ASSIST Application Design Guide: Parking Lot Lighting

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Introduction

With an estimated minimum of 100 million commercial parking spaces in the United States, parking lots are a major user of electric lighting systems. The successful design and operation of parking lots require the consideration of multiple objectives, including pedestrian and driver safety, property security, and operation costs. Properly designed lighting can support these objectives effectively.

This *ASSIST Application Design Guide* is meant to assist lighting designers, owners and operators in identifying appropriate metrics for quantifying the benefits of lighting relative to the costs, and in doing so, maximize the value of the specified lighting system.

Application Issues

Because of the direct interaction between pedestrians and vehicles, the emphasis of parking lot design, including lighting, has been on the safety of pedestrians. In addition to enabling drivers to clearly see pedestrians, particularly in the visual periphery, a parking lot's lighting system should also address pedestrians' relevant visual and perceptual tasks such as detection and identification of tripping hazards and evaluation of personal safety. The last issue, a sense of safety and personal security, has been rated by adults 25-34 and over 65 years old as the top consideration when deciding on where to park. Additional considerations include glare, light trespass and glow.

Benefit Metrics

Parking lot lighting for visual tasks

The possible visual tasks of pedestrians (e.g., detection of tripping hazards) and drivers (e.g., detection of objects on the ground or holes, reading signs) can be well served by illumination that is characterized by the **illuminance** either on the parking lot surface or the visual task itself. Recommended **uniformity ratios** of illumination are intended to ensure that no part of the visual task surface is too dark to be visible. However, recent research has shown that improved uniformity over that presently recommended would be beneficial to end users. Importantly too, although minimum illuminance recommendations on the ground (typically 5 lx) are often sufficient for detection of tripping hazards, these values do not necessarily support a pedestrian's sense of safety and security.

Parking lot lighting for perception of safety and security

The use of **scene brightness** as a metric can allow the designer to reinforce a sense of personal safety while meeting the minimum requirements for visibility. Brighter outdoor spaces, such as parking lots, have been rated as safer. Optimum scene brightness can be achieved through the color of the light (i.e., its spectral power distribution).

When used to illuminate outdoor spaces, “white” light sources create scenes that are typically rated as brighter in comparison to the “yellowish” light from low or high pressure sodium lamps.

Parking lot light source color can influence pedestrians’ perceptions of scene brightness, personal safety and security. In this example, to be judged equally bright, the illuminance of the condition on the right, from high pressure sodium lamps, was 20% lower than the illuminance of the condition on the left, from metal halide lamps.

The following table shows the relative brightness factors of a few common light sources used in parking lots. The resource section lists references with detailed information on how to estimate the brightness factors of other sources. Specifying light based on scene brightness will usually also increase the **visual efficacy** of the lighting system, which can assist in the detection of unexpected hazards in the periphery of the visual field.

Light Source	Brightness Factor
High pressure sodium (2100 K)	100%
Ceramic metal halide (4200 K)	140%
Light-emitting diode (6500 K)	185%

Glare and Light Pollution

Parking lot and area luminaires are classified in terms of the amount of light they produce in terms of backlight (B) such as onto adjacent properties, uplight (U) into the sky, and high-angle light that can contribute to glare (G). Selecting luminaires with low so-called **BUG ratings** can help reduce these characteristics. The **outdoor site-lighting performance (OSP) system** can be used with specific roadway installations to evaluate the potential to create sky glow, light trespass and discomfort glare. The **ASSIST discomfort glare metric** extends the **OSP glare metric** by incorporating the impact of the maximum source luminance.

Reducing Costs to Optimize Lighting Value

Parking lots, and their associated services such as lighting, can represent a large expense to their owners and operators. Thus, minimizing the costs of ownership and operation is a critical step to a successful application. Traditionally, designers address this issue by trading off the number of luminaires per pole, the mounting height, and the spacing between poles. One way to evaluate the effectiveness of a design at meeting the lighting objectives is by determining its **luminaire system application efficacy (LSAE)**. By measuring how effective a design is at sending light only where it is needed, LSAE can be a useful tool to minimize the number of luminaires needed

to meet target design values, which in turn often results in lower parking lot power density values. LSAE also helps identify options that will be better at controlling light trespass.

Finally, the small optical size of most light-emitting diodes (LEDs) can be an advantage in creating more efficient luminaire designs that provide improved LSAE compared to larger, traditional metal halide or high pressure sodium lamps, which can result in significant energy costs savings.

Summary

In order of priority, the following criteria and metrics should be considered for parking lot lighting:

- **Scene brightness** for the main parking lot area to match that from high pressure sodium lighting while maintaining the same sense of personal safety and security.
- **Photopic illuminance** (or **photopic luminance**) and uniformity to meet consensus recommendations for visual performance tasks such as detecting tripping hazards or reading signs.
- **Visual efficacy** for access roads or adjacent street lighting applications to match that from high pressure sodium lighting while reducing electric power demand.
- **BUG ratings** and **OSP system** characteristics to minimize light pollution and glare

Resources

This short design guide is meant to assist designers, owners and operators with a few preliminary considerations for parking lot lighting and is not meant to replace their design and decision process. The following resources describe in further detail the application metrics presented here and point the reader to additional information.

ASSIST. 2009. *ASSIST recommends…Outdoor lighting: A short guide to applications, objectives and considerations.* Vol. 6, Iss. 1. Troy, NY: Lighting Research Center. Internet: http://www.lrc.rpi.edu/programs/solidstate/assist/recommends/outdoorlighting.asp.

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ASSIST 2011. *ASSIST recommends...A method for estimating discomfort glare from exterior lighting systems*. Vol. 9, Iss. 1. Troy, NY: Lighting Research Center. Internet: http://www.lrc.rpi.edu/programs/solidstate/assist/recommends/discomfortglare.asp.

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Illuminating Engineering Society of North America. 2014. *Lighting for Parking Facilities*. RP-20-14. New York: IESNA.

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National Lighting Product Information Program (NLPIP). 2004. *Specifier Reports: Parking Lot and Area Luminaires.* Troy, N.Y.: Lighting Research Center. Internet: http://www.lrc.rpi.edu/nlpip/publicationDetails.asp?id=900&type=1.

Rea, M.S. (ed.). 2000. *IESNA Lighting Handbook: Reference and Application*, 9th Edition. New York: Illuminating Engineering Society of North America.

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Rea, M. S., L. C. Radetsky and J. D. Bullough. 2011. Toward a model of outdoor lighting scene brightness. *Lighting Research and Technology* 43(1): 7-30.

Rea, M.S. 2013. *Value Metrics for Better Lighting.* Bellingham, WA: SPIE Press.

About ASSIST: The Alliance for Solid-State Illumination Systems and Technologies (ASSIST) was established in 2002 by the Lighting Research Center as a collaboration among researchers, manufacturers, and government organizations. ASSIST's mission is to enable the broad adoption of solid-state lighting by providing factual information based on applied research and by visualizing future applications. ASSIST members include: 3M; Acuity Brands Lighting; Amerlux; BAE Systems; Bridgelux; Cree; Crouse-Hinds by Eaton; Dow Corning; Federal Aviation Administration; GE Lighting Solutions; Hubbell Lighting; Legrand; Lumileds; New York State Energy Research and Development Authority (NYSERDA); OSRAM SYLVANIA/OSRAM Opto Semiconductors; Philips Lighting; Samsung Electronics Co.; Seoul Semiconductor; United States Environmental Protection Agency.