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# Proposal Information Template for: **Outdoor Lighting**

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**Please note: all savings estimates and information in this document are preliminary and are based on data available to the authors at the time of the report. If the CEC moves forward with this topic, we anticipate updating our estimates and recommendations based upon additional input from stakeholders.**

**Proposal Information Template – Outdoor Lighting**

*2011 Appliance Efficiency Standards*

Prepared for: Pacific Gas and Electric Company, San Diego Gas & Electric, Southern California Edison, Southern California Gas Company

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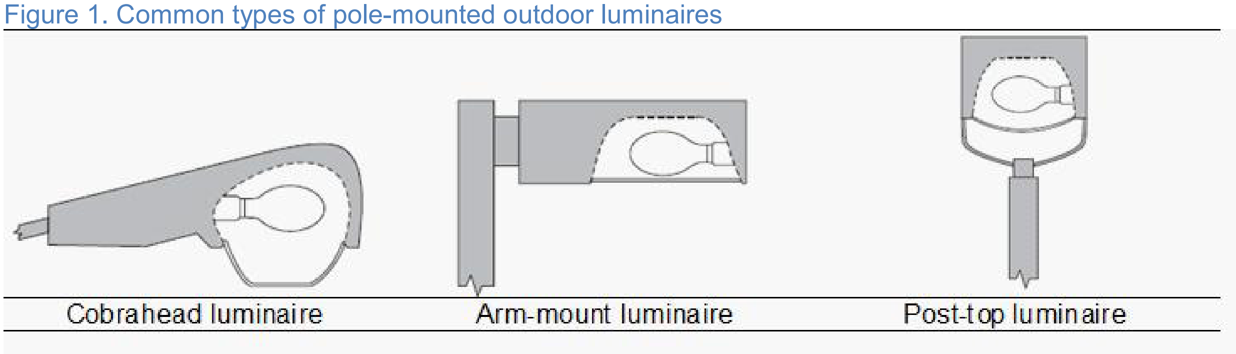
## Purpose

This document is a report template to be used by researchers who are evaluating proposed changes to the California Energy Commission's (Commission) appliance efficiency regulations (Title 20, Cal. Code Regulations, § 1601 – 1608). This report specifically covers pole-mounted outdoor lighting luminaires.

## Background

Outdoor lighting provides crucial services that increase public safety, productivity and comfort. Typical outdoor lighting applications include lighting for streets, highways, parking lots, and pedestrian walkways. The figure below presents three common types of pole-mounted outdoor luminaires.

Figure 1. Common types of pole-mounted outdoor luminaires

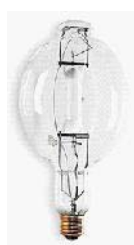
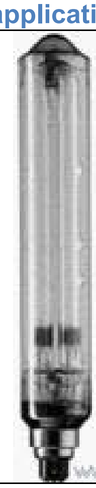



A typical outdoor luminaire is composed of two main components: the lamp and fixture. The lamp is the physical light source for the luminaire. Outdoor pole-mounted roadway and area lights typically use a high-intensity discharge (HID) lamp. HID lamps include the following types: mercury vapor (MV), metal halide (MH), and high pressure sodium (HPS). Of this

group, mercury vapor is the least energy efficient option[1], and is now obsolete. Low pressure sodium lamps (LPS) are also sometimes used for outdoor lighting, and are more luminous than HID lamps. However, LPS lamps are large in size (therefore unable to effectively distribute light laterally and forward), and produce light with very poor color revealing properties so are typically reserved for specialty applications (i.e. to avoid interference with observatories, turtle spawning, etc.) MH and HPS lamps are generally better choices for parking lot and area lighting. Of this pair, MH lamps have better color properties while HPS lamps have higher efficacy and rated life.
Other lamp types, including fluorescent and light emitting diode (LED) can also be used for outdoor lighting. The induction lamp is a fluorescent-based lamp technology with a rugged design, long life and good color properties, low raw source efficacy and efficiency in delivery -to-target because of its diffuse non-point source nature. LED streetlights are available and being installed with more regularity in recent years. LED's have been installed in multiple emerging technology demonstrations and, increasingly in municipal and commercial installations. LED technology is rapidly improving, and forecasts suggest it will soon be, as its economics improve, the most efficient and controllable option available for all outdoor lighting applications.

The figure below illustrates the most common types of lamps used in outdoor luminaires.

**Figure 2. Common lamp types used in outdoor lighting applications**

|  |  |  |  |  |  |
|---|---|---|---|---|---|
| Metal Halide lamp | HPS lamp | MV lamp | LPS lamp | Induction lamp | LED |

While the lamp is considered the physical source of light, the fixture is composed of the structural elements of the luminaire, as well as the electrical system used to power the lamp. The housing unit is used to protect the lamp from adverse outdoor conditions, while reflectors are used to direct the light emanating from the lamp. In many luminaires, a lens is also used to both focus the light and protect the lamp. NEMA defines a fixture as "the structural parts of a luminaire, including parts designed to distribute the light and to position and/or protect the lamp(s), to mount and support the ballast(s), and to provide a wire way or

[1] New sales of mercury vapor fixtures are banned in California.

means of connecting the lamp(s) and ballast(s) to the power supply. A fixture includes the ballast(s), but does not include lamp(s)."

A ballast is defined by NEMA as "an auxiliary device used with an electrical discharge lamp(s) to obtain the necessary circuit conditions (voltage, current, and wave form) for the proper starting and operation of a particular fluorescent or high-intensity discharge (HID) lamp(s) from a particular line voltage and frequency." The efficiency of a ballast is dependent on the rated lamp power, where higher rated lamp power typically corresponds to lower ballast losses. HID lamps are most commonly operated with magnetic ballasts, but can also be operated with newer, higher efficiency electronic ballasts. A 2006 Lighting Research Center (LRC) study focusing on 70 W MH lamps found magnetic ballasts to be 10% less energy efficient than electronic ballasts.

In total, outdoor lighting consumes roughly 4.1 TWh[2] of electricity in California each year. Currently, neither state nor federal standards exist that specifically target outdoor lighting; meanwhile, the rapid advancement of LED technology has led to the development of suitable, highly efficient LED fixtures, which can be installed in outdoor lighting applications in place of less efficient high intensity discharge (HID) fixtures. In addition, advanced controls systems can capture even more savings by adaptively dimming or turning off lights in over-lit areas. This standard aims to accelerate the market adoption of higher efficiency fixtures and lighting controls to achieve significant savings in outdoor lighting applications.

**Overview**

| | |
|---|---|
| Description of Standards Proposal | This standards proposal sets minimum Target Efficacy Rating (TER) requirements for each Backlight/Uplight/Glare ("BUG") classification[3] of outdoor lighting fixture. In addition, the standard will require selected fixtures to be "controls-ready," requiring the fixture to be dimmable and capable of accepting a future controls device. |
| California Stock and Sales | Current stock: 3.6 Million<br>Annual Sales: 223 Thousand<br>Projected annual growth rate (stock): 2% |
| Energy Savings and Demand Reduction | First-year energy savings: 135 GWh<br>First-year peak demand reduction: 3 MW<br>After stock turnover energy savings: 707 GWh<br>After stock turnover peak demand reduction: 13 MW |

[2] Modified from estimated total US outdoor lighting electricity consumption reported in Navigant 2011.
[3] Refer to Tables 5 and 6 for the proposed standard levels.

| | |
|---|---|
| Economic Analysis | Weighted average per unit incremental cost: $45<br>NPV of savings: $333<br>Note: These estimates do not include additional cost or benefit of installing controls. |
| Non-Energy Benefits | Efficient lighting, through the use of well-designed fixtures which direct light to where it is needed most, helps to reduce light pollution, which can cause glare, disrupts ecosystems, impacts human circadian rhythms, and obstructs astronomy. Transitioning to LEDs and eventually to fully controlled lighting systems also saves significant maintenance costs. HID lamps are rated for far shorter lifetimes than LEDs, therefore require more replacements and generate greater waste. Additionally, advanced lighting controls generally include monitoring capability that streamlines lighting operations and maintenance. Our proposal will also reduce greenhouse gas emissions at the power generation source, helping California to meet its AB 32 goals (1990 levels by 2020). |
| Environmental Impacts | TBD |
| Acceptance Issues | TBD |
| Federal Preemption or other Regulatory or Legislative Considerations | Currently, Federal appliance standards explicitly for "Outdoor Lighting" do not exist. However, Federal standards specific to metal halide fixtures preempt California from setting new standards for metal halide fixtures, which may be used in some outdoor lighting applications. Any new Title 20 outdoor lighting standard will therefore not apply to metal halide fixtures.<br>Title 24 sets power density and controls requirements for building load-connected fixtures (parking and area). The proposed Title 20 outdoor lighting standard overlaps with these requirements. While both standards would continue to be effective, savings estimates from the Title 20 standard need to be adjusted to account for savings that would already be captured by Title 24. |

**Methodology and Modeling used in the Development of the Proposal**

The lighting industry will undergo significant changes in the coming years. Lighting technology is improving significantly and at a rapid pace. By setting appropriate efficiency standards for outdoor lighting, we can accelerate the growth of higher efficiency luminaires and capture significant energy savings. Our model relies on an estimate of the current stock and energy consumption of outdoor lighting fixtures as well as projections of the future adoption of high efficiency LED luminaires. We also assume that LED market penetration will gradually increase as price decreases. By setting a minimum efficiency standard for outdoor lighting, we believe LEDs will be more cost-competitive with high performance HID products; therefore, we expect to see an accelerated shift towards more efficient LEDs and electronically-ballasted HID.

### *Baseline Stock and Energy Use*

To determine the existing stock of outdoor lighting fixtures, we relied on the 2011 Navigant Consulting study "Energy Savings Estimates of Light Emitting Diodes in Niche Lighting Applications." This report estimates the total number of outdoor lighting fixtures by technology type[4]; Navigant also provides estimates of total energy usage for each application of outdoor lighting. To break out the stock and energy usage attributable to California, we used a USDA estimate of the fraction of total US developed land located in California (~6%), which we assumed is the most suitable proxy for outdoor lighting needs. The table below represents our estimate of the first-year sales, total stock and energy use of outdoor lighting fixtures of all technology types in California, based on Navigant's original estimates, and classified by application.

**Table 1. Energy use and coincident peak demand of first-year sales and entire stock of outdoor lighting fixtures in CA**

| | *For First-Year Sales* | | *For Entire Stock* | |
|---|---|---|---|---|
| **Fixture Application** | **Coincident Peak Demand (MW)** | **Annual Energy Consumption (GWh/yr)** | **Coincident Peak Demand (MW)** | **Annual Energy Consumption (GWh/yr)** |
| Parking Lot Luminaire | 0.7 | 37 | 11 | 585 |
| Streetlight Luminaire | 1.5 | 77 | 23 | 1,232 |
| Highway Luminaire | 1.9 | 99 | 30 | 1,577 |
| Area Luminaire | 0.4 | 21 | 6 | 338 |

Currently, magnetically ballasted high intensity discharge (HID) fixtures comprise the majority of the existing stock of outdoor lighting fixtures. Electronically ballasted HID fixtures can be marginally more efficient, while LED fixtures generally consume significantly less energy.

In addition to the Navigant study, we compiled our own database of over 700 street and roadway fixtures by aggregating data from manufacturer catalogs. We used this database to solidify our baseline assumptions and to gain a sense of the current average and maximum achievable efficiency for different classifications of street and roadway luminaires.

*Expected Developments in High-Efficiency Options*

We expect high-efficiency LED lighting fixtures to improve dramatically in the coming years. The U.S. Department of Energy (DOE) forecasts significant increases in LED efficacy paired with steep declines in price, as shown in the figure below. We assume that by setting high TER requirements for outdoor lighting, we will help accelerate the market shift towards higher-efficiency products.

[4] Navigant includes estimates for metal halides, but these have not been included in this analysis, as standards applying to metal halide fixtures would be preempted by Federal standards.


**Figure 3. Projected LED efficacy and cost through 2020**
***Source: DOE's March 2010 "Solid State Lighting Research and Development: Multi-Year Program Plan"***

## Data, Analysis, and Results

We believe that a minimum TER standard for outdoor lighting will generate significant savings. The standard will likely increase first costs of HID fixtures, thereby decreasing the relative incremental cost of LED fixtures, which are capable of saving considerable energy through increased efficiency and improved lighting directionality. Our data indicates that LED TER levels are already significantly higher than HID in all classes in which they are available, while DOE research suggests that LED technology will continue to evolve. On a life-cycle basis, the current generation of LED fixtures are proving to be highly cost competitive in many applications, while on a first cost basis, absent standards, LEDs are generally expected to be competitive by 2018[5].

*Savings Estimates*

Using data from the Navigant study, presented in Appendix B, we calculated average values for baseline fixture power draw and annual energy consumption for each outdoor lighting

[5] See Figure 6 below.

application, as presented in Table 2. These values account for Navigant's best estimates for existing market penetration of different lighting technologies (including HPS, LED, etc.) in each application. Combining these data, we are able to calculate a single representative fixture (shown in the "Weighted Average" row in Table 2) to encompass all outdoor lighting technologies and applications.

**Table 2. Baseline unit energy consumption by fixture application**

| Fixture Application | Power Draw (W) | Annual Operating Hours | Unit Electricity Consumption (kWh/yr) |
|---|---|---|---|
| Parking Lot Luminaire | 308 | 4,745 | 1,459 |
| Area Luminaire | 220 | 4,380 | 964 |
| Streetlight Luminaire | 196 | 4,380 | 857 |
| Highway Luminaire | 261 | 4,380 | 1,145 |
| **Weighted Average** | **236** | **4,437** | **1,046** |

Navigant also estimates the wattage of a suitable LED replacement fixture for each technology type in each application, again shown in Appendix B. Using the same methodology as outlined above, we are able to determine a representative LED replacement fixture, as shown in the table below. The representative E-HID[6] was determined using an assumed savings achieved through replacing a magnetic ballast with an electronic ballast in a given fixture.

**Table 3. Unit energy consumption for high efficiency options**

| Fixture Application | Power Draw (W) | Annual Operating Hours | Unit Electricity Consumption (kWh/yr) |
|---|---|---|---|
| LED Outdoor Luminaire | 144 | 4,437 | 639 |
| E-HID Outdoor Luminaire | 212 | 4,437 | 942 |

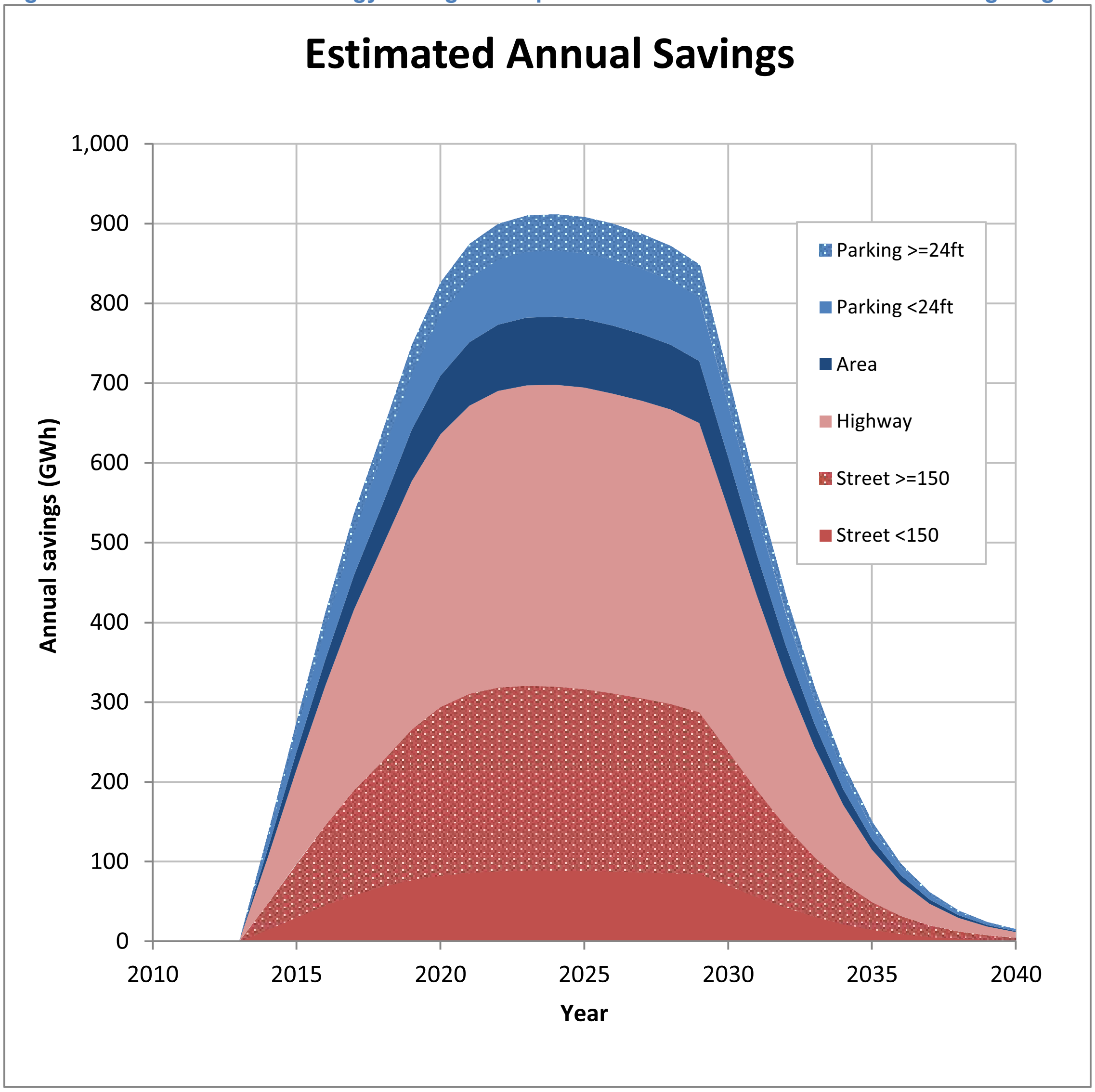
We use the difference between the annual unit electricity consumption of the baseline fixture shown in Table 2 and the annual unit electricity consumption of the high efficiency options presented in Table 3 to determine savings from the proposed measure.

Based on how we believe the market will react to standards for outdoor lighting, we estimate significant energy savings resulting from a shift towards higher efficiency fixtures and an accelerated adoption of advanced controls systems. Figure 5 below illustrates potential savings estimates

[6] While E-HID systems are promising, they are largely field-unproven. Our savings model therefore does not estimate a large shift towards this technology.

including projections for natural market adoption of high efficiency lighting options. As inefficient magnetically ballasted HID fixtures are replaced with electronically ballasted HID and LED fixtures, savings increase each year through around 2022. Savings then level out for several years before eventually declining as a result of the natural market adoption of LED fixtures catching up to the adopted standard levels.

**Figure 4. Estimated annual energy savings from potential Title 20 standards for outdoor lighting.**




Peak demand savings were estimated using an assumed 606% load factor for outdoor lighting (Koomey and Brown 2002). The table below lists first-year and after stock turnover savings estimates based on the assumptions detailed above.

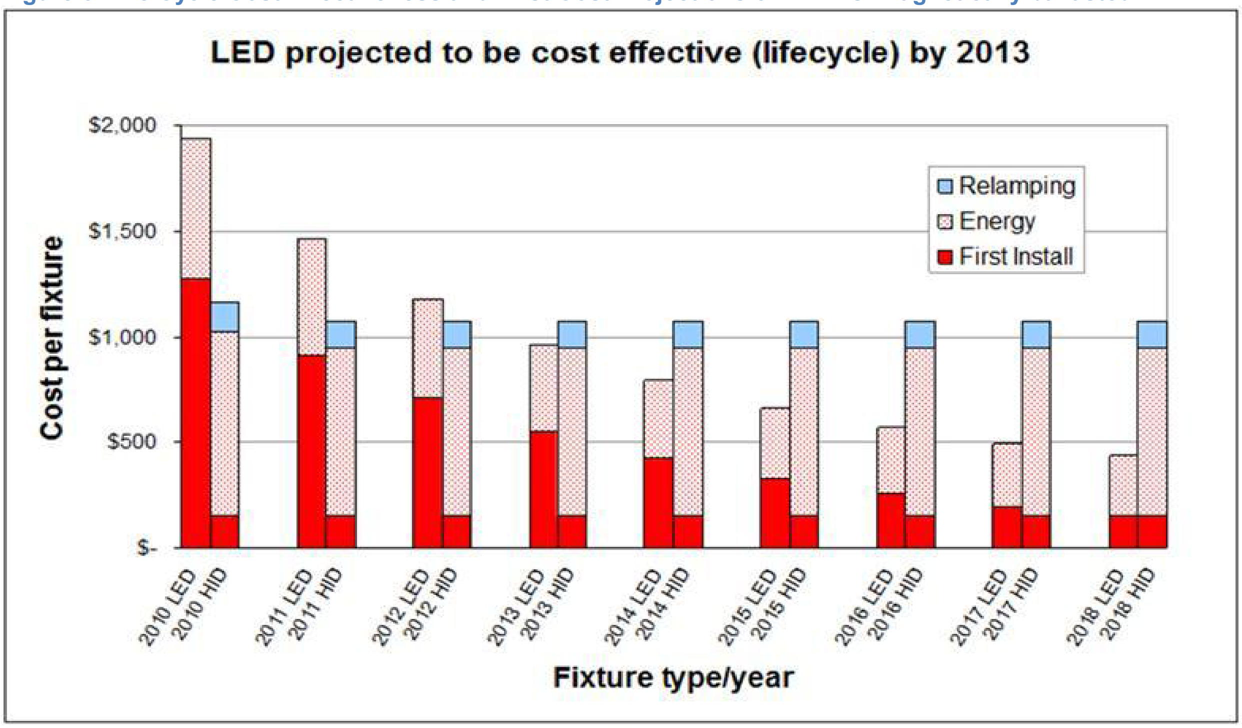
Table 4. Savings estimates for outdoor lighting standards

| *For First-Year Sales* | | *For Entire Stock* | |
|---|---|---|---|
| **Coincident Peak Demand Savings (MW)** | **Annual Energy Savings (GWh/yr)** | **Coincident Peak Demand Savings (MW)** | **Annual Energy Savings (GWh/yr)** |
| 3 | 135 | 13 | 707 |

***Cost Effectiveness Analysis***

We believe that high efficiency LED fixtures, which will have an easier time meeting the TER requirements set in this standard (outlined in Tables 5 and 6 below), are already life-cycle cost competitive in many applications, and will be first-cost competitive by ~2018. The figure below illustrates our projections for life-cycle costs and first costs of LED and magnetically ballasted HID lighting technologies.

Figure 5. Life Cycle Cost Effectiveness and First Cost Projections of LED vs. magnetically ballasted HID




*Source: DOE LED cost/efficacy projections combined with in-house estimates of baseline life-cycle costs*

## Proposed Standards and Recommendations

The structure of this outdoor lighting standards proposal borrows heavily from the structure of a negotiated agreement between industry and energy efficiency advocate organizations. The negotiated standards, which were finalized in 2009, proposed minimum the TER for new fixtures by BUG category, and included "controls-ready" specifications for some fixture types. These negotiated standards were incorporated into the Federal energy bill of 2010, but ultimately this bill was never enacted into Federal law. This Title 20 proposal also includes "controls-ready" requirements and efficiency levels based on TER levels by BUG category, though it proposes significantly higher

minimum TER levels than those in the negotiated agreement. The National Electric Manufacturers Association (NEMA) developed the TER system to measure the system efficiency of a luminaire, including the ability of a luminaire to appropriately direct light onto a target area.
This proposal sets minimum TERs by BUG classification for roadway, street, parking, area, decorative post-top and dusk-to-dawn luminaires, as shown in the tables below.

**Table 5. Minimum TER requirements for area, roadway and highmast luminaires**

Area, Roadway or Highmast Luminaires

| | Max of Uplight/Glare Rating | | |
|---|---|---|---|
| Backlight Rating | 0 or 1 | 2 or 3 | 4 or 5 |
| 0 or 1 | 41 | 43 | 43 |
| 2 or 3 | 56 | 58 | 60 |
| 4 or 5 | 73 | 73 | 75 |

**Table 6. Minimum TER requirements for decorative post-top and dusk-to-dawn luminaires**

Decorative Posttop or Dusk-to-Dawn Luminaires

| | Max of Uplight/Glare Rating | | |
|---|---|---|---|
| Backlight Rating | 0 or 1 | 2 or 3 | 4 or 5 |
| 0 or 1 | 28 | 28 | 28 |
| 2 or 3 | 36 | 36 | 40 |
| 4 or 5 | 43 | 48 | 48 |

In addition, this proposal includes the following “controls-ready” requirement:
Each fixture must have the capability of operating at full power and a minimum of one reduced power level between 30% and 80% of full power, in addition to off. Each fixture must be capable of being easily retrofitted with full controls. The following fixtures are exempted from the “controls-ready” requirement:

- TBD

**Bibliography and Other Research**

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## References and Appendices

### *Appendix A: IESNA BUG Classifications*

**Addendum A for IESNA TM-15-07: Backlight, Uplight, and Glare (BUG) Ratings**

The following Backlight, Uplight, and Glare ratings may be used to evaluate luminaire optical performance related to light trespass, sky glow, and high angle brightness control. These ratings are based on a zonal lumen calculations for secondary solid angles defined in TM-15-07. The zonal lumen thresholds listed in the following three tables are based on data from photometric testing procedures approved by the Illuminating Engineering Society for outdoor luminaries (LM-31 or LM-35).

**Table A-1: Backlight Ratings** (maximum zonal lumens)

| | Secondary Solid Angle | Backlight Rating B0 | B1 | B2 | B3 | B4 | B5 |
|---|---|---|---|---|---|---|---|
| Backlight / Trespass | BH | 110 | 500 | 1000 | 2500 | 5000 | >5000 |
| | BM | 220 | 1000 | 2500 | 5000 | 8500 | >8500 |
| | BL | 110 | 500 | 1000 | 2500 | 5000 | >5000 |

**Table A-2: Uplight Ratings** (maximum zonal lumens)

| | Secondary Solid Angle | Uplight Rating U0 | U1 | U2 | U3 | U4 | U5 |
|---|---|---|---|---|---|---|---|
| Uplight / Skyglow | UH | 0 | 10 | 100 | 500 | 1000 | >1000 |
| | UL | 0 | 10 | 100 | 500 | 1000 | >1000 |
| | FVH | 10 | 75 | 150 | >150 | | |
| | BVH | 10 | 75 | 150 | >150 | | |

**Table A-3: Glare Ratings** (maximum zonal lumens)

Glare Rating for
Asymmetrical Luminaire Types (Type I, Type II, Type III, Type IV)

| | Secondary Solid Angle | G0 | G1 | G2 | G3 | G4 | G5 |
|---|---|---|---|---|---|---|---|
| Glare / Offensive Light | FVH | 10 | 250 | 375 | 500 | 750 | >750 |
| | BVH | 10 | 250 | 375 | 500 | 750 | >750 |
| | FH | 660 | 1800 | 5000 | 7500 | 12000 | >12000 |
| | BH | 110 | 500 | 1000 | 2500 | 5000 | >5000 |

Glare Rating for
Quadrilateral Symmetrical Luminaire Types (Type V, Type V Square)

| | Secondary Solid Angle | G0 | G1 | G2 | G3 | G4 | G5 |
|---|---|---|---|---|---|---|---|
| Glare / Offensive Light | FVH | 10 | 250 | 375 | 500 | 750 | >750 |
| | BVH | 10 | 250 | 375 | 500 | 750 | >750 |
| | FH | 660 | 1800 | 5000 | 7500 | 12000 | >12000 |
| | BH | 660 | 1800 | 5000 | 7500 | 12000 | >12000 |

**Notes to Tables A-1, A-2, and A-3:**

(1) Any one rating is determined by the maximum rating obtained for that table. For example, if the BH zone is rated B1, the BM zone is rated B2, and the BL zone is rated B1, then the *backlight rating for the luminaire* is B2.

(2) To determine BUG ratings, the photometric test data must include data in the upper hemisphere unless no light is emitted above 90 degrees vertical (for example, if the luminaire has a flat lens and opaque sides), per the IES Testing Procedures Committee recommendations.

(3) It is recommended that the photometric test density include values at least every 2.5 degrees vertically. If a photometric test does not include data points every 2.5 degrees vertically, the BUG ratings shall be determined based on appropriate interpolation.

(4) A "quadrilateral symmetric" luminaire shall meet one of the following definitions:
   a. A Type V luminaire is one with a distribution that has circular symmetry, defined by the IESNA as being essentially the same at all lateral angles around the luminaire.
   b. A Type VS luminaire is one where the zonal lumens for each of the eight horizontal octants (0-45, 45-90, 90-135, 135-180, 180-225, 225-270, 270-315, 315-360) are within ±10 percent of the average zonal lumens of all octants.

## *Appendix B: Tables from Navigant Study*

**Table 3.2 – Roadway Light Installed Base**

| Application | Lamp Type | Percentage | Number of Lights (000's) |
|---|---|---|---|
| Street Lighting | Incandescent | 0.1% | 18 |
| | Mercury Vapor | 15.9% | 4,200 |
| | Low Pressure Sodium | 0.4% | 100 |
| | High Pressure Sodium | 80.9% | 21,500 |
| | Metal Halide | 2.5% | 700 |
| | LED | 0.2% | 60 |
| | **Total** | **100%** | **26,500** |
| Highway Lighting | Induction | 8.5% | 2,200 |
| | Low Pressure Sodium | 0.4% | 100 |
| | High Pressure Sodium | 86.1% | 22,500 |
| | Metal Halide | 5.0% | 1,300 |
| | **Total** | **100%** | **26,100** |

**Table 3.3 – System Wattage of Roadway Lights**

| Application | Lamp Type | Average System Wattage (W) | 2010 LED Replacement Wattage (W) |
|---|---|---|---|
| Street Lighting | Incandescent | 100 | 12 |
| | Mercury Vapor | 291 | 82 |
| | High Pressure Sodium | 178 | 118 |
| | Low Pressure Sodium | 90 | 84 |
| | Metal Halide | 310 | 183 |
| | LED | 74 | n/a |
| Highway Lighting | Induction | 176 | 104 |
| | High Pressure Sodium | 270 | 178 |
| | Low Pressure Sodium | 199 | 185 |
| | Metal Halide | 237 | 140 |

**Table 3.6 – Parking Light Installed Base**

| Application | Lamp Type | Percentage | Number of Lights (000's) |
|---|---|---|---|
| Garage Lighting | Incandescent | 1.6% | 600 |
| | Halogen | 2.2% | 800 |
| | Fluorescent | 45.9% | 16,600 |
| | Induction | 7.4% | 2,700 |
| | Mercury Vapor | 0.1% | 44 |
| | High Pressure Sodium | 23.2% | 8,500 |
| | Metal Halide | 15.3% | 5,600 |
| | LED | 4.1% | 1,500 |
| | **Total** | **100%** | **36,400** |
| Lot Lighting | Incandescent | 2.6% | 400 |
| | Halogen | 0.1% | 16 |
| | Mercury Vapor | 2.4% | 400 |
| | High Pressure Sodium | 36.0% | 5,700 |
| | Metal Halide | 54.2% | 8,600 |
| | LED | 4.6% | 700 |
| | **Total** | **100%** | **15,800** |

**Table 3.7 – System Wattage of Parking Lights**

| Application | Lamp Type | Average System Wattage (W) | 2010 LED Replacement Wattage (W) |
|---|---|---|---|
| Garage Lighting | Incandescent | 86 | 18 |
| | Halogen | 107 | 27 |
| | Fluorescent | 82 | 68 |
| | Induction | 106 | 68 |
| | Mercury Vapor | 185 | 71 |
| | High Pressure Sodium | 183 | 138 |
| | Metal Halide | 152 | 91 |
| | LED | 54 | n/a |
| Lot Lighting | Incandescent | 150 | 22 |
| | Halogen | 150 | 26 |
| | Mercury Vapor | 421 | 119 |
| | High Pressure Sodium | 340 | 245 |
| | Metal Halide | 307 | 199 |
| | LED | 72 | n/a |

**Table 3.10 – Area and Flood Lighting Installed Base**

| Application | Lamp Type | Percentage | Number of Lamps (000's) |
|---|---|---|---|
| Area Lighting | Incandescent | 2.3% | 1,200 |
| | Halogen | 19.0% | 8,600 |
| | Fluorescent | 5.8% | 3,600 |
| | Induction | 0.3% | 200 |
| | Mercury Vapor | 12.7% | 6,700 |
| | High Pressure Sodium | 22.1% | 10,700 |
| | Metal Halide | 36.9% | 18,900 |
| | LED | 0.9% | 600 |
| | **Total** | **100%** | **50,400** |
| Flood Lighting | Incandescent | 3.6% | 1,600 |
| | Halogen | 18.6% | 8,000 |
| | Compact Fluorescent | 0.2% | 74 |
| | Fluorescent | 7.9% | 3,400 |
| | Mercury Vapor | 8.4% | 3,600 |
| | High Pressure Sodium | 21.4% | 9,200 |
| | Metal Halide | 39.7% | 17,100 |
| | LED | 0.2% | 74 |
| | **Total** | **100%** | **43,200** |

**Table 3.11 –Wattages of Area and Flood Lights**

| Application | Lamp Type | Average System Wattage (W) | 2010 LED Replacement Wattage (W) |
|---|---|---|---|
| Area Lighting | Incandescent | 202 | 23 |
| | Halogen | 150 | 26 |
| | Fluorescent | 160 | 61 |
| | Induction | 287 | 178 |
| | Mercury Vapor | 254 | 69 |
| | High Pressure Sodium | 285 | 183 |
| | Metal Halide | 451 | 255 |
| | LED | 67 | n/a |
| Flood Lighting | Incandescent | 202 | 23 |
| | Halogen | 150 | 26 |
| | Compact Fluorescent | 53 | 36 |
| | Fluorescent | 159 | 61 |
| | Mercury Vapor | 254 | 69 |
| | High Pressure Sodium | 294 | 194 |
| | Metal Halide | 460 | 264 |
| | LED | 67 | n/a |