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LED Site Lighting Performance Specification

Supplier Summit

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New York, New York



Commercial Building
Energy Alliance



Why LEDs for commercial parking lots?

- Energy savings
 - Enhanced luminaire optical efficiency
 - Better total luminaire efficacy (lumens per watt)
 - Driver (control gear) efficiency
 - Control capability, e.g., dimming
- Potential for reduced maintenance costs
- Improved uniformity
- Environmentally friendly
- BUT products on the market vary greatly in terms of performance – buyer beware!

Project Background

- The Retailer Energy Alliance (REA) identified LED site lighting as a near-term project to pursue in early 2008
- REA Working Group established April 2008
 - Frequent Working Group conference calls
- Large coordinated purchases expected in summer 2009
- Technical Resource – DOE SSL Program¹

CBEA Performance Specification

- Version 1.0 completed in early 2009²
- Iterative process with Alliance members and suppliers
- Updates to specification will occur over time
- Technical assistance provided by DOE via PNNL
 - SSL GATEWAY program provides additional resources³
 - SSL CALiPER program provides additional resources⁴
- Investigation of the specification via demonstration projects completed or underway
 - Raley's in West Sacramento, CA
 - Wal-Mart in Leavenworth, KS

CBEA Performance Spec: Demo Data-Raley's

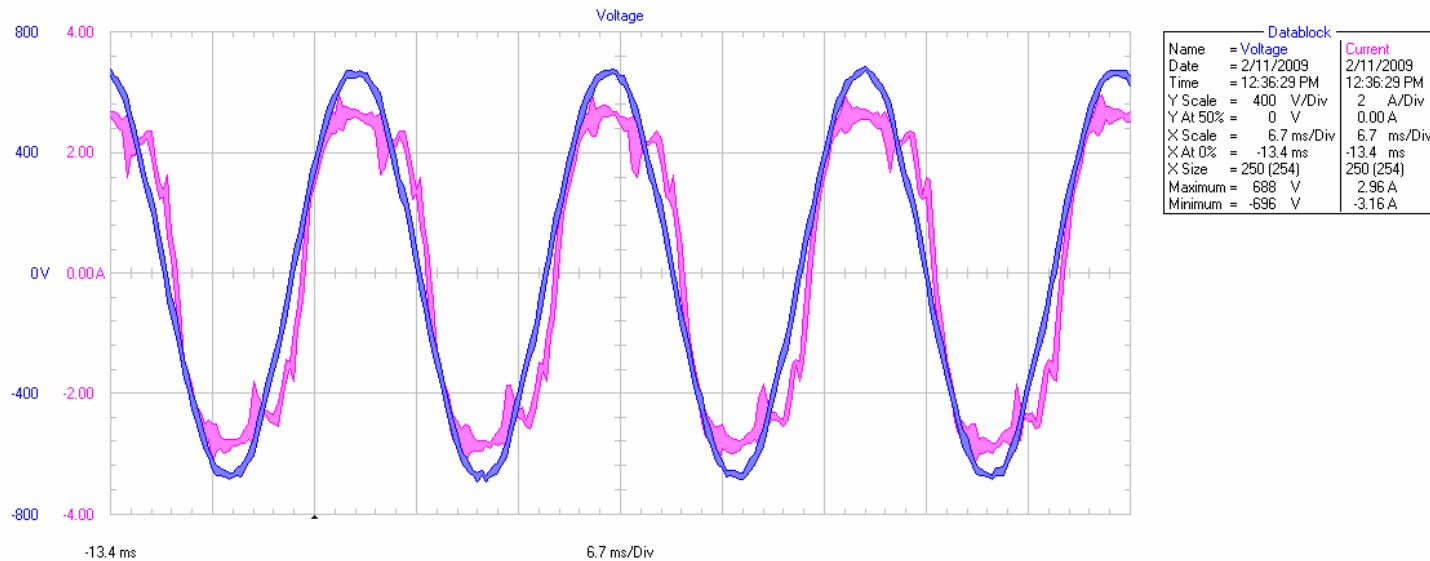


LED Luminaire High Output
149W
Operated: 55% of the time
PG&E Emerging Technologies
Program, 2009, Report #0815⁵



LED Luminaire Low Output 52W
Operated: 45% of the time
PG&E Emerging Technologies
Program, 2009, Report #0815

CBEA Performance Spec: Demo Data-Other



Total Harmonic Distortion:

LED Product: 20%

Magnetic core & coil ballast: 10%

CBEA Performance Spec: Application focused

Current trends:

- LEED⁶ (SS8) – application focused
- Model Lighting Ordinance⁷ – application focused
- Outdoor Site-lighting Performance⁸ – application focused
- ENERGY STAR^{®9} – product focused



CBEA Performance Spec: Overview

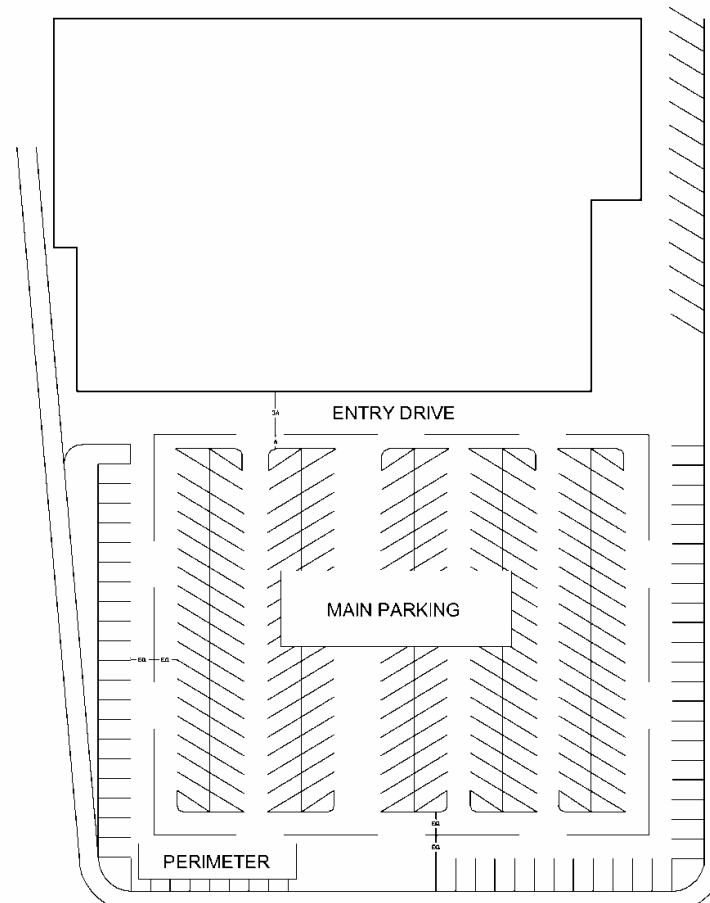
Application-focused specification

- Provides the minimum desired illuminance
 - Mounting Height and site layout affects lighting
- Sets the maximum power density (W/SF) of site
 - Achieves energy efficiency/savings

Product-focused portion

- Luminaire plays role in achieving specification
- Some requirements need to be about the luminaire
 - Color characteristics
 - Warranty
 - Reliability of luminaire

CBEA Performance Spec: Site Requirements



CBEA Performance Spec: Site Requirements

Power Density & Illuminance Requirements

	Power Density	Main Parking Area	Perimeter Parking Area	Front Aisle	Entry/Rear Drive, Bale and Pallet Areas
LZ0	N/A	N/A	N/A	N/A	N/A
LZ1	0.04 W/sf	N/A	N/A	N/A	N/A
LZ2	0.05 W/sf	0.50 fc	0.20 fc	1.00 fc	0.20 fc
LZ3	0.06 W/sf	0.75 fc	0.40 fc	1.50 fc	0.40 fc
LZ4	0.08 W/sf	1.00 fc	0.50 fc	2.00 fc	0.50 fc

Illuminance values meet or exceed IESNA RP-20-98, *Lighting Parking Facilities*, requirements

CBEA Performance Spec: Site Requirements

Uniformity

- Specified via Coefficient of Variation (CV)
 - Max : Min and Avg : Min only look at (2) values
 - CV examines the distribution of data
 - Required CV: 0.41
 - Corresponds with 10:1 max:min
- Calculating CV:
 - σ = Standard of Deviation
 - X_i = illuminance at point I
 - n = the number of points measured
 - \bar{x} = the mean illuminance value

$$\sigma = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n}}$$

$$CV = \frac{\sigma}{\bar{x}}$$

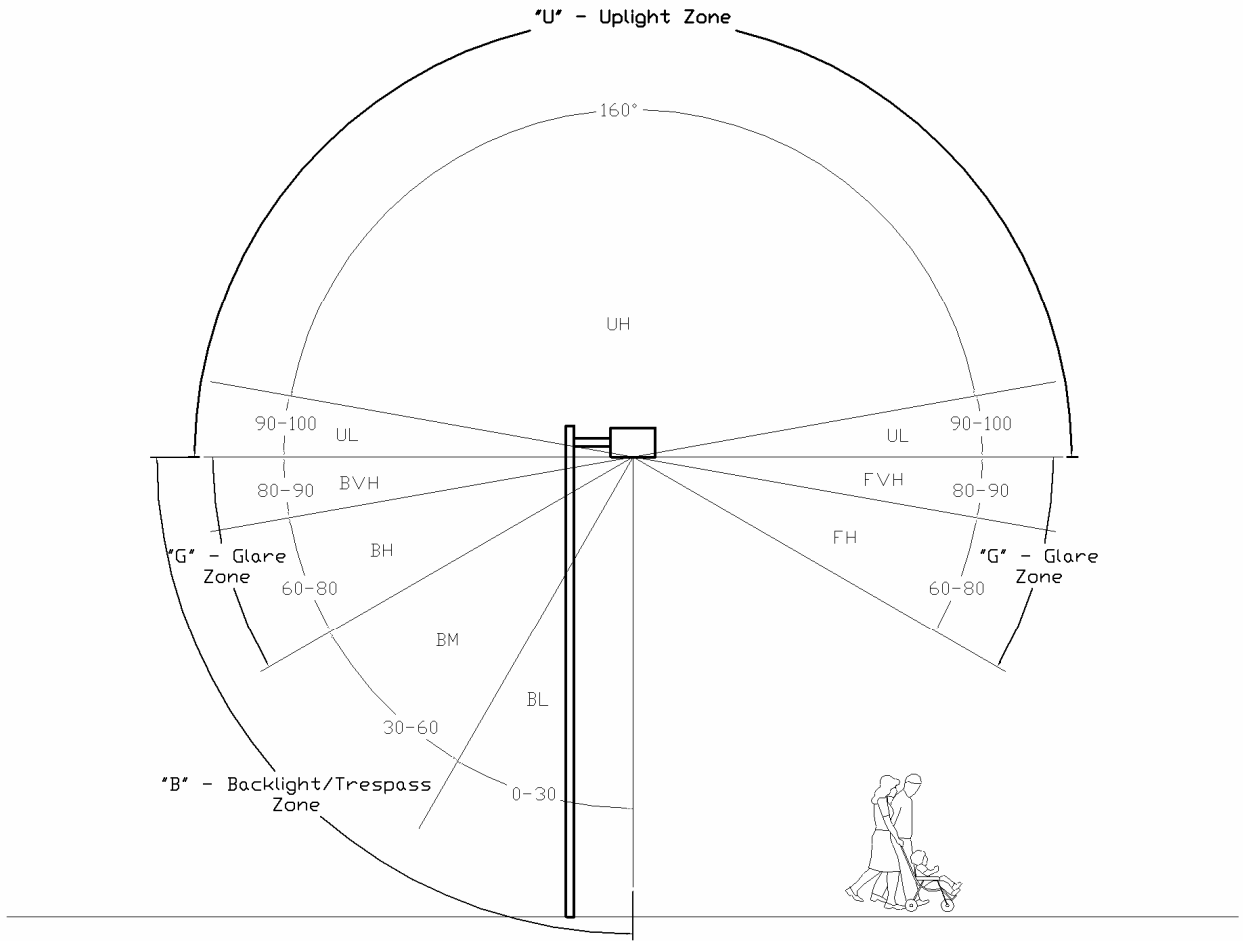
CBEA Performance Spec: Luminaire Requirements

Luminaire Requirements

- Output/Distribution
 - Cut-off classifications – outdated IESNA metric
 - “BUG” Ratios – new IESNA metric
- Color-related output
 - Correlated Color Temperature (CCT)
 - Color Rendering Index (CRI)
- Warranty



CBEA Performance Spec: Luminaire Requirements



CBEA Performance Spec: Luminaire Requirements

Maximum Allowed Lumens in the Uplight Zone for Luminaires

Lighting Zone	Uplight Low (90° – 100°)	Uplight High (100° – 180°)
LZ0	0 lumens (U0)	0 lumens (U0)
LZ1	10 lumens (U1)	10 lumens (U1)
LZ2	100 lumens (U2)	100 lumens (U2)
LZ3	500 lumens (U3)	500 lumens (U3)
LZ4	1000 lumens (U4)	1000 lumens (U4)

CBEA Performance Spec: Luminaire Requirements

Maximum Allowed Lumens in the Glare Zone for Asymmetric Luminaires

	Forward High (60° – 80°)	Forward Very High (80° – 90°)	Back High (60° – 80°)	Back Very High (80° – 90°)
LZ0	660 lumens (G0)	10 lumens (G0)	110 lumens (G0)	10 lumens (G0)
LZ1	1800 lumens (G1)	250 lumens (G1)	500 lumens (G1)	250 lumens (G1)
LZ2	5000 lumens (G2)	375 lumens (G2)	1000 lumens (G2)	375 lumens (G2)
LZ3	7500 lumens (G3)	500 lumens (G3)	2500 lumens (G3)	500 lumens (G3)
LZ4	12000 lumens (G4)	750 lumens (G4)	5000 lumens (G4)	750 lumens (G4)

CBEA Performance Spec: Luminaire Requirements

Maximum Allowed Lumens in the Glare Zone for Symmetric Luminaires

	Forward High (60° – 80°)	Forward Very High (80° – 90°)	Back High (60° – 80°)	Back Very High (80° – 90°)
LZ0	660 lumens (G0)	10 lumens (G0)	660 lumens (G0)	10 lumens (G0)
LZ1	1800 lumens (G1)	250 lumens (G1)	1800 lumens (G1)	250 lumens (G1)
LZ2	5000 lumens (G2)	375 lumens (G2)	5000 lumens (G2)	375 lumens (G2)
LZ3	7500 lumens (G3)	500 lumens (G3)	7500 lumens (G3)	500 lumens (G3)
LZ4	12000 lumens (G4)	750 lumens (G4)	12000 lumens (G4)	750 lumens (G4)

CBEA Performance Spec: Luminaire Requirements

Correlated Color Temperature

- The color appearance of the light source(s)
- Not a performance metric
- Acceptable CCTs: 2700 K – 6500 K
 - In line with ANSI C78.377

Color Rendering Index

- CRI of 65 or better
 - Acknowledged that CRI metric not designed for LEDs

Warranty

- 5 years on luminaire and power supply
- Possible option for extended warranty;
 - Terms and \$\$ to be negotiated by site and manufacturer

CBEA Performance Spec: Performance Verification

Photometric Analysis

- Manufacturer/Specification Entity provides 2 analyses:
 - Installation conditions
 - Future conditions (assuming Light Loss Factors)
- Luminaire independently tested (LM-79-08)
 - http://www.netl.doe.gov/ssl/comm_testing-labs.htm
- LED subjected to JEDEC reliability tests:
 - HTOL/RTOL/LTOL/PTMCL/TMSK/Mechanical Shock/Variable Vibration Frequency/SHR/Autoclave

Mechanical Vibration

- Numerous cycles and multiple Gs applied to the luminaire
 - No damage to the luminaire is allowed as a result of the test
 - Luminaire must produce light post test

CBEA Performance Spec: Reliability

Lamp Lumen Depreciation

- A value is needed options include:
 - L_{70} – IESNA handbook recommended point for relamping
 - Temperature and drive current will affect each site differently
- LM-80-08
 - Applies to chips, not luminaires
- TM-21
 - Method for extrapolating LM-80-08 data
 - At least a few months off
 - Multiple competing extrapolation methods

End-of-life verification

- Light source does not outright fail
 - What happens when luminaire goes below LLD value
 - How will sites know when to replace luminaire
 - How to verify the LLD of the luminaires



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Additional Resources

1. DOE SSL Homepage

- <http://www1.eere.energy.gov/buildings/ssl/>

DOE SSL Research & Development Homepage

- <http://www1.eere.energy.gov/buildings/ssl/projects.html>

DOE SSL Market-Based Program Homepage

- <http://www1.eere.energy.gov/buildings/ssl/market.html>

2. Retailer Energy Alliance

- www1.eere.energy.gov/buildings/retailer/subcommittees.html

3. SSL GATEWAY Demonstrations Program

- <http://www1.eere.energy.gov/buildings/ssl/gatewaydemos.html>



Additional Resources

4. CALiPER Program

- <http://www1.eere.energy.gov/buildings/ssl/caliper.html>

5. SSL GATEWAY Demonstrations Program – Raley’s

- http://apps1.eere.energy.gov/buildings/publications/pdfs/ssl/gateway_raleys.pdf

6. U.S. Green Building Council

- <http://www.usgbc.org/>

7. Model Lighting Ordinance

- <http://www.darksky.org/mc/page.do?sitePageId=58880>

Illuminating Engineering Society of North America

- <http://www.iesna.org>

International Dark-Sky Association

- <http://www.darksky.org>



Additional Resources

8. Lighting Research Center

- <http://www.lrc.rpi.edu/>
- http://www.lrc.rpi.edu/researchAreas/pdf/instructions_for_building_OSP_box.pdf
- *Outdoor site-lighting performance: A comprehensive and quantitative framework for assessing light pollution* – Lighting Research & Technology 2008; 40: 201-224
- *Predicting discomfort glare from outdoor lighting installations* – Lighting Research & Technology 2008; 40: 225-242

9. SSL ENERGY STAR

- http://www1.eere.energy.gov/buildings/ssl/energy_star.html