PD-32: Light Pollution

1-3 points

Goal: To safely illuminate roadways while minimizing unnecessary and potentially harmful illumination of the surrounding sky, communities, and habitat.

Affected Triple Bottom Line Principles

Sustainability Linkage

Reducing lighting pollution benefits both the natural and human environment.

Background and Scoring Requirements

Background

Roadway lighting is an essential component of safe roadway design. However, in addition to useful light that illuminates the roadway, light can be emitted upward directly from existing light fixtures, or reflect from the roadway surface, both of which contribute to sky glow. Light from overhead fixtures can "trespass" and illuminate surfaces and areas other than the roadway, including private property and or natural areas. Mismanaged lighting can alter the appearance of a dark sky; eclipse natural starlight; disrupt the feeding, sleeping, mating, and migration cycles of wildlife; and disrupt the growth cycles of plants. However, in many cases, careful lighting design can provide safe driving conditions while minimizing wasted light and adverse lighting effects.

The purpose of this criterion is to promote the management of Backlight, Uplight, and Glare (BUG) using prescribed Backlight, Uplight, and Glare ratings to evaluate luminaire optical performance related to light trespass, sky glow, and high angle brightness control. For the purposes of this criterion, the key terms are defined as follows:

- **"Backlight"** refers to the light directed in back of mounting pole.
- **"Glare"** is the sensation produced by luminance within the visual field that is sufficiently greater than the luminance to which the eyes are adapted causing annoyance, discomfort, or loss in visual performance and visibility.
- **"Glare ratings"** refer to the amount of light emitted from the luminaire at angles known to cause glare.
- **"Light trespass"** is the effect of light that strays from the intended purpose and becomes an annoyance, a nuisance, or a determent to visual performance.
- **"Lighting boundary"** is located at the edge of the roadway plus any adjacent features intended to be lit, such as sidewalks, bikepaths, multi-use paths, etc. It does not include adjacent areas to be lit for private purposes such as parking lots or car dealerships.
- **"Lighting Zone"** is the lighting zone type being modelled based on characteristics of the natural environment, including, but not limited to, flora, fauna and humans as described by the Illuminating Engineering Society of North America (IES).
- **"Roadway or Highway lighting"** is defined as lighting provided for freeways, expressways, limited access roadways, and roads on which pedestrians, cyclists, and parked vehicles are generally not present. The primary purpose of roadway or highway lighting is to help the motorist remain on the roadway and help with the detection of obstacles within and beyond the range of the vehicle's headlights.
- **"Sky glow"** refers to the brightening of the night sky that results from the reflection of radiation (visible and non-visible), scattered from the constituents of the atmosphere (gaseous molecules, aerosols, and particulate matter), in the direction of the observer.

- **"Street lighting"** is defined as lighting provided for major, collector, and local roads where pedestrians and cyclists are generally present. The primary purpose of street lighting is to help road users identify obstacles, provide adequate visibility of pedestrians and cyclists, and assist in visual search tasks, both on and adjacent to the roadway.
- **"Uplight"** refers to or the light directed above the horizontal plane of the luminaire.

Lighting Zone (LZ)

The IES defines the lighting zones shown in Table PD-32.0.A.

TABLE PD-32.0.A LIGHTING ZONES

Lighting Zone (LZ)	Zoning Considerations	Recommended Uses or Areas
LZ0	Undeveloped areas within national parks, state parks, forest land, rural areas, and other undeveloped areas	Should be applied to areas in which permanent lighting is not expected and when used, is limited in the amount of lighting and the period of operation. LZ0 typically includes undeveloped areas of open space, wilderness parks and preserves, areas near astronomical observatories, or any other area where the protection of a dark environment is critical. Special review should be required for any permanent lighting in this zone. Some rural communities may choose to adopt LZ0 for residential areas.
LZ1	Developed areas of national parks, state parks, forest land, and rural areas.	Pertains to areas that desire low ambient lighting levels. These typically include single and two family residential communities, rural town centers, business parks, and other commercial or industrial/ storage areas typically with limited nighttime activity. May also include the developed areas in parks and other natural settings.
LZ2	Areas predominantly consisting of residential zoning, neighborhood business districts, light industrial with limited nighttime use, and residential mixed-use areas.	Pertains to areas with moderate ambient lighting levels. These typically include multifamily residential uses, institutional residential uses, schools, churches, hospitals, hotels/motels, commercial and/or businesses areas with evening activities embedded in predominately residential areas, neighborhood serving recreational and playing fields and/or mixed use development with a predominance of residential uses. Can be used to accommodate a district of outdoor sales or industry in an area otherwise zoned LZ1.
LZ3	All areas not included in LZ0, LZ1, LZ2, or LZ4.	Pertains to areas with moderately high lighting levels. These typically include commercial corridors, high intensity suburban commercial areas, town centers, mixed use areas, industrial uses and shipping and rail yards with high night time activity, high use recreational and playing fields, regional shopping malls, car dealerships, gas stations, and other nighttime active exterior retail areas.

Lighting Zone (LZ)	Zoning Considerations	Recommended Uses or Areas
LZ4	High activity commercial districts in major metropolitan areas as designated by the local jurisdiction.	Pertains to areas of very high ambient lighting levels. LZ4 should only be used for special cases and is not appropriate for most cities. LZ4 may be used for extremely unusual installations such as high density entertainment districts, and heavy industrial uses.

Source: IES

BUG Rating System

Fundamentals of Lighting – Addenda #1 BUG Ratings – Backlight, Uplight, and Glare (ref. TM-15 and addenda)[1], published by IES, makes the evaluation and selection of outdoor luminaires fast, easy and complete. Added to TM-15 as an addenda, the BUG stands for "Backlight", "Uplight" and "Glare", each describing one of the three types of stray light that escape from a lighting fixture as defined above.

The BUG Rating System divides the sphere around a luminaire into zones, assigning B, U, and G values according to expected environmental impact for each type of light trespass. It takes into account uplight shielding, glare shielding and backlight shielding as well as limiting lamp lumens to values appropriate for the lighting zone. Once the lowest BUG Ratings have been established, the System provides tables of acceptable values against which any luminaire having photometric data can be evaluated.

Scoring Requirements

The following scoring requirements are cumulative.

Requirement PD-32.1

1 point. Uplight Design

Do not exceed the luminaire uplight ratings shown in Table PD-32.1.A, based on the specific light source installed in the luminaire, as defined in IES TM-15-11, Addendum A[2].

TABLE PD-32.1.A. MAXIMUM UPLIGHT RATINGS

	Lighting Zone				
	LZ0	**LZ1**	**LZ2**	**LZ3**	**LZ4**
Allowed uplight ratings	U0	U1	U2	U3	U4

Requirement PD-32.2

1 point. Backlight Design

Do not exceed the luminaire backlight ratings shown in Table PD-32.2.A (based on the specific light source installed in the luminaire), as defined in IES TM-15-11, Addendum A[2], based on the mounting location and distance from the lighting boundary.

TABLE PD-32.2.A. MAXIMUM BACKLIGHT RATINGS

	Lighting Zone				
Luminaire Mounting	**LZ0**	**LZ1**	**LZ2**	**LZ3**	**LZ4**
> 2 mounting heights from lighting boundary	B1	B3	B4	B5	B5
1 to 2 mounting heights from lighting boundary and properly oriented	B1	B2	B3	B4	B4
0.5 to 1 mounting height to lighting boundary and properly oriented	B0	B1	B2	B3	B3
< 0.5 mounting height to lighting boundary and properly oriented	B0	B0	B0	B1	B2

Requirement PD-32.3

1 point. Glare Design

Do not exceed the glare ratings shown in Table PD-32.3.A, based on the specific light source installed in the luminaire, as defined in IES TM-15-11, Addendum A[2].

TABLE PD-32.3.A. MAXIMUM GLARE RATINGS

	Lighting Zone				
	LZ0	**LZ1**	**LZ2**	**LZ3**	**LZ4**
Allowed glare ratings	G0	G1	G2	G3	G4

Resources

Above-Referenced Resources

The following resources are referenced in this criterion and consolidated here:

1. IES, *Fundamentals of Lighting – Addenda #1 BUG Ratings – Backlight, Uplight, and Glare (ref. TM-15 and addenda)*, https://brownep.files.wordpress.com/2014/01/ies-fol-addenda-1-bug-ratings.pdf
2. IES, *TM-15-11 Addendum A*, https://www.ies.org/wp-content/uploads/2017/03/TM-15-11BUGRatingsAddendum.pdf

Additional Resources

The following resources provide information on this criterion topic in addition to the sources directly referenced:

3. International Dark Sky Association, *Specifier Bulletin for Dark Sky Applications* (2009), Volume 2: Issue 1, http://www.aal.net/content/resources/files/BUG_rating.pdf
4. LEED, *REQSS8o1-0: Bug rating method*, http://www.usgbc.org/credits/reqss8o1-0
5. U.S. Department of Energy, *LED Application Series: Outdoor Area Lighting* (June 2008), http://apps1.eere.energy.gov/buildings/publications/pdfs/alliances/outdoor_area_lighting.pdf
6. IES, *TM-15-11: Luminaire Classification System for Outdoor Luminaires + Addendum A*, https://www.ies.org/store/technical-memoranda/luminaire-classification-system-for-outdoor-luminaires/

Scoring Sources

The project is considered to have met this criterion if the requirements above can be reasonably substantiated through the existence of one or more of the following documentation sources (or equal where not available):

1. Contract documents showing the plans and specifications required BUG compliant or equivalent fixtures.
2. Illumination design documentation showing that lighting was required for this project to meet safety requirements, that the types of lighting fit the context of the roadway and that, if the illumination levels were reduced, that safety was not compromised.