philips - http://docketpublic.energy.ca.gov/PublicDocuments/17-BSTD-02/TN222615_20180220T142807_Kelly_Seeger_Comments_Philips_Lighting_Comments_on_the_2019_Bui.pdf

Naomi Miller, Supports NEMA 77, but wants limit to be SVM ≤1.0. http://docketpublic.energy.ca.gov/PublicDocuments/17-BSTD-02/TN222567_20180215T153340_Naomi_Miller_Comments_Flicker_standards_aren't_perfect_but_NEMA.pdf

Kelly Seeger, Philips - http://docketpublic.energy.ca.gov/PublicDocuments/17-BSTD-02/TN222548_20180214T105221_Kelly_Seeger_Comments_Philips_Lighting_comments_on_Reinstatemen.pdf

Kelly Seeger, Philips - http://docketpublic.energy.ca.gov/PublicDocuments/17-BSTD-01/TN221550_20171019T163944_Kelly_Seeger_Comments_Philips_Lighting_Comments_on_Title_24_201.pdf

Pekka Hakkarainen, Lutron - http://docketpublic.energy.ca.gov/PublicDocuments/17-BSTD-01/TN221547_20171019T161544_Lutron_Electronics_Co_Inc_Comments_On_2019_Building_Energy_Effi.pdf

Pekka Hakkarainen, Lutron - http://docketpublic.energy.ca.gov/PublicDocuments/17-BSTD-02/TN222613_20180220T123152_Michael_Jouaneh_Comments_Lutron_Electronics_Co_Inc_Comments_on.pdf