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CA IOU Comments on 45 day Language - Deep Dimming Ballasts

Additional submitted attachment is included below.

Dimming Ballasts

Codes and Standards Enhancement (CASE) Initiative
For PY 2015: Title 20 Standards Development

Comments on 45-day language for
Dimming Ballasts

Submitted: April 9, 2015

Prepared for:

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1 Comments regarding 45-day language

The California Investor Owned Utilities (CA IOUs) support the energy efficiency standards for dimming ballasts proposed by the California Energy Commission (CEC). Specifically, the CA IOUs strongly support the adoption of the weighted ballast luminous efficiency (Weighted BLE) metric, based on ballast performance at 100%, 80%, and 50% of full output, as well as the standard levels for active mode efficiency, based on minimum weighted BLE as a function of full output arc power. Additionally, we generally support the proposed definitions and test methods. The comments below outline recommendations for improving the proposed standard to provide greater clarity in defining certain key terms, as well as recommendations for capturing additional energy savings achievable by this product class.

1.1 Weighted Ballast Luminous Efficiency (Weighted BLE) Definition

The CA IOUs support the adoption of the Weighted BLE metric. This metric adequately captures performance of the ballast at 100%, 80%, and 50%, thereby allowing for the efficiency of dimming ballasts when operated at part load to be effectively evaluated and regulated. We believe the current section of the 45-day language that defines the method for calculating Weighted BLE can be improved, and we provide the following comments and proposed changes (proposed language identified with red text) accordingly.

Currently, CEC defines Weighted BLE in Section 1604(j)(3)(D) as follows:

$$Weighted\ ballast\ luminous\ efficacy = P_{100} \times w_{100} + P_{80} \times w_{80} + P_{50} \times w_{50}$$

Using P_{100}, P_{80}, and P_{50} to represent BLE at 100%, 80%, and 50% can cause confusion, given that P_{100}, P_{80}, and P_{50} can also be understood to represent ballast input power at 100%, 80%, and 50%, respectively. We suggest that CEC adopt the following definition of Weighted BLE:

$$Weighted\ ballast\ luminous\ efficacy = BLE_{100} \times w_{100} + BLE_{80} \times w_{80} + BLE_{50} \times w_{50}$$

In addition, we recommend that CEC adopt the following changes within Section 1604.(j), to more clearly define intermediate measurements used to calculate weighted BLE:

(B) Three sets of input power and arc power shall be measured using the federal test procedure with the total arc power tuned to 100, 80, and 50 percent of the measured maximum arc power. If a step dimming ballast or a ballast that can only turn connected lamps on or off has dimming steps other than 80 and 50 percent, then the closest step that is between 90 and including 65 percent shall be used for 80 percent testing, and the closest step that is between 65 and including 35 percent shall be used for 50 percent testing. If no step exists in the above prescribed ranges, then no result shall be recorded for that percentage dimming test. The resulting arc powers shall be recorded and referred to as AP_{100}, AP_{80}, and AP_{50}; the resulting input powers shall be recorded and referred to as P_{100}, P_{80}, and P_{50}. BLE_{100}, BLE_{80}, and BLE_{50} shall be calculated as AP_{100}/P_{100}, AP_{80}/P_{80}, and AP_{50}/P_{50}, respectively.

Accordingly, in Section 1605.3(j), where the standard level is presented, the variables in the equation can be more clearly defined to ensure that manufacturers are correctly interpreting the rule. We recommend the following changes to Section 1605.3(j):

$$Weighted\ Ballast\ Luminous\ Efficacy \geq \frac{AP_{100}\ *}{AP_{100}\ \times 1.091 + 7.55}$$

*AP_{100} *is shorthand for maximum arc power as defined in section 1602 and discussed in section 1604*

These recommended changes will help clarify the definition and determination of Weighted BLE and increase the likelihood that the metric and corresponding standard is properly understood.

1.2 Power Factor

The CA IOUs support CEC's proposal to require a minimum power factor of 0.9 when the ballast is operated at full output; however, we recommend that this requirement extend to all operating modes, including 80% and 50% of full output. Duty cycle assumptions used to calculate Weighted BLE assume that ballasts will be operated a combined 80% of the time they are active at either 80% or 50% of full output, so it is crucial to ensure that PF is maintained at these test points. Conversely, when focusing only on PF at 100% full output, only 20% of the assumed active mode duty cycle is being addressed by the standard.

In other industries, we have seen PF correction slip when it goes unregulated as manufacturers seek to take shortcuts in their product design and manufacturing. The compact fluorescent lamp (CFL) market serves as an example of this potential loophole. Among CFLs, high power factor (0.85 or greater was historically considered "high power factor") is common in non-integrated CFL lamp and ballast systems in the United States today. It is less common among integrated CFLs; most integrated CFLs have very low PF, in the range of 0.5 to 0.6. However, in the earlier days of the American CFL market, most major manufacturers actually did offer integrated CFLs with PF correction. As other countries have promoted or adopted policy initiatives to encourage or require high PF in CFLs, these products are available from a number of major manufacturers at competitive prices in other markets. For example, in the European Union (EU) and in India, high PF is common for many CFL products, and these products are often found to be offered at prices that are comparable to low power factor product prices. The CA IOUs attribute this discrepancy in market availability of high power factor CFLs in the US versus in other markets as being due in large part to the relaxed PF standards in the US for these products. By relaxing PF requirements for dimming ballasts operating below 100%, CEC risks opening a loophole to allow for poor PF performance in these operating modes, which, as in the case of the integrated CFL market, could lead manufacturers to adjust their product offerings accordingly.

It is important to ensure high PF across the range of active performance, as dimming ballasts are likely to be operated below 100% full output for a significant portion of their useful lives. It is important to note that all of the products that we tested would pass the proposed PF standard at 100%, 80%, and 50% full output, so this proposal does not appear to cause significant added manufacturing or product development burden, based on existing products in the market. By maintaining a PF standard at 0.9 for all active mode test points, CEC would be ensuring that these products will continue to perform at a high level, even as product efficiency is improved in future product cycles.

1.3 Standby Mode Power Limit

The CA IOUs support CEC's intent to regulate standby mode power draw; however, 0.5W is a more appropriate level at which to cap standby load. As mentioned in previous comments submitted to the docket by the CA IOUs on June 6, 2014,1 limiting standby power to 0.5W is technically feasible for dimming ballasts. The standby mode functionality required of digitally controlled ballasts is essentially limited to the relatively simple task of responding to a control signal that indicates the desired light level at which the lamp should be operated. There are many examples of more complex devices, with far more sophisticated standby and active mode functionality, such as TVs and cell phones, that are able to confine standby power to less than 0.5W, suggesting that with proper drivers, dimming ballasts can also achieve similarly low levels of standby power.

CEC estimates that the total stock of dimming ballasts will be over 48.7 million, statewide, by the time the stock turns over in 2029. Assuming only half of the total stock will be digitally controlled (and thereby substantively impacted by the standby limit), a reduction in standby mode power consumption of 0.5W (comparing the 1W standby mode limit proposed by CEC and the 0.5W standby mode limit proposed by the IOUs), will result in significant additional energy savings after stock turnover, due to the large number of hours ballasts typically spend operating in standby mode. This is particularly the case when assuming that manufacturers are not strongly incentivized to exceed the proposed standard level, and will therefore most likely design products to just barely meet the proposed standard level; in other words, if the standard level is set at 0.5W, products will consume close to 0.5W in standby, whereas if the standard level is set to 1W, products will consume close to 1W in standby. We provide a simple calculation of the total potential energy savings impact in the stock turnover year (2029) below:

$$Total\ standby\ power\ at\ 1W\ limit = Total\ stock * Annual\ hours\ in\ standby\ mode * 1W$$

$$Total\ standby\ power\ at\ 0.5W\ limit = Total\ stock * Annual\ hours\ in\ standby\ mode * 0.5W$$

$$\begin{aligned} Potential\ additional\ savings\ in\ 2029 &= Total\ standby\ power\ at\ 1W\ limit \\ &- Total\ standby\ power\ at\ 0.5W\ limit \\ &= Total\ stock * Annual\ hours\ in\ standby\ mode * 0.5W \\ &= 24.4 million * 5576h * 0.5W \end{aligned}$$

$$Potential\ additional\ savings\ in\ 2029 = 68GWh$$

This is significant and almost a 20% increase over the total projected savings of the measure when implementing a standby mode limit at 1W. We request that CEC consider the potential large scale energy savings impacts of setting more stringent standards for standby mode power consumption.

1.4 Test Method Accuracy and Repeatability

During the public workshop to discuss the 45-day language, some questions were raised regarding the reliability of the proposed test procedure. Specifically, a commenter representing General Electric rasied questions regarding high frequency operation preventing accurate and repeatable measurements when lamps are operated in a dimmed state. In order to address this issue, the CA IOUs are providing additional detail to the docket on the test setup as well as the model numbers and specifications for the testing equipment used to take the measurements.

[1] http://www.energy.ca.gov/appliances/2014-AAER-01/prerulemaking/comments/14-AAER-01_CA_IOUs_Response_to_Draft_Regulations_Dimming_Ballasts_Finalv2_2014-06-06_TN-73146.pdf

The test data provided by the CA IOUs was collected using a Yokogawa WT 1800 Power Analyzer and Fluke i50s current probes. Individual i50s current probes were used to measure each lamp's arc current. For lamp arc voltage measurements, the Yokogawa WT-1800 direct voltage inputs were used per the DOE test procedure. The Fluke i50s current probes are rated for measuring frequencies up to 50MHz and the Yokogawa WT-1800 is rated for measuring voltage frequencies up to 5MHz. The frequency measurement capabilities of both of these instruments are well above the typical frequencies of electronic dimming ballasts operating units at 50% of full output. In our measurements, the dimming ballast samples we tested had frequencies as high as 109 kHz and as low as 50 kHz at 50% of full output, which is clearly within the range of the equipment specifications used for the current and voltage measurements.

The CA IOUs strictly adhered to guidelines provided in the federal BLE test procedure (Federal Register, 76 FR 25211) that outline the test bench setup and wiring configurations. Specifically, in Section 2.3 Test Setup, DOE provides specific guidance on wiring configurations to be used during the test to prevent capacitive coupling in the ballast wiring. These specifications ensure measurement accuracy and repeatability, and were closely followed by the IOU testing team when conducting the BLE measurements for each ballast in the dataset at each measurement point.

The test setup and measurement equipment used by the CA IOUs has been openly shared with industry stakeholders for input and comment on measurement accuracy and repeatability. In comments docketed on June 14, 2014, in response to the CEC Title 20 dimming ballasts standard proposal, the National Electrical Manufacturers Association (NEMA) supported the proposal to test and measure BLE from full output down to (but not lower than) 50% of full output, relying on the test method and equipment used by the CA IOU team.[2] The CA IOUs continue to support this methodology strongly believe that measuring BLE for dimming ballasts operated at 50% of full output can be accurately measured.

[2] http://www.energy.ca.gov/appliances/2014-AAER-01/prerulemaking/comments/14-AAER1_NEMA_Comments_on_Title_20_Dimming_Ballast_Proposal_2014-06-18_TN-73229.pdf