Occupancy Sensor Coupled LED Lighting for Cold Cases and Exterior Lots

ET11SCE1220 / ET11SCE1221

Prepared by:

Design & Engineering Services
Customer Service Business Unit
Southern California Edison

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Acknowledgements

Southern California Edison's Design & Engineering Services (DES) group is responsible for this project. It was developed as part of Southern California Edison's Emerging Technologies Program under internal project numbers ET11SCE1220 and ET11SCE1221. DES' Jack Melnyk conducted this technology evaluation with overall guidance and management from Anthony Hernandez. For more information on this project, contact Jack.Melnyk@sce.com.

Disclaimer

EXECUTIVE SUMMARY

This project examines performance parameters and effective use of controllable light-emitting diode (LED) component systems for commercial cold storage and exterior outdoor parking lots (pole and structure mounted). Currently, there is not a standard systems approach for presence sensor technology (occupants or transports/vehicles sensing) coupled to LED technology. Bundling these technologies, thereby creating a systems approach, has the potential for significant energy reduction for both environments. While these tests were concurrently performed on the same site, implementation of emerging technology LED lighting and occupancy sensor technology, as a package, has standalone value for both applications. If Southern California Edison (SCE) were to incentivize LED lighting with occupancy (motion sensor) controls as a system, such a system could be marketed and implemented at exterior sites as well as cold storage warehouse facilities, or sites with both functions. This systems approach also has potential with other industrial, commercial, and governmental environments exhibiting similar characteristics.

The major goals for this project are as follows:

- Examine performance and effectiveness of controllable LED component systems for commercial cold storage and exterior outdoor parking lots (pole and structure mounted).
- Demonstrate that bundling these technologies (LED-lamped luminaires and occupancy sensing motion controls), provides an effective energy saving system.
- Explore viability potential for significant energy reduction in a diverse range of spaces with the adaptation of this technology into existing and new construction environments.

Results of the projects controllable LED component system testing were very promising. Use of controllable LED component systems for commercial cold storage as well as outdoor parking lots demonstrated that significant energy savings and demand reduction is possible for such environments. Overall, sensors exhibited good response to vehicular (fork lifts, pallet jacks, and delivery trucks) and occasional pedestrian traffic.

Currently this technology system package is not under an SCE incentive program.

Test results from the project model were extremely favorable. Based on findings from this test model, several beta field applications at similar and related sites are recommended. These beta installations would serve to verify the reliability and constancy of performance and effective energy savings recorded on the model.

Given these favorable results and observing the quality (rugged nature) and ease of commissioning of the luminaire systems, it is believed they are now reliable high-performance systems capable of delivering consistent energy savings. They are candidates bundled for packaging into SCE customer incentive programs. There are no interior cold case PIR limitations. The PIR limitations on exterior applications occur when fixture spacing exceeds approximately 65 feet. Where this spacing is exceeded, pole or structure mounted systems can use mesh control coupled PIR motion sensing or microwave sensors. Applying the same best-practice system discovery used for this project, it is believed this study can serve as a baseline for two LED occupancy/motion control system SCE incentive programs.

TABLE ES-1. SUMMARY OF ENERGY SAVINGS AND DEMAND REDUCTION PER LUMINAIRE-COLD CASES

	ANNUAL ENERGY CONSUMPTION (KWH/YR)	ANNUAL ENERGY SAVINGS (KWH/YR)	PEAK DEMAND (KW)	PEAK DEMAND REDUCTION (KW)
Baseline	1,528	-	0.452	-
New Technology	426	1,102	0.167	0.326

TABLE ES-2. SUMMARY OF ENERGY SAVINGS AND DEMAND REDUCTION PER LUMINAIRE-EXTERIOR (PARKING LOT & DOCK)

	ANNUAL ENERGY CONSUMPTION (KWH/YR)	ANNUAL ENERGY SAVINGS (KWH/YR)	PEAK DEMAND (KW)	PEAK DEMAND REDUCTION (KW)
Baseline	1,528	-	0.452	-
New Technology	423	1,105	0.193	0.327

ABBREVIATIONS AND ACRONYMS

AGI	AGI-32 is Lighting Simulation Software made by Lighting Analysts, Inc.
CRI	Color Rendering Index
CWA	Constant Wattage Autotransformer
eV	Electron Volt
fc	Footcandle
IESNA	Illuminating Engineering Society of North America
ILC	Integrated Lighting Concepts, Inc.
LED	Light Emitting Diodes
LDD	Lamp Dirt Depreciation
LLD	Lamp Lumen Depreciation
LLF	Light Loss Factor
Lm	Lumen
LPD	Lighting Power Density
LPW	Lumens per watt
kW	Kilowatt
kWh	Kilowatt-hour
mA	Milli-Amp
MH	Metal Halide
NA	Not Applicable
N/A	Not Available
Niche Market	Market segment that is specialized and/or has limited application or use
PSMH	Pulse Start Metal Halide
RMS	Root Mean Square
SCE	Southern California Edison Company
SCLTC	Southern California Lighting Technology Center
W	Watt

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INTRODUCTION

Currently, Occupancy Sensor Coupled light-emitting diode (LED) lighting applications are not prevalent. LED technology, as a stand-alone - is still rare. There are however, large markets present for both cold case and exterior parking lot applications for the marriage of occupancy sensors and LED lighting. The goal of this project was to demonstrate how effective such marriages could be. Using Occupancy Sensor Coupled LED lighting can result in significant energy savings over incumbent technologies, and on cold case and exterior parking lot applications. An additional benefit, unique to LED and derived from operating LED at reduced energy loads, is the significantly extended life of the LED lighting component (light engine) while at reduced load.

- The cold case study included analyses of incumbent pulse start metal halide (PSMH) lighting versus the emerging technology Occupancy Sensor Coupled LED lighting. An overview of those two systems follows:
    - Incumbent – 400 Watt (W) PSMH non-dimmable with manual on/off switches uses 452W connected load per luminaire providing 100% light/power output continuously on during each operational period.
    - Emerging – LED with controllable on/off by occupancy sensing, uses 172W connected load per luminaire at 100% output when the space is occupied. It shuts off to zero power/zero light 6 minutes after the space becomes vacant. Lights switch on/off individually for maximum consumption/demand savings.
- The exterior open lot study included analyses of incumbent PSMH lighting versus the emerging technology Occupancy Sensor Coupled LED lighting. An overview of those two systems follows:
    - Incumbent – 400W PSMH non-dimmable operated dusk-to-dawn via time clock control uses 452W connected load per luminaire providing 100% light/power output continuously on during each operational period.
    - Emerging – LED with sensor controllable high/low via occupancy sensing and on/off via same time clock control as incumbent, uses 204W connected load per luminaire at 100% light/power output when the lot is occupied, and 19% power (25W) and 17% of full light after 6 minutes of no occupant or vehicular traffic. Lights switch high/low individually for maximum consumption/demand savings.
- Commercial cold case and parking lots for all market segments can yield significantly reduced energy and demand loads using this marriage of technologies. Performance of the LED, as a standalone on the test models, captures energy reductions of 62% and 55%, respectively for the cold case and exterior models. Adding the occupancy sensor component can result in an overall 70% to 80%, and 65% to 75 % energy load reductions, respectively for the cold cases and the exterior during their operational periods. The cold cases may experience an energy demand reduction estimated at an additional zero to 10%; the exterior system demand reduction is estimated at 20% to 30%.
- Results from the test model were extremely positive. Based on these findings immediate introduction of these packaged technologies is warranted.

A food company, located in Rancho Cucamonga, California, was chosen because this site represented an excellent opportunity to accommodate the assessment of both cold case lighting and exterior parking lot lighting. Occupancy sensor coupled LED lighting was installed for each test space. The LED lighting replaced the incumbent PSMH lighting on a one-to-one luminaire basis without power point relocations.

BACKGROUND

Occupancy Sensor Coupled LED lighting has generated interest as the marriage of these two technologies that allows users additional control within spaces that employ the technologies. This higher-level control results in significant load reduction. Additionally, benefits such as extended life of LED systems and environmental control (dark-sky requirements) are benefits of the married technologies. Prior testing and evaluation by Southern California Edison (SCE) and others of LED and motion-sensor married technology has led to interest in expanding Occupancy Sensor Coupled LED lighting into a wider range of application spaces within a broader market.

One prior SCE project, in particular, proved positive results with Occupancy Sensor Coupled LED lighting. A juvenile center parking garage located in Southern California compared incumbent MH (non-controlled) lighting to occupancy sensor coupled LED lighting for covered parking garages. In this study, 82.5W LED luminaires provided equivalent light output on high to 175W MH luminaires. In addition, when switched to low level (27.5W), they provided additional load reduction as well as extending LED operational life.

Figure 1, Figure 2, and Figure 3 show the incumbent MH system versus the LED with motion sensor control at both high and low levels for the Downey covered lot study conducted by SCE in 2008.

FIGURE 1. INCUMBENT PSMH SYSTEM 175W

5.3 FC WITH 5:1 MIN/MAX UNIFORMITY

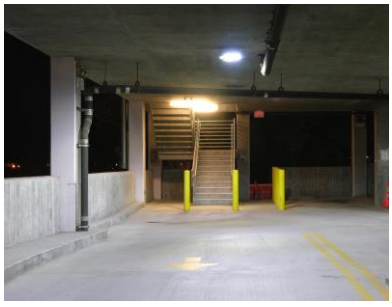


FIGURE 2. LED SYSTEM AT FULL OUTPUT 82.5W

6.9 FC WITH 3:1 UNIFORMITY

FIGURE 3. LED SYSTEM AT LOW OUTPUT 27.5W

3.7 FC WITH 3:1 UNIFORMITY

EMERGING TECHNOLOGY/PRODUCT

- Occupancy Sensor Coupled LED lighting test models are installed to evaluate cold case freezer and refrigerated storage lighting, and open parking lot lighting at our test site.
- Illumination is produced via LED technology. White light LED modules use coatings that are applied to the LED. Radiant energy excites the coating giving off visible white light. This action is somewhat similar to fluorescent lamp technology.
- Occupancy Sensor Coupled LED lighting will eventually replace incumbent PSMH and HPS technologies/products.

- Occupancy Sensor Coupled LED lighting is more energy efficient, affords improved lighting quality, and the ability for wider range control than PSMH and HPS products.
- Current market barriers are price and system knowledge as to application and availability.

ASSESSMENT OBJECTIVES

Objectives were to collect data from the test models, both cold storage and open lot parking, to establish consumption, load, and cost savings potential using Occupancy Sensor Coupled LED lighting. The initial goals were to:

- Save significant energy via fixed deltas inherent to the sources,
- Capture additional (i.e., enhance savings) energy with occupancy sensing controls taking advantage of the instant on-off and deep dimming capacity of the LED technology, and
- See if, for the cold cases, any refrigeration (REFR) compressor savings could be measured.

Methods for measuring and accessing design performance and energy-saving objectives used on this project were:

- Illuminance measurements of the incumbent system (PSMH) versus the test model technology (Occupancy Sensor Coupled LED lighting).
- Field monitoring of power usage (kWh) logged over time comparing; a. incumbent non-dimmable PSMH technology to the dimmable LED with sensor technology, and b. Refrigeration compressor plus cold case lighting load compared before and after the lighting installation.
- Lab sphere testing of luminaire samples used for the emerging technology field test models. Testing to validate manufacturer's performance claims for luminaires used on the project.

The assessment plan for this project includes field and lab testing (a sample of each luminaire model only), lifecycle cost (LCC) analysis, and review of all test data for performance of the LED with motion sensor technology versus the incumbent non-dimmable PSMH technology.

- The main objectives of this project are to determine the viability, performance, and cost effectiveness of LED with motion sensor technology as a replacement for incumbent PSMH technology.
- This project is a technology assessment and evaluation project.
- This technology assessment will include performance evaluations of the emerging technology (LED with motion sensors) versus the incumbent PSMH technology under field conditions. Included in the performance parameters are determining the energy savings and demand reduction over the incumbent technology.

TECHNOLOGY/PRODUCT EVALUATION

The unique feature of the LED systems demonstrated on this project is its instant (and approximately linear) dimming response, which is capable of performing these duties with off-the-shelf products.

- The test site was selected for this field assessment as it provided good access, easy monitoring, and was relatively easy to setup.
- DES staff, along with ILC, conducted this assessment. DES staff conducted the power monitoring and lab testing.
- Fixed (non-controllable with manual on/off switches) electromagnetic ballasted PSMH vs. presence sensor coupled dimmable LED
- Commercial cold case and parking lot applications suitable and scalable to all market segments

TECHNICAL APPROACH/TEST METHODOLOGY

FIELD TESTING OF TECHNOLOGY

A food distribution facility was selected as the test site for both models.

Technology tests consisted of LED luminaires with integrated occupancy sensing motion-detector control gear. The study included two different applications.

The interior test model consisted of LED luminaires placed within cold cases (large walk-in/drive-in freezers and a walk-in/drive-in refrigerator). This system employed occupancy sensor motion controls to turn the system on when the space is occupied and turn completely off when not. Occupants, forklifts, and pallet jacks are entering the freezers and coolers on a periodic basis within a 10-hour workday.

The second test model consisted of exterior LED parking lot luminaires with occupancy sensor motion controls to ramp the system to full output when vehicles or people are in the lot, and lowering system output to 19% power (energy savings mode), and 17% of full light when the lot is not occupied. This system operates from dusk to dawn. The site has a large parking lot located to the east of the warehouse for delivery service trucks and warehouse open storage. There are also parking lots at the west side (front) and the north side of the building. All three lots were used for the exterior test model.

Existing lighting within warehouse walk-in freezers and cold storage areas were 400W PSMH luminaires without controls. Existing luminaires remained on during the full typical 10-hour work cycle, Monday through Friday. Existing illumination with this system was measured to establish an illumination baseline. Power monitoring was also used to establish an energy consumption baseline for this existing system. Figure 4 and Figure 5 are examples of a freezer room with original PSMH lighting.

All existing parking lot luminaires were also 400W PSMH. Parking lot lighting operates from dusk to dawn year round. The existing parking lot lighting had only time clock On/Off control, with lights on at dusk and off at dawn throughout the year. In addition, light levels for existing lighting were recorded to establish an illumination baseline. Again, as with the interior model, power use was monitored to establish an energy consumption baseline for the existing technology. Original PSMH parking lot lighting appears in Figure 6, Figure 7, and Figure 8.

Emerging technology LED replacement luminaires with motion sensors were installed one-to-one using the same power points as the incumbent PSMH luminaires. Cold case replacements are Beta Edge LED canopy lights with 40-degree optic distribution. (See Appendix A for complete specifications.) Exterior open lot replacements are Beta Edge LED area lights with Type 3 medium distribution. (See Appendix A for complete specifications.)

FIGURE 4. PSMH LIGHTING

Existing PSMH lighting in cold storage and freezers remains On during the typical 10-12 hour work cycle. Lighting must remain on during this cycle because PSMH, when turned off, has a long (over 8-minutes) re-strike start-up time. This lengthy delay is not acceptable as it hinders day-to-day operations.

FIGURE 5. PSMH LIGHTING

Illumination recorded for the incumbent PSMH lighting was on the "low end" of IES recommended illumination of 10 footcandles (fc) to 30fc. The existing PSMH lighting had not been re-lamped and luminaires were not cleaned. Had the system been re-lamped and luminaires cleaned, illumination would have probably been closer to the IES recommended illuminance.

FIGURE 6. TYPICAL POLE- MOUNTED LOT LIGHTS

At the perimeter of the open lot, existing incumbent PSMH lighting consisted of four 400W luminaires mounted on poles 26 feet above finished grade (AFG). The LED test luminaires were mounted one-for-one on existing poles.

FIGURE 7. TYPICAL BUILDING-MOUNTED LOT LIGHTS FOR LOADING DOCK & OPEN LOT EXISTING LIGHTING

Mounted on the building at the rear lot, existed four wall packs with PSMH lighting consisting of 400W luminaires 26 feet AFG. The LED test luminaires were mounted on existing brackets at the same power points as the existing wall packs.

FIGURE 8. TYPICAL BUILDING-MOUNTED LOT LIGHTS FOR PARKING

Mounted on the building, using brackets, at the west (front) and north lots are ten 400W PSMH luminaires 26 feet AFG. The LED test luminaires were mounted on the existing brackets at the same power points as the existing PSMH luminaires.

TEST PLAN

- The incumbent technology in the small freezer was at approximately 1 year of operation, so the lamp burn time is customer estimated at 2,000 hours. Approximately 3 lamp burnouts out of about 18 occurred in the large cold case (combo freezer/refrigerator), so the array in that case is estimated to be at its lamp-rated life of 20,000 hours. Comparisons of existing unrefreshed systems versus refreshed and/or new systems will be calculated using the collected illuminance of existing and the new LED test systems. Industry accepted maintenance and performance data will be used to formulate the variance between new and maintained lighting for incumbent PSMH and the emerging technology LED lighting.
- Energy input and output were monitored for both the incumbent PSMH lighting and the emerging technology LED lighting during the duration of this technology testing and evaluation. Representative monitoring data intervals before and after the respective cold case and exterior new installations were analyzed.
- Revolution Wireless data logging equipment and a Power Vista power quality analyzer meter recorded data every one 1 - 5 minutes over the course of testing. This was done for both the incumbent PSMH as well as the LED lighting.
- In addition to data logging power usage and operational functions (sensors on/off – cold storage and dimming exterior outdoor lots), illuminance readings were compiled and reviewed against IES recommended illuminance for the applications in our test models. LPD of incumbent PSMH and emerging technology LED lighting were also calculated for the areas comprising our test models. LPD's were then compared to California T24 energy code allowed LPD's to validate compliance with code.

TABLE 3. REFRIGERATED WAREHOUSE

GUIDELINES & TARGETS	ILLUMINANCE (H)	ILLUMINANCE (V)	UNIFORMITY	POWER DENSITY
IES Recommendations (10th HB)	10fc – 30fc	15fc – 5fc	5:1 (avg.: min.)	NA
TITLE 24 Compliance (T24-08)	NA	NA	NA	0.7W Sq. Ft

TABLE 4. OPEN PARKING LOTS

GUIDELINES & TARGETS	ILLUMINANCE (H)	ILLUMINANCE (V)	UNIFORMITY	POWER DENSITY
IES (10th HB) Standard Security	0.2fc Min.	0.1fc Min.	20:1 (max.: min.)	NA
IES (10th HB) High Security	0.5fc Min.	0.25fc Min.	15:1 (max.: min.)	NA
TITLE 24 Compliance (T24-08)	NA	NA	NA	LZ-3 Targets*

* LZ-3: 0.092W X Sq. Ft + 0.92W X Lin. Ft. + 770W = Total Allowed LPD

INSTRUMENTATION PLAN

Test instruments to measure illuminance, demand load, and laboratory testing of luminaires used for the test models were employed for testing of the LED luminaires with integrated occupancy sensing motion detector control gear. In addition, photographic equipment and computer modeling software for reference designs prior to install of the test model were employed.

- Minolta T-10 Luminance Meter
- Canon 450D SLR with EFS 17-85MM lens
- PMI Revolution Wireless Power Quality Recorders 600V/500A Max
- Power Vista Power Quality Analyzer
- AGI-32 Lighting Simulation Software
- SCE LTTC Labsphere SLMS LED 7650

INSTRUMENTATION PLAN - ILLUMINANCE

- Illuminance readings were obtained using a Minolta T-10 illuminance meter Performance specifications for the Minolta T-10 is described with the image of the meter in Figure 9.
- Illuminance readings were taken at grade (horizontal) and at 6-foot (vertical) for existing PSMH lighting and LED test lighting in freezer and refrigerated warehouse walk-in cases. At the open parking lots, only the illuminance for LED test models was recorded. Illuminance for existing PSMH incumbent technology was not documented.

Illuminance Meter T-10 <standard receptor head>

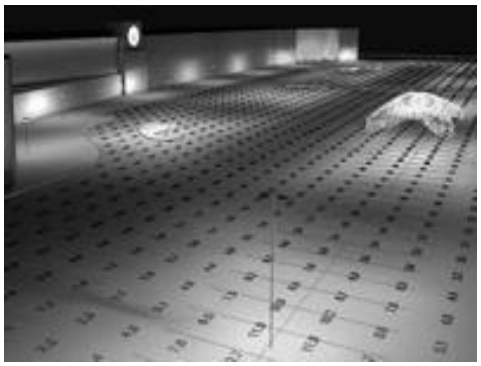
Minolta T-10 SPECIFICATIONS

Type:	Digital illuminance meter with detachable head and cable
Receptor:	Silicon photocell
Range:	0.1 – 200,900 Lux 0.001 – 29,990 Foot-candles
Accuracy:	+- 2% +-1 digital value displayed
Purchase & Calibration:	August 14, 2010 *(1876-242)*

FIGURE 9. – MINOLTA T10 ILLUMINANCE METER USED FOR MEASUREMENTS

- Photographic equipment consisted of a single-lens reflex camera and Canon 17mm to 85mm high-resolution image stabilized lens.
- Reference images were taken with camera set at ISO 800 and 1600 with use of semi-manual metering.
- AGI-32 lighting simulation software was used to render computer models before installation of the LED lighting field models with integrated occupancy sensing motion detector control gear.
- This tool was used to create computer models used in evaluating the technologies prior to field install test models is a recognized premier computer software program modeling tool for lighting design and evaluation. AGI-32 is primarily a calculation tool for accurate photometric predictions. A technical tool, the AGI-32 can compute illuminance in any situation, assist in luminaire placement and aiming, and validate adherence to any number of lighting criterion.

However, there is so much more that can be done to enhance the understanding of photometric results. Visualization is extremely important to comprehend changes in luminance for different materials and surface properties, and predict the effect of various luminaire designs in real world, light and surface interaction.



AGi32 rendering with Overlay feature enabled

INSTRUMENTATION PLAN – DATA LOGGING

Kilowatt consumption over time (kWh) was monitored using Revolution Wireless Power Quality Recorders and a Power Vista Power Quality Analyzer. Logging for both the incumbent PSMH and the emerging technology LED lighting was performed using this equipment. Detail specifications are located in Appendix A.

INSTRUMENTATION PLAN – SPHERE TESTING LUMINAIRES

Luminaires used for the cold storage and open lot lighting analysis field test model were also tested in the SCE Lighting Technology Center's Spectroradiometer sphere. Two different LED luminaires with integral occupancy senor control were sphere tested. One luminaire was a canopy style mount 5-bar unit, the other an area style pole and/or bracket mount 6-bar unit. Manufacturers outline specifications of each luminaire type follows:

- 5 BAR CANOPY MOUNT LUMINAIRE-525 ma driver (used for freezer & refrigerated cases)
    - Rated Watts: 172
    - Rated Lumens: 14,205
    - Rated Chromaticity: 4,300K
    - Rated Color Rendering : 70 CRI
    - Rated Photometric Distribution: 40-degree Flood
    - Rated Life: 50,000 hrs. LM-85

- 6 BAR AREA POLE/BRACKET LUMINAIRE-525/75 ma driver (used for open lots) cases
    - Rated Watts: 204
    - Rated Lumens: 17,045
    - Rated Chromaticity: 4,300K
    - Rated Color Rendering: 70 CRI
    - Rated Photometric Distribution: Type III Medium
    - Rated Life: 50,000 hrs. LM-85

Results of SCEs LTTC sphere testing for these two luminaires is posted in the "Results" section of this report. Sphere results for the sample luminaires tested were compared against manufacturer's claims. Sphere testing is used to confirm claimed luminaire and lamp performance as well as to identify potential anomalies or other deviation from filed performance testing.

RESULTS

Results were obtained for illuminance and power usage of the incumbent PSMH versus the advanced technology LED lighting with motion sensor control. The data recordings as well as analysis of the recordings are presented in this section of the report.

DATA ANALYSIS

DATA ANALYSIS – ILLUMINANCE AND LPD FOR FREEZER COLD CASE STORAGE

Illuminance levels for the LED technology were over six times higher and almost four times higher than the incumbent PSMH lighting. These significantly higher light levels were obtained with LED luminaires using only 38% of the energy (172W) versus (453W) of each PSMH incumbent luminaire. LPD for the incumbent PSMH system (0.98W/SF) is not compliant with current Title 24-2008 allowed LPD for refrigerated warehouses. The LED systems LPD (0.46W/SF) is almost 40% lower than that allowed under Title 24-2008 compliance. This significantly lower LPD should also meet the future Title 24 2013 compliance thresholds.

TABLE 5. FREEZER MODULE COLD STORAGE WAREHOUSE

GUIDELINES & TARGETS	ILLUMINANCE (H)	ILLUMINANCE (V)	UNIFORMITY (H	POWER DENSITY
IES Recommendations (10th HB)	10fc – 30fc	15fc – 5fc	5:1 (avg: min)	NA
TITLE 24 Compliance (T24-08)	NA	NA	NA	0.7W/ Sq. Ft
Metal Halide Incumbent (Exist)	6.5fc	2.8fc	3:1 (avg: min)	0.98W/ Sq. Ft
LED New Technology (Test Mod)	40.9fc	10.1fc	4:1 (avg: min)	0.46W/ Sq. Ft
LED New Technology (AGI-32 Sim)	23.4fc	40.9fc	2:1 (eV: min)	0.46W/ Sq. Ft

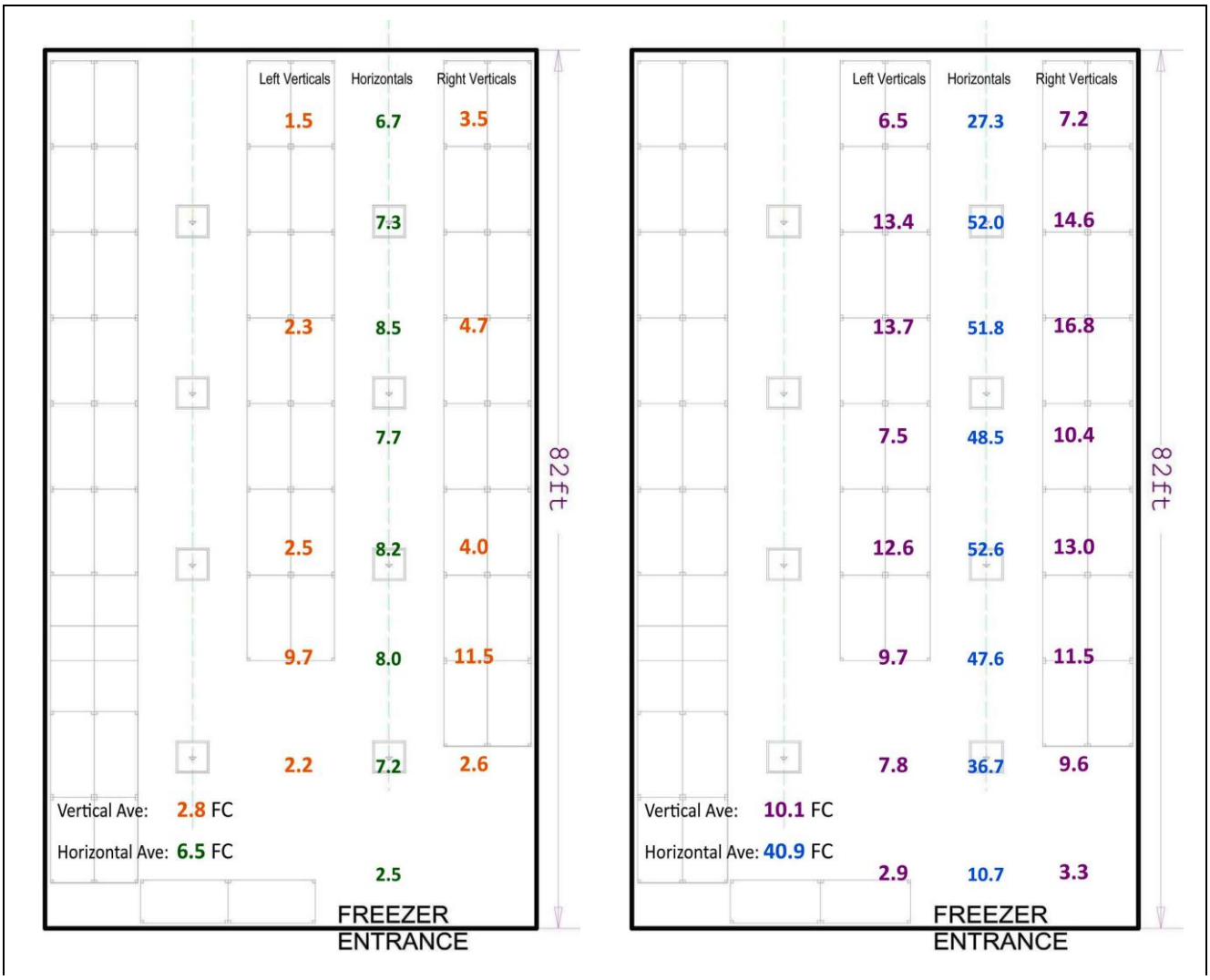


FIGURE 10. MAP COMPARISON OF LIGHT LEVELS IN FREEZER MODULE COLD STORAGE WAREHOUSE

Illuminance levels (horizontal and vertical) were recorded for the stand-a-lone freezer case prior to installation of the LED test model, with existing PSMH lighting. Note: The incumbent system was not re-lamped nor cleaned prior to baseline illumination measurements. Initial light levels for a new or re-lamped/well-cleaned PSMH system are approximately 40% higher than those shown.

Illuminance levels (horizontal and vertical) were also recorded for the stand-a-lone freezer case after installation of the LED test model lighting. Performance of the LED model is superior to that of the incumbent PSMH lighting. Initial light levels are shown. At IES, LM-70 light (50K hours) levels are 30% lower than shown.

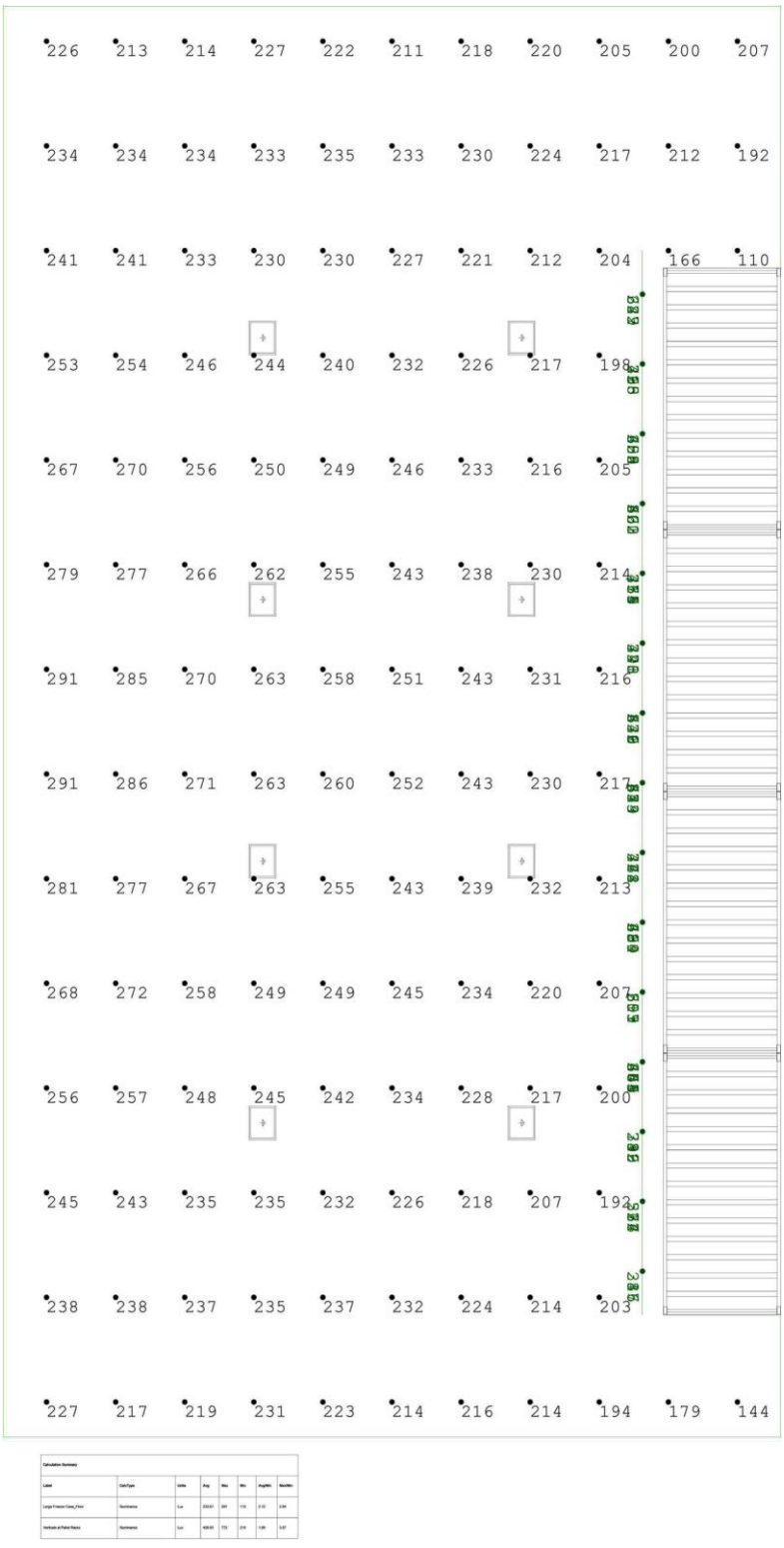


FIGURE 11. AGI-32 LED MODEL - HORIZONTAL LIGHT LEVELS IN FREEZER MODULE COLD STORAGE WAREHOUSE

AGI-32 COMPUTER MODEL OF FREEZER CASE – VERTICAL ILLUMINATION

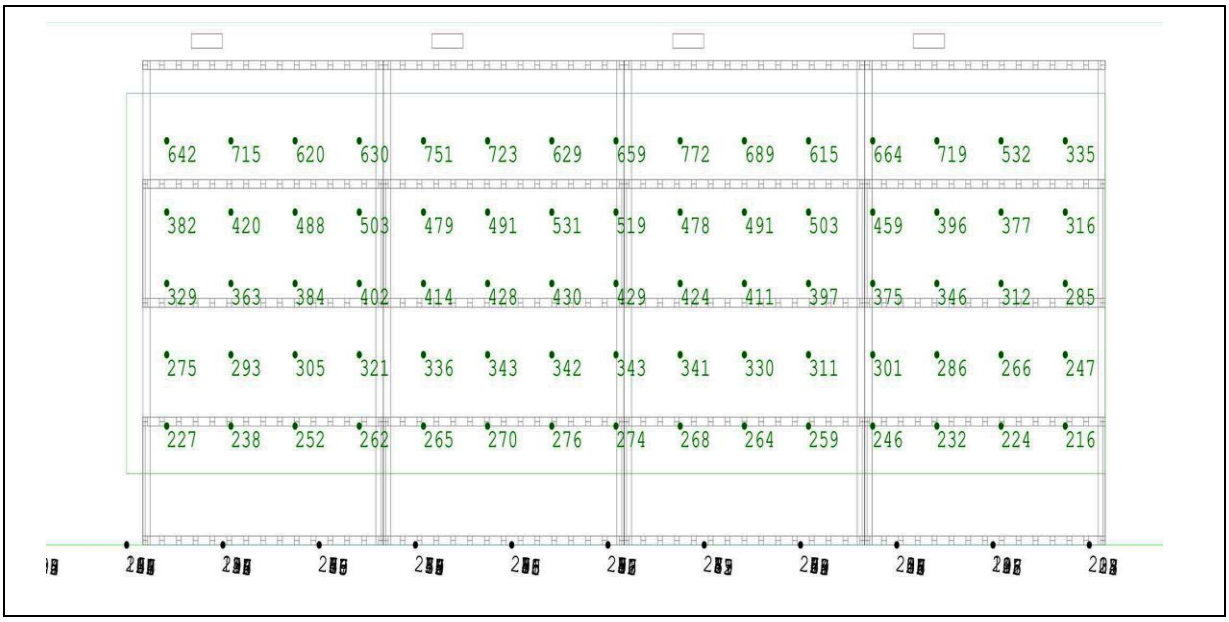


FIGURE 12. AGI-32 LED MODEL - VERTICAL LIGHT LEVELS IN FREEZER MODULE COLD STORAGE WAREHOUSE

Figure 12 demonstrates a vertical illuminance model using AGI-32 modeling computer software. Illuminance readings shown are in Lux. Converted to footcandles, the average illuminance shown on the AGI-32 model at 6-feet vertical off the deck is 23.7fc. AGI-32 modeling projected twice the light levels versus field measurements of the actual test model at the same 6-foot vertical plane in the test model. This more than normal deviancy is being studied to resolve the discrepancy. What is suspected is; the installed luminaires have different photometry and are of a different LED generation than the ones used for the computer model. This hypothesis, however, must be verified.

DATA ANALYSIS – ILLUMINANCE AND LPD FOR REFRIGERATED COLD CASE STORAGE

Illuminance levels for the LED technology were almost five times higher and almost four times higher than the incumbent PSMH lighting. These significantly higher light levels were obtained with LED luminaires using only 38% of the energy (172W) versus (453W) of each PSMH incumbent luminaire. LPD for the incumbent PSMH system (1.18W/SF) is not compliant with current Title 24-2008 allowed LPD for refrigerated warehouses. The LED systems LPD (0.55W/SF) is about 25% lower than that allowed under Title 24-2008 compliance. This lower LPD, most likely, will meet the future Title 24-2013 compliance thresholds.

TABLE 6. REFRIGERATED MODULE COLD STORAGE WAREHOUSE

GUIDELINES & TARGETS	ILLUMINANCE (H)	ILLUMINANCE (V)	UNIFORMITY (H	POWER DENSITY
IES Recommendations (10th HB)	10fc – 30fc	15fc – 5fc	5:1 (avg / min)	NA
TITLE 24 Compliance (T24-08)	NA	NA	NA	0.7W/ Sq. Ft
Metal Halide Incumbent (Exist)	7.5fc	2.9fc	2:1 (avg : min)	1.18W/ Sq. Ft
LED New Technology (Test Mod)	36.3fc	10.6fc	3:1 (avg : min)	0.55W/ Sq. Ft
LED New Technology (AGI-32 Sim)	N/A*	N/A*	N/A*	N/A*

N/A*: AGI-32 modeling not produced for the cold storage design

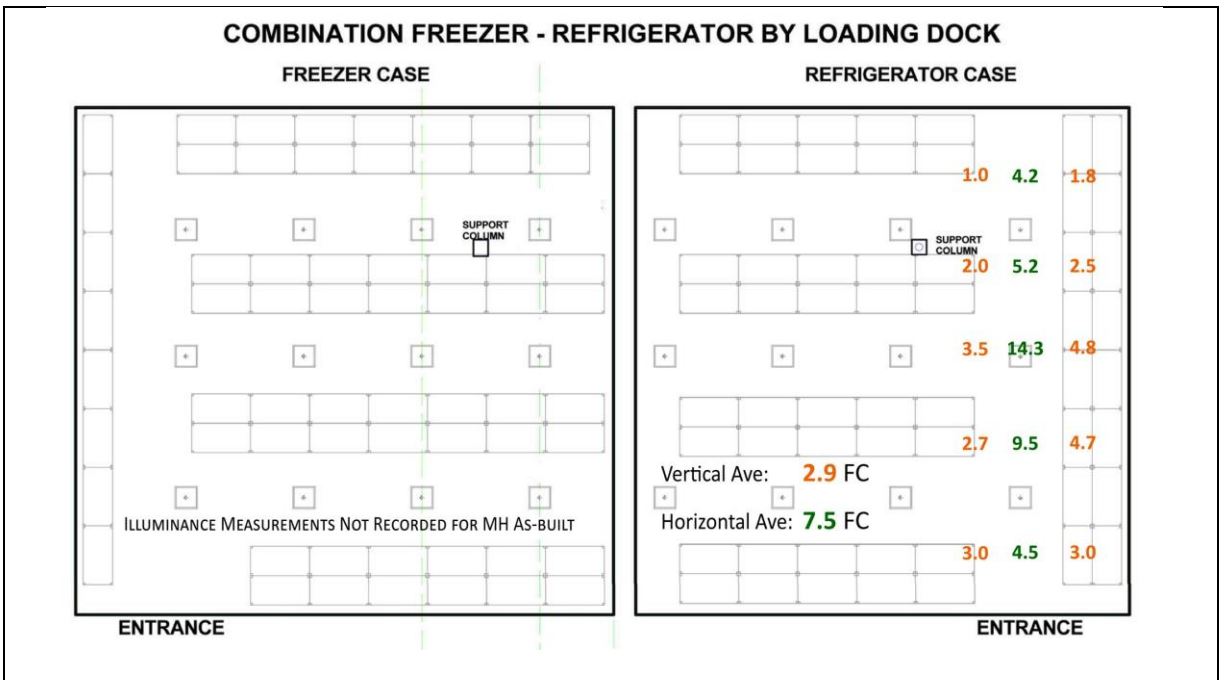


FIGURE 13. MAP - LIGHT LEVELS OF PSMH IN COMBINATION MODULE COLD STORAGE WAREHOUSE

Illuminance levels (horizontal and vertical) were recorded for the refrigerated case prior to installation of the LED test model, with existing PSMH lighting. Illumination with the incumbent PSMH lighting was not measured.

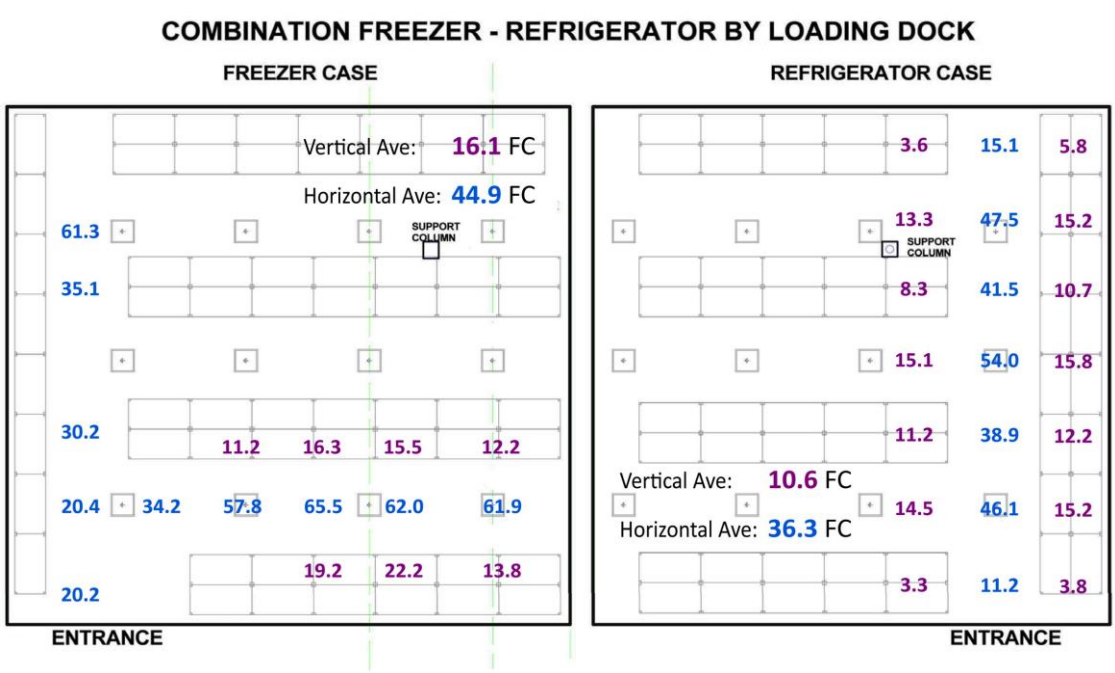


FIGURE 14. MAP - LIGHT LEVELS OF LED IN COMBINATION MODULE COLD STORAGE WAREHOUSE

FIGURE 15. INCUMBENT PSMH LIGHTING

FIGURE 16. EMERGING TECHNOLOGY LED LIGHTING

Visual comparison of the incumbent PSMH versus the LED test model lighting shows the dynamic improvement in color rendering as well as vertical illumination produced by the LED lighting versus the PSMH lighting.

FIGURE 17. INCUMBENT PSMH LIGHTING

FIGURE 18. EMERGING TECHNOLOGY LED LIGHTING

The LED luminaires used in the test model lighting also exhibited less surface luminance, resulting in less glare, versus the incumbent PSMH luminaires.

DATA ANALYSIS – ILLUMINANCE AND LPD FOR EXTERIOR OPEN LOTS

Illuminance levels with LED lighting within the open lots were well above IES recommended practice as outlined in the IES Handbook, 10th Edition. Uniformity was also well above the minimums outlined by the IES. The LED system's LPD (0.040W/SF) is more than 50% lower than that allowed by Title 24-2008. This new system will also fall well within the more stringent LPD for parking lots proposed for compliance under the future Title 24-2013 California Energy Code.

TABLE 7. TEST SITES OPEN PARKING LOTS (AVG. OF THREE AREAS)

GUIDELINES & TARGETS	ILLUMINANCE (H)	ILLUMINANCE (V)	UNIFORMITY (H)	POWER DENSITY
IES (10th HB) Standard Security	0.2fc Min.	0.1fcMin.	20:1 (max : min)	NA
IES (10th HB) High Security	0.5fc Min.	0.25fc Min.	15:1 (max : min)	NA
TITLE 24 Compliance (T24-08)	NA	NA	NA	0.12W/ Sq. Ft.*
Incumbent PSMH Base Model	N/A	N/A	N/A	0.093W/ Sq. Ft.
Test Model LED with Sensors	0.97fc	0.61fc	11:1 (max. : min.)	0.040W/ Sq. Ft.
LED New Technology (AGI-32 Sim)	0.33fc **	0.33fc **	10:1 (max. : min.)	0.040W/ Sq. Ft.

*** LZ-3:** 0.092W X Sq. Ft + 0.92W X Lin. Ft. + 770W = Total Allowed LPD of 11,098W

****AGI:** AGI-32 modeling represents truck parking and staging area only while test model data is average of field measured illumination for all the open lot model areas.

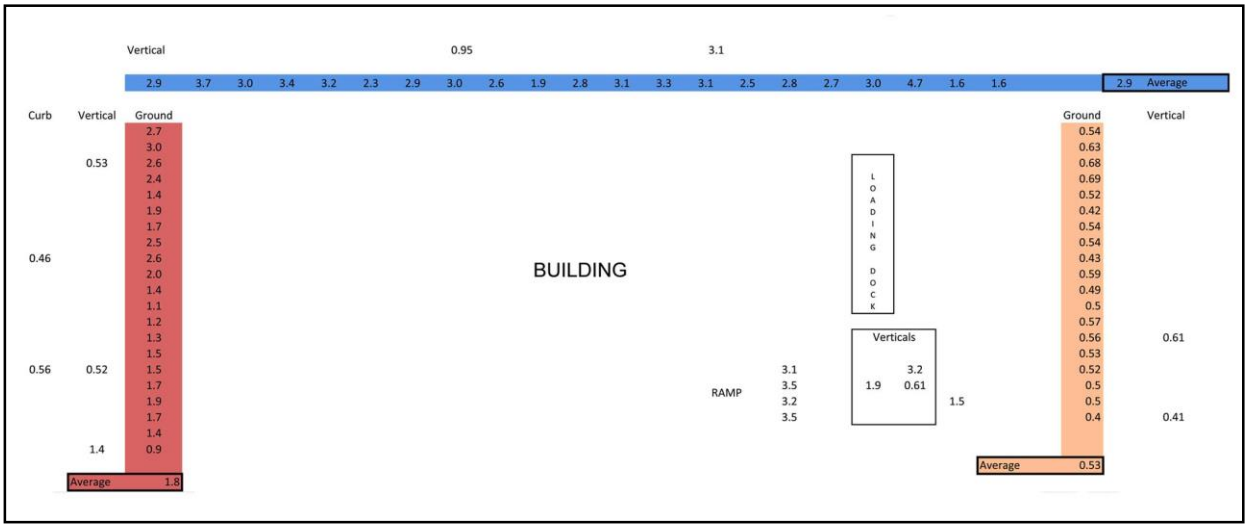


FIGURE 19. MEASURED LIGHT LEVELS OF LED MODEL AT PARKING LOTS PLUS – TRUCK QUEUE & LOADING DOCKS

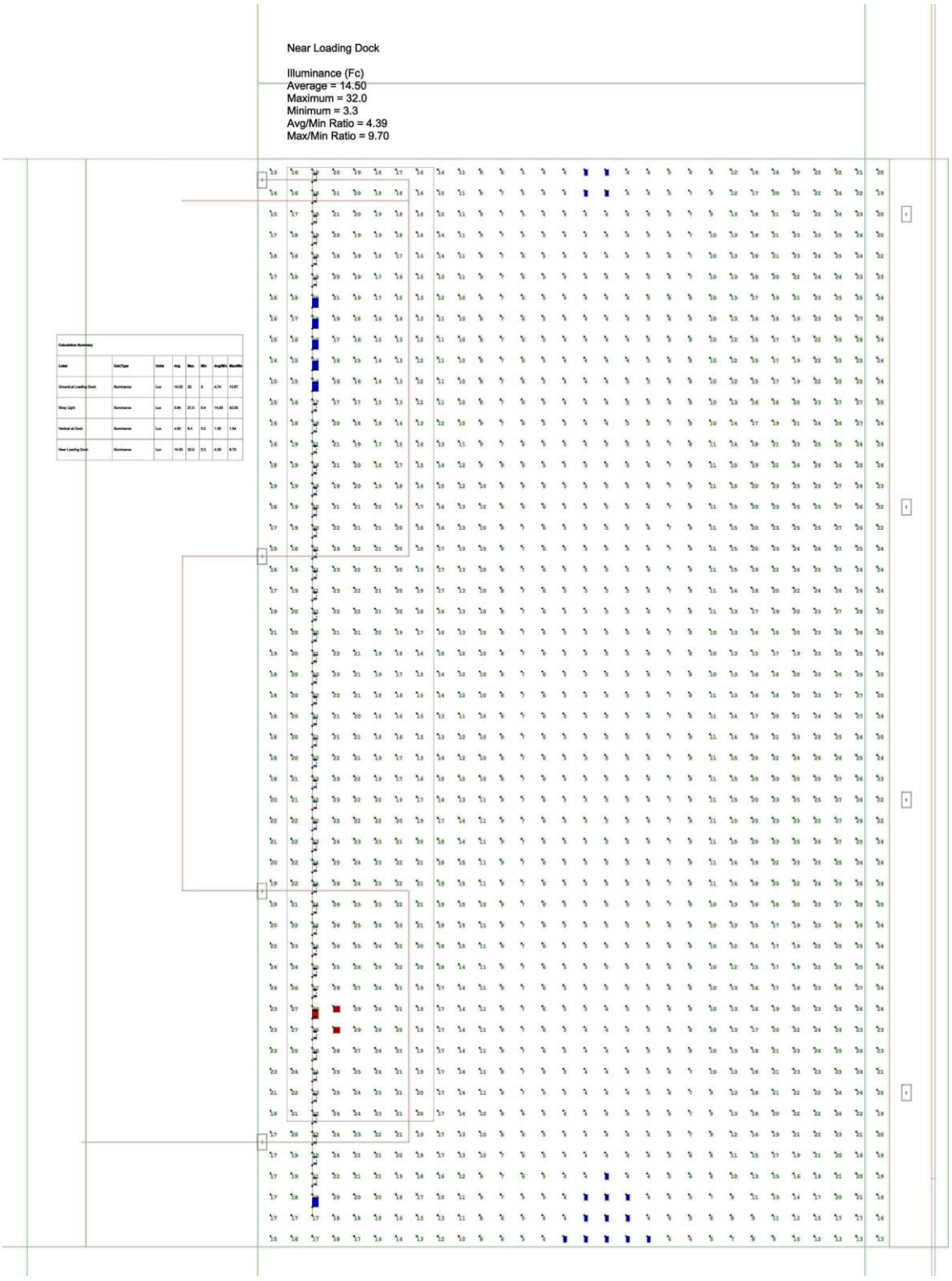


FIGURE 20. MEASURED LIGHT LEVELS OF LED MODEL AT PARKING LOTS PLUS – TRUCK QUEUE & LOADING DOCKS

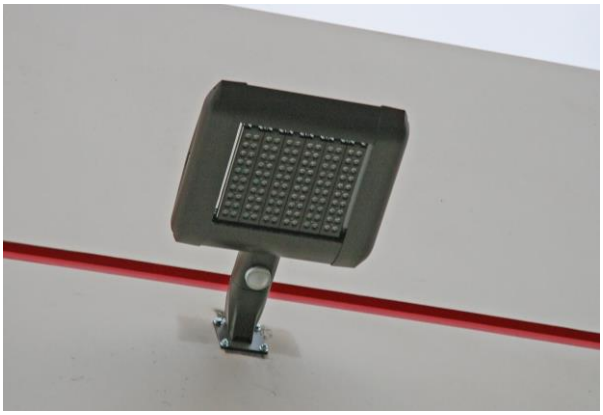


FIGURE 21. LED LUMINAIRE DURING THE DAY

FIGURE 22. LED LUMINAIRE AT NIGHT

FIGURE 21 represents a daytime image of one of the LED test luminaires mounted level to face of building. The new LED filled the same power point locations as the old PSMH.

FIGURE 22 represents a nighttime image of several LED luminaires mounted to the building. These luminaires are lighting the north parking lot.

FIGURE 23. LED lighting at rear lot (truck staging and dock area)

FIGURE 23 is a nighttime image of the rear parking lot (truck staging, loading unloading area) showing LED luminaires mounted on poles. Additional luminaires (not shown here) mounted to the building are also used to illuminate this lot/staging area. Color quality of the LED lighting contributes to enhanced visual acuity. Note: yellow-orange color lighting is HPS mounted to adjacent building on adjoining site, not part of this project.

DATA ANALYSIS – POWER CONSUMPTION; FREEZER & REFRIGERATED COLD CASE STORAGE

Replacing the incumbent PSMH with LED in the small freezer resulted in a 62% energy reduction versus the incumbent PSMH. Coupling the occupancy sensor to the LED system resulted in an additional 17% savings for a total 79% savings in the small freezer. Energy savings for the combination refrigerator/freezer combo case was close to 70% (reduced wattage of LED luminaires as well as occupancy sensor coupling). The 9% lower savings is attributed to an added load of two additional LED luminaries in the combo case to resolve a design/safety deficiency in the base PSMH incumbent lighting model.

TABLE 8. TEST SITES FREEZER & REFRIGERATED COLD CASE ENERGY STUDIES

COLD CASES - Energy Use Before and After

Eighty-eight hour intervals with the same Monday starting times used for both items

Small Freezer

jmm
SCE D&ES 12/20/2011

PSMH Base

Oct 24 @ 0800 to Oct 28 @ 0000

11726 kwminutes	195.4333 kwh	0.2776042	before avg kw per ppt

LED Emerging Technology

Nov 13 @ 0800 to Nov 17 @ 0000

2466 kwminutes	41.1 kwh	0.0583807	after avg kw per ppt
		78.97%	**reduction small freezer**

79% Reduction in kwh - Replacing PSMH with LED

Combo refrigerator/freezer

PSMH Base

Oct 17 @ 0800 to oct 21 @ 0000

34005.11 kwminutes	566.7518 kwh	0.306684	before avg kw per ppt

LED Emerging Technology

Nov 7 @ 0800 to nov 11 @ 0000

11304.01 kwminutes	1717.026 kwh	0.093083	after avg kw per ppt
		69.70%	**reduction combo unit**

70% Reduction in kwh - Replacing PSMH with LED

Weighted average % savings - COLD CASES : 72.1

Average daily energy consumption of the cold case lighting PSMH versus LED as well as impact of compressor energy loads before and after LED lighting are depicted in the graphs below. The comparison before (PSMH lights – blue graph) versus the after (LED lighting – red graph) tracks the combined weighted 72.1% energy savings. An additional energy reduction is shown for reduced energy load on the compressors because of the lower lighting load. This reduction is tracked at 10% to 15% energy savings because of the lower wattage (less heat) and luminaire off mode when the cold cases are not occupied, which is a byproduct benefit of the LED cold case lighting system.

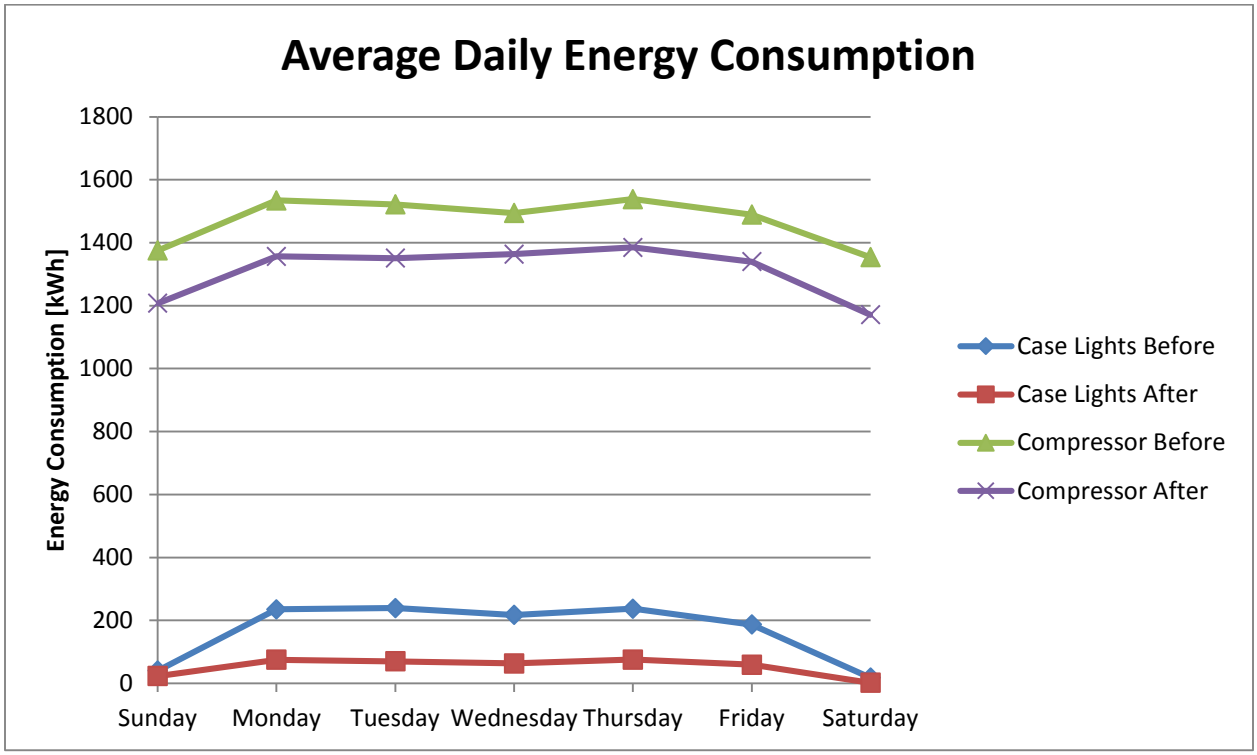


FIGURE 24. AVG. DAILY KWH USAGE CASE LIGHTS AND COMPRESSOR LOAD - INCUMBENT PSMH VERSUS EMERGING LED LIGHTING WITHIN THE FREEZER AND REFRIGERATED COLD CASES

Note: Cold case compressor energy use is dependent on the number of picks and drops (i.e., case entries and portal open times), the characteristics of the loads in those picks and drops (i.e., delivered temperature of the load, its mass…), and exterior (to the main building) ambient temperatures (EAT). Operations were steady as to all of the mentioned factors. To verify the weather effect, local weather data was gathered and found to be consistent, on the average, before and after the LED installation. This is depicted in Table 9. Exterior Ambient Before & After LED Installation.

TABLE 9. EXTERIOR AMBIENT BEFORE & AFTER LED INSTALLATION

Exterior Ambient Before LED Installation
[three day window - 26, 27 & 28 October]

High	Low	
63.0	57.0	
69.0	47.0	
75.0	42.0	
207.0	146.0	Average
69.0	48.7	**58.8**

Exterior Ambient After LED Installation
[three day window - 15, 16 & 17 November]

High	Low	
66.0	45.0	
71.0	45.0	
74.0	47.0	
211.0	137.0	Average
70.3	45.7	**58.0**

DATA ANALYSIS – POWER CONSUMPTION; EXTERIOR OPEN LOTS

LED luminaires used only 45% of the energy (204W) versus (452W) of each PSMH incumbent luminaire resulting in a 55% base energy reduction over the PSMH incumbent lighting. The sensor-coupled occupancy sensors added an additional savings of 17.3% by dimming the LED lighting when occupants were not in the lot. LPD for the incumbent PSMH system (0.098W/SF) is not compliant with current Title 24-2008 allowed LPD for exterior lots. The LED systems LPD (0.046W/SF) is almost 40% lower than that allowed under Title 24-2008 compliance. This significantly lower LPD should also meet the future Title 24-2013 compliance thresholds.

TABLE 10. TEST SITE OUTDOOR EXTERIOR PARKING LOT ENERGY STUDIES

EXTERIOR LIGHTING Energy Use Before and After

Four - 9.25 hour representative intervals

jmm

18 lights SCE D&ES 12/21/2011

Overall savings were 72.3% of which 55% is due to
the fixed differential in connected kW between the luminaires.

PSMH Base

sun	Oct 16 @ 20:00 to Mon oct 17 @ 05:15	
	118984 Wh units	
		Before
mon	Oct 17 @ 20:00 to Tues oct 18 @ 05:15	
	117928 Wh units	

LED Emerging Technology

sun	Nov 27 @ 20:00 to Mon nov 28 @ 05:15	
	34151 Wh units	
		After
mon	Nov 28 @ 20:00 to Tues nov 29 @ 05:15	
	34151 Wh units	

Wh means: watt-hour

		connected watts
before	PSMH	453
after	LED high	204
after	LED low	38

118984	34151
117928	34151
236912	68302

0.288301

55% Reduction in Kwh - Replacing PSMH wi

17.3% Reduction in kwh - Additional for Sensor use

Overall % savings - OPEN LOTS: 72.3

Tracking the energy use of the incumbent PSMH exterior parking lot lighting versus the installed LED with occupancy sensors test model lighting shows that the LED systems performance resulted in a 60% to 80% load reduction. This comparison is depicted in the power consumption graphed Figure 25**.** The 60% energy reduction is primarily from the reduced load of the LED lighting while the 80% reduction represents the energy savings gained when the occupancy sensors coupled to the LED system have lowered luminaire output to the "vacant" position.

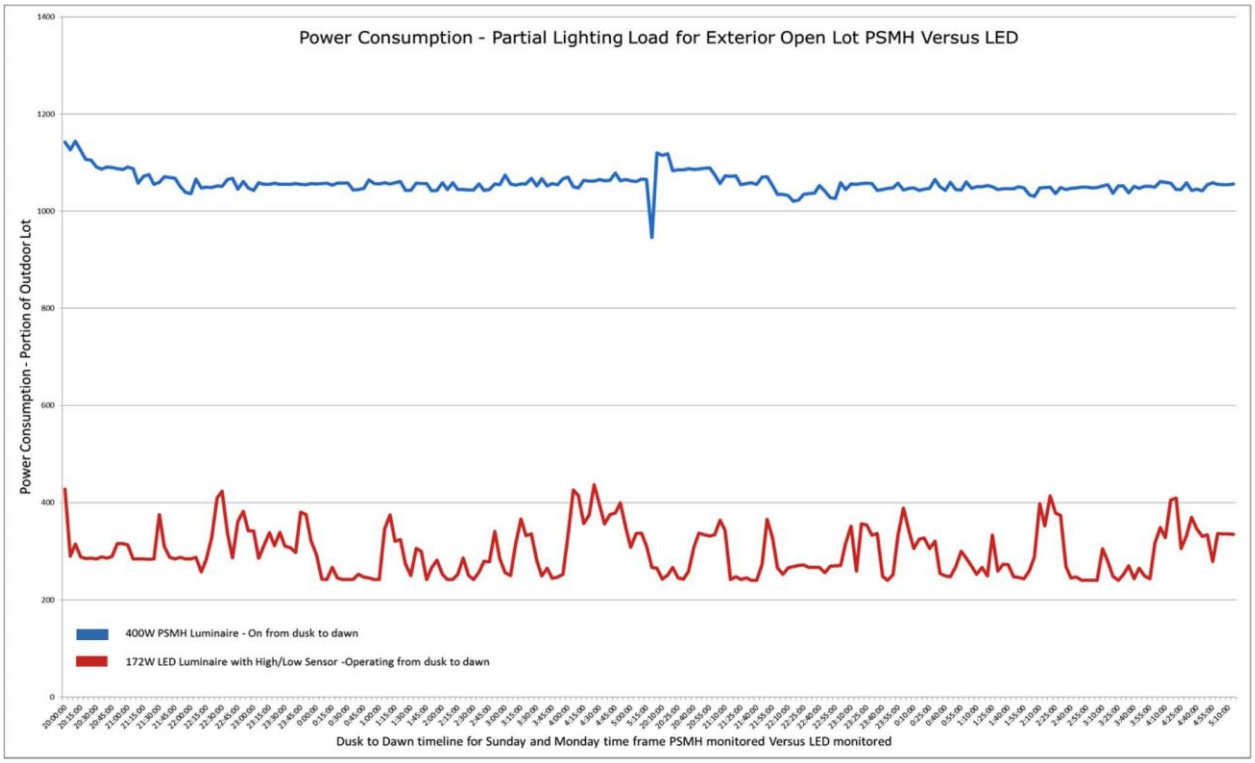


FIGURE 25. KWH USAGE DUSK TO DAWN TRACKED FROM SUNDAY EVENING TO TUESDAY MORNING INCREMENTS FOR BOTH INCUMBENT PSMH AND EMERGING LED LIGHTING WITHIN THE EXTERIOR OPEN LOTS

Summary of Energy Savings and Demand Reduction per Luminaire

	Annual Baseline Metal Halide Energy Use (kWh / YR)	New LED System Energy Use (kWh / YR)	Total Energy Savings (kWh/YR)	Peak Baseline Demand (kW)	Peak New Demand (kW)	Fixed Demand Reduction (kW)	LED Dims to (kW)	Estimated Annual Average Demand (kW)
Cold Cases	1528	426	1102	0.452	0.167	0.285	0	0.126
Exterior	1528	423	1105	0.452	0.193	0.259	0.036	0.125

DATA ANALYSIS – SCE LTTC SPHERE TESTING; LED LUMINAIRES FOR TEST MODEL

Results of SCE LTTC sphere testing for these two luminaires are posted on the pages that follow. Results for canopy luminaires, used for the freezer and refrigerated case cold storage models, are shown at full-output only (after 6 minutes of vacancy) as these luminaires are controlled (using the occupancy sensors) as an off/on mode only, no dimming. The area luminaires for the open lot model has results shown for both high (100% output) when occupants are present and low (dimmed output) when the areas are not occupied. The occupancy sensor in this arrangement dims the system after 6 minutes of vacancy to low, as opposed to shutting it off.

TABLE 11. RESULTS OF SPHERE TESTING

5-BAR CANOPY MOUNT LUMINAIRE-525 ma driver (Freezer & Refrigerated Cases)

Luminaire	Manufacturers Claim	LTTC Sphere Results
Watts:	172	167
Lumens 100% Output:	14,205	13,390
Chromaticity:	4,300K	4,379K
Color Rendering:	70 CRI	75.4 CRI
Photometric Distribution:	40-degree Flood	Not Tested
Rated Life:	50,000 hrs. LM-85	Not Tested

TABLE 12. RESULTS OF SPHERE TESTING

6-BAR AREA LIGHT LUMINAIRE-525 ma driver (Exterior Open Lots)

Luminaire	Manufacturers Claim	LTTC Sphere Results
Watts:	204	193
Lumens 100% Output:	17,045	14,610
Chromaticity:	4,300K	4,235K
Color Rendering :	70 CRI	74.6 CRI
Photometric Distribution:	Type III Medium	Not Tested
Rated Life:	50,000 hrs. LM-85	Not Tested

Results of sphere testing for the canopy fixture (cold storage luminaires) were within 2% to 3% of manufacturer's claims for watts, lumens, and chromaticity. Color rendering (CRI) tested 8% above the manufacturers claim. Photometric distribution and rated life was not sphere tested. Sphere testing of the area light fixture (exterior open lots) was also within 2% to 3% of manufacturer's claims for watts and chromaticity. However, lumen output was 14% lower than manufacturers rated lumen output. CRI tested 7% above the manufacturer's claim.

EVALUATIONS

Data gained from illuminance readings as well as data logging of energy consumption and occupancy tracking supported the potential energy efficiency and expanded controls potential offered by this technology marriage. LED luminaires coupled with motion sensor equipment performed within range of manufacturer's performance claims. There were no barriers encountered in achieving the goals targeted for this technology assessment.

- Results of testing demonstrate that LED lighting applications with occupancy/motion sensor control is significantly better than the incumbent PSMH, non-controlled, technology. The LED system offers significant potential energy savings over the incumbent MH technology.
- From our data logging records the load reduction (energy savings for freezer and refrigerated cold storage) resulted in 60% less energy consumption using LED lighting versus incumbent PSMH. Additionally, another 19% savings is captured with use of the occupancy sensors for a 79% reduction over the incumbent PSMH technology. With respect to open lots, data logging records would suggest that load reduction (energy savings for parking lot lighting) results in 55% less energy consumption with use of LED lighting versus incumbent PSMH, and another 17% additional savings from the marriage of occupancy sensors technology with the LED system for 72% less than the incumbent PSMH lighting..
- In addition to energy savings, the LED has a much longer lamp life (over 50,000 hours versus only 15,000 hours for the horizontal burn position incumbent PSMH). Lumen maintenance of the LED is also improved versus the incumbent PSMH.
- First cost and limited exposure to the new technology, especially the marriage of occupancy sensor technology with LED technology are the main market barriers that restrain acceptance and adoption of the technology.
- Lifecycle costing (LCC) was very positive with the Sensor Coupled LED lighting proving highly cost effective. Simple payback targets for these LED systems on the project calculated to 3-1/2 years for the cold storage model and just over 3 years for the exterior open lot model.

A review of the LCC for both the cold storage model and the exterior open lot model are shown in Appendix A. Also provided in Appendix A is a static copy of the LCC engine used for our cost analysis. There are also links provided (Figure 31 to an active (dynamic LCC engine) that can be used to calculate other design scenarios as well as a link to the excel worksheet (Full active version) of the LCC calculations and analysis.

RECOMMENDATIONS

Lessons learned from prior assessments, such as the juvenile centers covered lot parking, coupled with the stellar results produced by this project test site validates the effectiveness and reliability of Occupancy Sensor Coupled LED lighting.

Results from this application of dimmable LED to cold case and exterior lighting were extremely positive. Based on these findings immediate introduction of these packaged technologies into incentive candidacy is warranted.

Two control issues demonstrating major improvement should be noted:

1. The time to tune and commission the integral motion sensor controls (IMSC) *in each luminaire* improved from about 1 labor hour at the juvenile center to about 5 labor *minutes* at the current test site, and
2. The ability to accurately, precisely, and permanently adjust and set the time-to-off-after-vacancy feature of the IMSC improved dramatically from imprecise potentiometers (which never could be set identically to the others) at the juvenile center, to robust twist and click gear easily set in the staging shop, or field, for the current test site.
    - Based on earlier findings from the juveniles center testing as well as the results documented at this this test site's cold storage and exterior open lot project, LED luminaires with motion sensor occupancy controls warrants adoption into the Energy Efficiency program.
    - It is believed the current compliance tool can simulate this at least by superposition of controls with luminaire, if necessary.

APPENDIX A – SPECIFICATION SHEETS

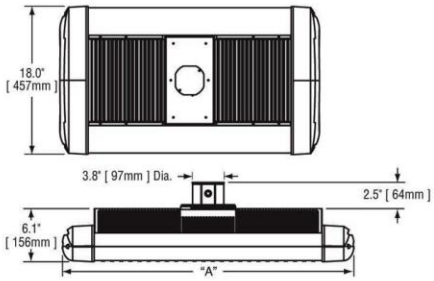
CAN-EDG-40-DM THE EDGE® LED Canopy Light – 40° Flood Optic

Rev. Date:9/22/11

BetaLED Catalog #: CAN - EDG - 40 - DM - - D - - - - -

Reset

Notes:



# of LEDs	Dim. "A"
40	16.06"
60	18.06"
80	16.06"
100	18.06"
120	20.06"
140	22.06"
160	24.06"
200	28.06"
240	32.06"

Product	Family	Optic	Mounting	# of LEDs (x 10)	LED Series	Voltage	Color Options	Drive Current Not Field Adjustable	Factory-Installed Options Please type additional options in manually on the lines provided above.
CAN	EDG	40[1]	DM[2]	☐ 04[3] ☐ 06[4] ☐ 08 ☐ 10 ☐ 12 ☐ 14 ☐ 16 ☐ 20 ☐ 24	D	☐ UL Universal 120–277V ☐ UH Universal 347–480V ☐ 12 120V ☐ 24 240V ☐ 27 277V ☐ 34 347V	☐ SV Silver ☐ BK Black ☐ BZ Bronze ☐ PB Platinum Bronze ☐ WH White	☐ 350 350mA ☐ 525[5] 525mA ☐ 700[6] 700mA	☐ 43K 4300K Color Temperature[7] ☐ DIM 0–10V Dimming[8,9] ☐ F Fuse[10,11,12] ☐ HL Hi/Low (175/350/525, dual circuit input)[13] ☐ P Photocell[12,14,15] ☐ ML Multi-Level (75/525)[13]

Footnotes

1. Distribution similar to narrow flood (40°)
2. Direct mount
3. Uses 80 LED size with two blanks in outside positions
4. Uses 100 LED size with two blanks in outside positions
5. Available on fixtures with 40–160 LEDs
6. Available on fixtures with 40–120 LEDs
7. Color temperature per fixture; 6000K standard; minimum 70 CRI
8. Control by others
9. Refer to the dimming spec sheet for availability and addtional information
10. When code dictates fusing use time delay fuse
11. Not available when UH voltage is selected
12. Refer to the multi-level spec sheet for availability and additional information
13. This option not available with all multi-level spec options. Refer to the multi-level spec sheet for more information
14. Must specify voltage other than UL or UH

LED PERFORMANCE SPECS

# of LEDs	Initial Delivered Lumens – 40 ° Optic @ 6000K	Initial Delivered Lumens – 40° Optic @ 4300K	System Watts 120–480V	Total Current @ 120V	Total Current @ 240V	Total Current @ 277V	Total Current @ 347V	Total Current @ 480V	L_{70} Hours* @ 25° C (77° F)	50K Hours Lumen Maintenance Factor* @ 15° C (59° F)
350mA Fixture Operating at 25° C (77° F)										
40[3]	4,472 (04)	4,122 (04)	47	0.40	0.21	0.19	0.15	0.12	>150,000	
60[4]	6,622 (06)	6,103 (06)	68	0.58	0.30	0.26	0.20	0.16	>150,000	
80	8,829 (08)	8,137 (08)	90	0.77	0.38	0.34	0.26	0.20	>150,000	
100	11,009 (10)	10,146 (10)	111	0.95	0.47	0.42	0.32	0.24	>150,000	
120	13,210 (12)	12,175 (12)	132	1.15	0.56	0.50	0.38	0.28	>150,000	93%
140	15,342 (14)	14,140 (14)	157	1.34	0.67	0.61	0.47	0.35	149,000	
160	17,534 (16)	16,160 (16)	179	1.54	0.76	0.68	0.53	0.39	149,000	
200	21,918 (20)	20,200 (20)	221	1.92	0.95	0.84	0.65	0.48	149,000	
240	26,301 (24)	24,240 (24)	264	2.30	1.12	1.00	0.77	0.56	149,000	
525mA Fixture Operating at 25° C (77° F)										
40[3]	6,261 (04)	5,771 (04)	70	0.57	0.29	0.26	0.21	0.16	136,000	
60[4]	9,271 (06)	8,544 (06)	102	0.87	0.44	0.39	0.30	0.22	129,000	
80	12,361 (08)	11,392 (08)	133	1.14	0.56	0.49	0.39	0.29	129,000	
100	15,412 (10)	14,205 (10)	172	1.47	0.75	0.67	0.51	0.38	128,000	
120	18,495 (12)	17,045 (12)	204	1.76	0.88	0.78	0.60	0.44	128,000	92%
140	21,479 (14)	19,796 (14)	233	2.01	0.99	0.87	0.69	0.51	123,000	
160	24,548 (16)	22,624 (16)	265	2.29	1.11	0.98	0.78	0.57	123,000	
700mA Fixture Operating at 25° C (77° F)										
40[3]	7,648 (04)	7,048 (04)	93	0.79	0.40	0.35	0.27	0.20	111,000	90%
60[4]	11,323 (06)	10,436 (06)	137	1.18	0.59	0.51	0.39	0.29	111,000	

* For recommended lumen maintenance factor data see TD-13

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FIGURE 26. LED CANOPY LIGHT USED FOR ILLUMINATION IN BOTH FREEZER AND REFRIGERATED COLD STORAGE (PAGE 1)

CAN-EDG-40-PD THE EDGE® LED Canopy Light – 40º Flood Optic

Rev. Date: 9/22/11

General Description

Slim, low profile, easy mounting below deck design. Luminaire sides are rugged cast aluminum with integral, weather-tight LED driver compartments and high performance aluminum heatsinks specifically designed for LED lighting application, J-Box sized to fit through existing 4-inch (102mm) diameter mount holes and is designed for through wiring and wet location installations. Luminaire mounts directly to canopy with lag bolts (by others). When mounting to solid surfaces, Adaptor Plate Kit accessory is required. Mating surface is gasketed to prevent water leak through. Includes bug/bird guard. Five year limited warranty on fixture.

Electrical

Modular design accommodates varied lighting output from high power, white, 6000K (+/- 500K per full fixture), minimum 70 CRI, long life LED sources. Optional 4300K (+/- 300K per full fixture) also available. 120–277V 50/60 Hz, Class 1 LED drivers are standard. 347–480V 50/60 Hz driver is optional. LED drivers have power factor >90% and THD <20% at full load. Units provided with integral 10kV surge suppression protection standard. Surge protection tested in accordance with IEEE/ANSI C62.41.2.

Testing & Compliance

UL listed in the U.S. and Canada for wet locations and enclosure rating IP66 per IEC 60529. Consult factory for CE Certified products. Dark Sky Friendly. IDA Approved. RoHS compliant.

Finish

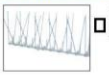
Exclusive Colorfast DeltaGuard® finish features an E-Coat epoxy primer with an ultra-durable silver powder topcoat, providing excellent resistance to corrosion, ultraviolet degradation and abrasion. Bronze, black, white and platinum bronze powder topcoats are also available. The finish is covered by our 10 year limited warranty.

Fixture and finish are endurance tested to withstand 5,000 hours of elevated ambient salt fog conditions as defined in ASTM Standard B 117.

Patents

U.S. and international patents granted and pending. BetaLED is a division of Ruud Lighting, Inc. For a listing of Ruud Lighting, Inc. patents, visit www.uspto.gov.

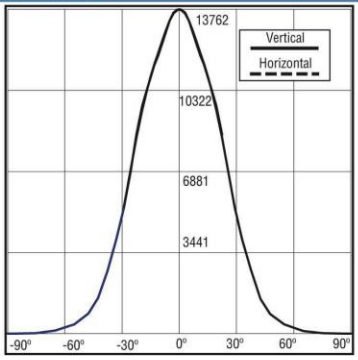
Field-Installed Accessories



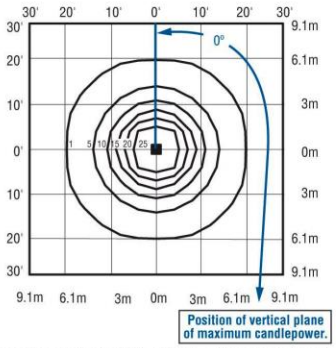
☐ **Bird Spikes**
XA-BRDSPK

☐ **Adaptor Plate Kit**
XA-CLSB16
For use when mounting fixture to solid surfaces.

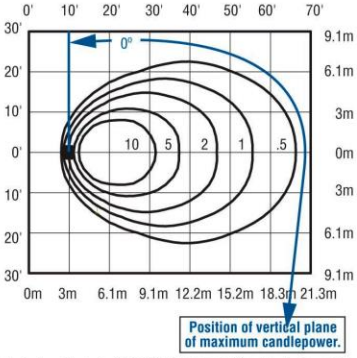
Photometrics



Preliminary candlepower trace of 6000K 60 LEDs LED EDGE Flood series luminaire with 10,661 inital delivered lumens operating at 700mA.



Isofootcandle plot of 4300K, 120 LED, 40° flood luminaire at 25' (7.6m) A.F.G. Luminaire with 17,045 initial delivered lumens operating at 525mA. Initial FC at grade.



Isofootcandle plot of 4300K, 120 LED, 40° flood luminaire at 25' (7.6m) A.F.G. Luminaire with 17,045 initial delivered lumens operating at 525mA. Initial FC at grade.

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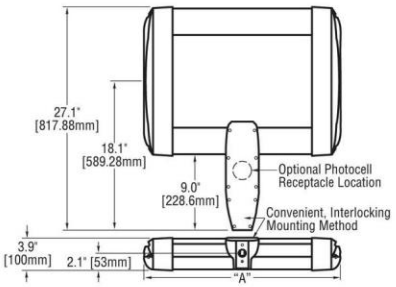
FIGURE 26B. LED CANOPY LIGHT USED FOR ILLUMINATION IN BOTH FREEZER AND REFRIGERATED COLD STORAGE (PAGE 2)

ARE-EDG-3M-DA THE EDGE® LED Area Light – Type III Medium

Rev. Date: 8/23/11

BetaLED Catalog #: ARE - EDG - - DA - - D - - - - -

Reset



# of LEDs	Dim. "A"
20	12.06" [306mm]
40	12.06" [306mm]
60	14.06" [357mm]
80	16.06" [408mm]
100	18.06" [459mm]
120	20.06" [510mm]
140	22.06" [560mm]
160	24.06" [611mm]
200	28.06" [713mm]
240	32.06" [814mm]

Notes:

Product	Family	Optic	Mounting	# of LEDs (x 10)	LED Series	Voltage	Color Options	Drive Current (Not Field Adjustable)	Factory-Installed Options (Please type additional options in manually on the lines provided above)
ARE	EDG	☐ 3M[1] ☐ 3MB[2]	DA[3]	☐ 02 ☐ 04 ☐ 06 ☐ 08 ☐ 10 ☐ 12 ☐ 14 ☐ 16 ☐ 20 ☐ 24	D	☐ UL Universal 120–277V ☐ UH Universal 347–480V ☐ 34 347V	☐ SV Silver ☐ BK Black ☐ BZ Bronze ☐ PB Platinum Bronze ☐ WH White	☐ 350 350mA ☐ 525[4] 525mA ☐ 700[5] 700mA	☐ 43K 4300K Color Temperature[6] ☐ DIM 0–10V Dimming[7,8,9] ☐ F Fuse[10,11,12] ☐ HL Hi/Low (175/350/525, dual circuit input)[13] ☐ P Photocell[12,14] ☐ R NEMA Photocell Receptacle[12,15,16] ☐ ML Multi-Level (75/525)[13]

Footnotes

1. IESNA Type III Medium distribution
2. IESNA Type III Medium distribution w/ backlight control
3. Direct mounting arm for use with 3–6" (76–152mm) square or round pole
4. Available on fixtures with 20–160 LEDs
5. Available on fixtures with 20–60 LEDs
6. Color temperature per fixture; 6000K standard; minimum 70 CRI
7. Control by others
8. Refer to dimming spec sheet for availability and additional information
9. Not available when UH voltage is selected
10. When code dictates fusing use time delay fuse
11. Not available with all multi-level options. Refer to the multi-level spec sheet for availability and additional information
12. Refer to multi-level spec sheet for availability and additional information
13. Must specify voltage other than UH
14. Intended for horizontal mounting
15. Photocell by others

LED PERFORMANCE SPECS

# of LEDs	Initial Delivered Lumens – Type III Medium @ 6000K	B U G Rating**	Initial Delivered Lumens – Type III Medium w/ backlight control @ 6000K	B U G Rating**	Initial Delivered Lumens – Type III Medium @ 4300K	B U G Rating**	Initial Delivered Lumens – Type III Medium w/ backlight control @ 4300K	B U G Rating**	System Watts 120–480V	Total Current @ 120V	Total Current @ 240V	Total Current @ 277V	Total Current @ 347	Total Current @ 480V	L_{70} Hours* @ 25° C (77° F)	50K Hours Lum Maintenance Factor* @ 15° C (59° F
350mA Fixture Operating at 25° C (77° F)																
20	1,814 (02)	1 1 1	1,342 (02)	0 1 1	1,672 (02)	1 1 1	1,237 (02)	0 1 1	26	0.20	0.11	0.10	0.09	0.07	>150,000	
40	3,628 (04)	1 1 1	2,683 (04)	1 1 1	3,343 (04)	1 1 1	2,473 (04)	0 1 1	47	0.40	0.21	0.19	0.15	0.12	>150,000	
60	5,371 (06)	2 2 2	3,973 (06)	1 2 1	4,950 (06)	2 2 2	3,662 (06)	1 2 1	68	0.58	0.30	0.26	0.20	0.16	>150,000	
80	7,161 (08)	2 2 2	5,298 (08)	1 2 2	6,600 (08)	2 2 2	4,882 (08)	1 2 1	90	0.77	0.38	0.34	0.26	0.20	>150,000	
100	8,929 (10)	3 3 3	6,605 (10)	1 3 2	8,230 (10)	2 2 2	6,088 (10)	1 2 2	111	0.95	0.47	0.42	0.32	0.24	>150,000	93%
120	10,715 (12)	3 3 3	7,926 (12)	1 3 2	9,876 (12)	3 3 3	7,305 (12)	1 3 2	132	1.15	0.56	0.50	0.38	0.28	>150,000	
140	12,444 (14)	3 3 3	9,205 (14)	1 3 2	11,469 (14)	3 3 3	8,484 (14)	1 3 2	157	1.34	0.67	0.61	0.47	0.35	149,000	
160	14,222 (16)	3 3 3	10,520 (16)	1 3 2	13,108 (16)	3 3 3	9,696 (16)	1 3 2	179	1.54	0.76	0.68	0.53	0.39	149,000	
200	17,778 (20)	3 3 3	13,151 (20)	2 3 3	16,385 (20)	3 3 3	12,120 (20)	1 3 2	221	1.92	0.95	0.84	0.65	0.48	149,000	
240	21,333 (24)	3 3 3	15,781 (22)	2 3 3	19,662 (24)	3 3 3	14,544 (24)	2 3 3	264	2.30	1.12	1.00	0.77	0.56	149,000	
525mA Fixture Operating at 25° C (77° F)																
20	2,539 (02)	1 1 1	1,878 (02)	0 1 1	2,340 (02)	1 1 1	1,731 (02)	0 1 1	37	0.31	0.17	0.16	0.12	0.10	136,000	
40	5,079 (04)	2 2 2	3,757 (04)	1 2 1	4,681 (04)	2 2 2	3,462 (04)	1 2 1	70	0.57	0.29	0.26	0.21	0.16	136,000	
60	7,520 (06)	2 2 2	5,562 (06)	1 2 2	6,930 (06)	2 2 2	5,127 (06)	1 2 1	102	0.87	0.44	0.39	0.30	0.22	129,000	
80	10,026 (08)	3 3 3	7,417 (08)	1 3 2	9,240 (08)	3 3 3	6,835 (08)	1 3 2	133	1.14	0.56	0.49	0.39	0.29	129,000	92%
100	12,501 (10)	3 3 3	9,247 (10)	1 3 2	11,521 (10)	3 3 3	8,523 (10)	1 3 2	172	1.47	0.75	0.67	0.51	0.38	128,000	
120	15,001 (12)	3 3 3	11,097 (12)	1 3 2	13,826 (12)	3 3 3	10,227 (12)	1 3 2	204	1.76	0.88	0.78	0.60	0.44	128,000	
140	17,422 (14)	3 3 3	12,888 (14)	2 3 2	16,057 (14)	3 3 3	11,878 (14)	1 3 2	233	2.01	0.99	0.87	0.69	0.51	123,000	
160	19,911 (16)	3 3 3	14,729 (16)	2 3 2	18,351 (16)	3 3 3	13,575 (16)	2 3 3	265	2.29	1.11	0.98	0.78	0.57	123,000	
700mA Fixture Operating at 25° C (77° F)																
20	3,102 (02)	1 1 1	2,281 (02)	0 1 1	2,858 (02)	1 1 1	2,102 (02)	0 1 1	50	0.42	0.22	0.20	0.15	0.12	111,000	
40	6,203 (04)	2 2 2	4,562 (04)	1 2 1	5,717 (04)	2 2 2	4,204 (04)	1 2 1	93	0.79	0.40	0.35	0.27	0.20	111,000	90%
60	9,185 (06)	3 3 3	6,754 (06)	1 3 2	8,465 (06)	2 3 2	6,225 (06)	1 2 2	137	1.18	0.59	0.51	0.39	0.29	111,000	

* For recommended lumen maintenance factor data see TD-13

** For more information on the IES BUG (Backlight-Uplight-Glare) Rating visit www.iesna.org/PDF/Erratas/TM-15-07BugRatingsAddendum.pdf

NOTE: All data subject to change without notice.

Made in the U.S.A. of U.S. and imported parts.
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FIGURE 27. LED AREA LIGHT USED FOR ILLUMINATION IN EXTERIOR OPEN LOTS (PAGE 1)

ARE-EDG-3M-DA THE EDGE® LED Area Light – Type III Medium

Rev. Date: 8/23/11

General Description

Slim, low profile design minimizes wind load requirements. Fixture sides are rugged cast aluminum with integral, weather-tight LED driver compartments and high performance aluminum heatsinks. Convenient, interlocking mounting method. Mounting housing is rugged die cast aluminum and mounts to 3–6" (76–152mm) square or round pole. Fixture is secured by two (2) 5/16-18 UNC bolts spaced on 2" (51mm) centers. Includes leaf/debris guard. Five year limited warranty on fixture.

Electrical

Modular design accommodates varied lighting output from high power, white, 6000K (+/- 500K per full fixture), minimum 70 CRI, long life LED sources. Optional 4300K (+/- 300K per full fixture) also available. 120–277V 50/60 Hz, Class 1 LED drivers are standard. 347–480V 50/60 Hz driver is optional. LED drivers have power factor >90% and THD <20% at full load. Units provided with integral 10kV surge suppression protection standard. Integral weather-tight electrical box with terminal strips (12Ga - 20Ga) for easy power hook-up. Surge protection tested in accordance with IEEE/ANSI C62.41.2.

Testing & Compliance

UL listed in the U.S. and Canada for wet locations and enclosure rated IP66 per IEC 60529 when ordered without P or R options. Consult factory for CE Certified products. Certified to ANSI C136.31-2001, 3G bridge and overpass vibration standards.
Dark Sky Friendly. IDA Approved. RoHS Compliant.

Product qualified on the Design Lights Consortium ("DLC") Qualified Products List ("QPL") when ordered without backlight control shield.

Finish

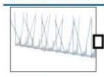
Exclusive Colorfast DeltaGuard® finish features an E-Coat epoxy primer with an ultra-durable silver powder topcoat, providing excellent resistance to corrosion, ultraviolet degradation and abrasion. Bronze, black, white and platinum bronze powder topcoats are also available. The finish is covered by our 10 year limited warranty.

Fixture and finish are endurance tested to withstand 5,000 hours of elevated ambient salt fog conditions as defined in ASTM Standard B 117.

Patents

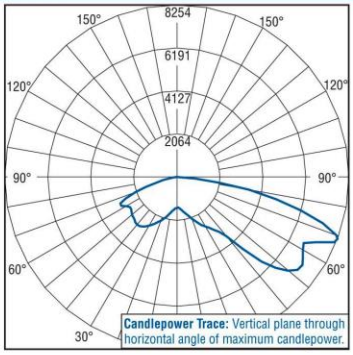
U.S. and international patents granted and pending. BetaLED is a division of Ruud Lighting, Inc. For a listing of Ruud Lighting, Inc. patents, visit www.uspto.gov.

Field-Installed Accessories

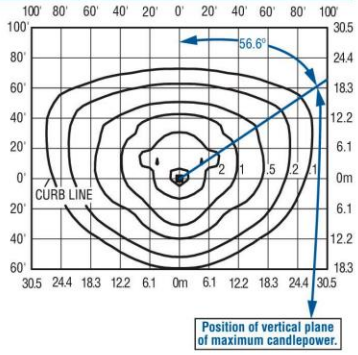


Bird Spikes
☐XA-BRDSPK

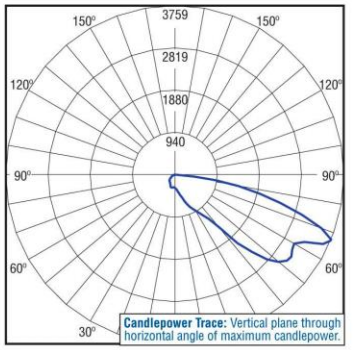
Photometrics



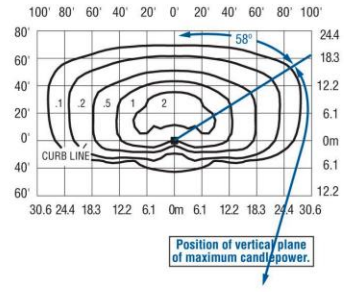
Independent Testing Laboratories certified test. Report No. ITL67871. Candlepower trace of 4300K, 160 LED Type III Medium area luminaire with 18,862 initial delivered lumens operating at 525mA. **All published luminaire photometric testing performed to IESNA LM-79-08 standards.**



Isofootcandle plot of 4300K, 120 LED Type III Medium area luminaire at 25' (7.6m) A.F.G. Luminaire with 13,826 initial delivered lumens operating at 525mA. Initial FC at grade.



Independent Testing Laboratories certified test. Report No. ITL68539. Candlepower trace of 4300K, 40 LED Type III Medium w/ backlight control area luminaire with 5,084 initial delivered lumens operating at 525mA. **All published luminaire photometric testing performed to IESNA LM-79-08 standards.**



Isofootcandle plot of 4300K, 120 LED Type III Medium area luminaire at 25' (7.6m) A.F.G. Luminaire with 10,227 initial delivered lumens operating at 525mA. Initial FC at grade.

THE EDGE® EPA & Weight Calculations

# of LEDs	Approximate Weight 120–480V[1]	Single	2@ 180°	2@ 90°	3@ 90	4@ 90°
Fixed Arm Mount						
20	21.0 lbs. (9.5kg)	0.60	1.20	0.87	1.47	1.75
40	23.7 lbs. (10.8g)	0.60	1.20	0.87	1.47	1.75
60	27.0 lbs. (12.3kg)	0.60	1.20	0.92	1.51	1.83
80	28.1 lbs. (12.8kg)	0.60	1.20	0.96	1.55	1.91
100	32.3 lbs. (14.7kg)	0.60	1.20	1.00	1.60	2.00
120	33.5 lbs. (15.2kg)	0.60	1.20	1.04	1.64	2.08
140	36.9 lbs. (16.7kg)	0.60	1.20	1.08	1.68	2.16
160	41.4 lbs. (18.8kg)	0.60	1.20	1.12	1.72	2.24
200	43.3 lbs. (19.6kg)	0.61	1.21	n/a[2]	n/a[2]	n/a[2]
240	47.8 lbs. (21.7kg)	0.69	1.38	n/a[2]	n/a[2]	n/a[2]

1. Add 5 lbs. (2.3kg) for transformer in 347–480V fixtures when multi-level options are selected.
2. For applications requiring 200 or more LEDs at 90 degrees refer to the DL mount version of our spec sheet.

NOTE: All data subject to change without notice.

Made in the U.S.A. of U.S. and imported parts.
Meets Buy American requirements within the ARRA

FIGURE 27LED AREA LIGHT USED FOR ILLUMINATION IN EXTERIOR OPEN LOTS (PAGE 2)

FIGURE 28. REVOLUTION WIRELESS RECORDER (PAGE 1 OF 2)

Revolution®

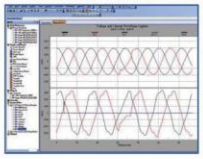
pmi

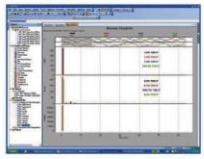
HARMONICS	Voltage	to the 51st
	Current	to the 51st
	Measures	Magnitude, phase, THD
COMMUNICATIONS	Standard	Bluetooth® 2.0 Wireless, USB 2.0
	Options	Mobile Phone, Wi-Fi
INFORMATION STORAGE	Data Storage	16 MB (Standard); 128 MB, 512MB or 1 GB (Optional)
	Significant Change	1000 records
	Flicker	1000 records
RECORD SETTINGS	Interval Graphs	1 cycle to 4 hour interval, user selected, stop-when-full or wrap-around memory modes
	Significant Change	1V to 8V in 1V steps
	Flicker Settings	User-defined, or conform to IEEE 1453/ IEC 61000-4-15, and IEEE Std. 141
	Waveform Capture	Voltage and current threshold, periodic capture, waveshape, event cross triggers
	Transient Capture	Peak voltage threshold
POWER SUPPLY REQUIREMENTS	Voltage	60-600VAC Channel 1 to Common (47-63Hz)
	Power Consumption	5 Watts max, 15 VA max at 600V
ENVIRONMENTAL	Operating Temp	-20°F to +135° F
	Humidity	Less than or equal to 85%
	Shock	60 Hz to 2 kHz, acceleration 25G
	Vibration	10Hz to 60Hz, amplitude 1.8mm
	Max Altitude	2.0km (6560 ft), derated above 2.0km
PHYSICAL DIMENSIONS	Size	4.8" L x 3.35" W x 1.84" H
	Weight	less than 1 lb
	Case	NEMA 4X
SAFETY	IEC 61010-1, 600V CAT IV, UL listed	

PROVISION SOFTWARE

ProVision® is the latest generation of PMI's popular, power quality analytical software for PCs. Virtually everything about ProVision's graphical user interface (GUI) has been redesigned–so it's not only easier to use, but also more flexible in the way it helps you to manage and report power quality data.

With ProVision's wireless communications features you can remotely initialize, schedule, download and manage multiple PQ recorders from within a single GUI. All recorder settings are viewable and configurable in real-time on your laptop or desktop PC. Once PQ data is downloaded to your computer, ProVision® gives you unprecedented control over the way it's viewed, managed and reported. You determine the way you want the software to search for and access your files. You choose your own scale, colors and font styles for viewing and printing. You can even insert your company logo to give reports and presentations a truly custom look.





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With ProVision® you can create and print your own standard and custom reports, or if you prefer, send PMI your data in digital form and our exclusive, Custom Report Service will prepare and print professional looking reports to meet your unique needs.

ProVision® transforms real-time and stored PQ data into an array of colorful charts and graphs that make it easy to track long-term trends and identify problems during triggered events:

- Event Change
- Interval
- Single Cycle Voltage Histogram
- Significant Change
- Power Outage
- Flicker
- Abnormal/Loose Neutral

Voltage, Current & Power:

- Interval Graph
- Out of Limits
- Histogram Graph
- Daily Profile Graph

ProVision®

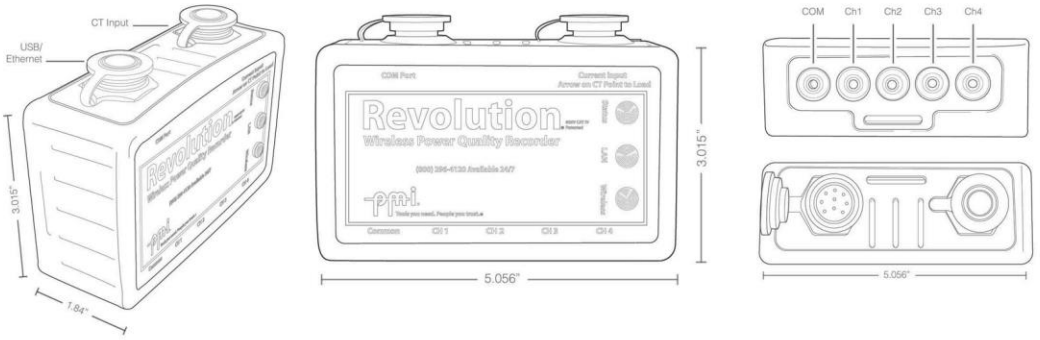

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FIGURE 14B REVOLUTION WIRLWSS RECORDER (PAGE 2 OF 2)

PowerVisa

Power Quality Analyzer

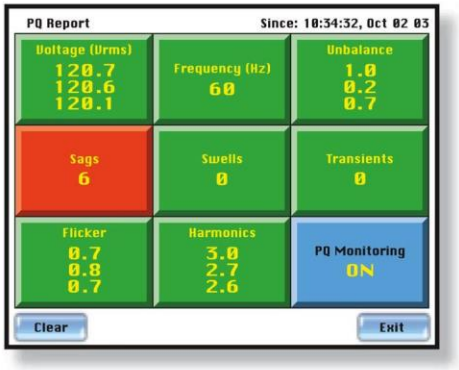
Equipped with 8 independent channels, the 3-phase PowerVisa® is the only advanced power monitoring instrument to incorporate a color touch screen into its lightweight design. Automated setups provide instant detection of circuits and configurations, ensuring that the instrument is ready to successfully collect data. Users can select the length and mode of data collection, including troubleshooting, data logging, power quality surveys, energy and load balancing. The PowerVisa collects data at 256 samples/cycle/channel, offers remote communications using RS-232, ethernet or USB options, and meets IEEE 1159 and the newest European standards.

Measured Parameters
(4) differential inputs, 1-600 Vrms, AC / DC, 0.1% rdg + 0.05% FS, 256 samples/cycle, 16 bit ADC
(4) inputs with CTs 1-6000 Arms, CT -dependent, AC/DC, 256 samples/cycle, 0.1% rdg + CTs, 16 bit ADC
Frequency range, 10 mHz resolution, 45-65 Hz
Phase lock loop – standard PQ mode
Monitoring/Compliance
IEEE 1159
IEC 61000-4-30 Class A
EN50160 Quality of Supply
Power Quality Triggers
Cycle-by-cycle analysis; 256 samples/cycle; ½ RMS stpes
L-L, L-N, N-G RMS variations: sags/swells/interruptions
RMS recordings and Waveshape recordings (30 pre-fault, 100 post -fault cycles)
Low and medium frequency transients – V&I
Harmonics summary parameters
Cross trigger V&I channels
RMS event characterization (IEEE or IEC)
Distortion/Power/Energy
W, VA, VAR, TPF, DPF, Demand, Energy, etc.; Harmonics & interharmonics per IEC 61000-4-7
THD/Harmonic Spectrum, TID/Interharmonic Spectrum (V, I, W) to 63rd
Crest factor, K factor, transformer derating factor, telephone interference factor
General Specifications
Size (HxWxD): 12" x 2.5" x 8"; Weight: 3.8 lbs
Operating temperature: 0 to 50 degrees C; Storage temperature: -20 to 55 degrees C
Humidity: 10 – 90% non-condensing
Memory options (must have one): Up to 128M removable compact flashcard

FIGURE 29. POWER VISA – POWER QUALITY ANALYZER (PAGE 1 OF 2)

Troubleshooting

The PowerVisa unique annunciator "report card" provides instant power quality answers in the field. A wide range of power monitoring data is collected, analyzed and tabulated in color-coded categories to quickly identify areas of concern, which are identified in red. Drill down for more detailed information by simply touching the intuitive graphical screen to troubleshoot problems, locate the source and pinpoint the root cause of power quality disturbances.

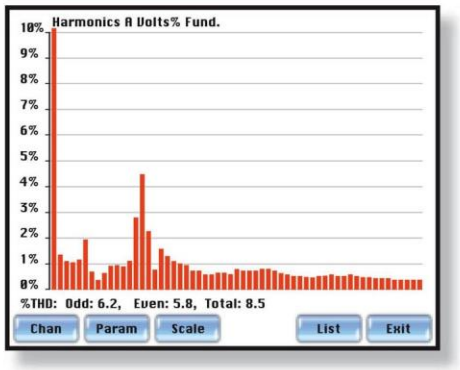


Energy Surveys

The cost of energy is oftentimes a facility's largest operating expense. Reducing energy consumption during peak times, shifting loads, purchasing energy efficient equipment, or changing energy suppliers can shave 10-40% annually off that cost. The PowerVisa is an invaluable tool for performing energy surveys, including monitoring energy consumption, usage patterns, peak demands and the activation of large loads to reduce electricity costs. Plus, the PowerVisa makes it easy to track and allocate energy costs by process or department.

Harmonics

As the sensitivity of power electronics increases, equipment ranging from HVAC systems, personal computers and copiers to computerized process equipment and manufacturing systems are susceptible to harmonic pollution. In fact, harmonics can cause small, almost imperceptible variations in performance that aggregate to effect significant long-term damage. Current harmonics generated by a source can pollute the entire power system without being affected itself. The PowerVisa captures detailed harmonics, interharmonics and subharmonics to effectively troubleshoot the complex problems caused by these events.



Equipment Performance Testing

Determining the availability and compatibility of facility power prior to the installation of new equipment is simplified using the PowerVisa. The instrument incorporates advanced features such as RMS triggers, low/medium frequency transients, and cross triggering between channels to demonstrate that power mitigation devices such as UPSs are operating properly. Real time readings observed during maintenance and startup processes enable users to see results and tweak that equipment during the testing process.

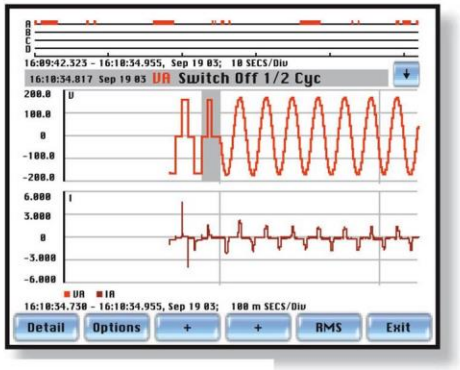


FIGURE 29. POWER VISA – POWER QUALITY ANALYZER (PAGE 2 OF 2)

Occupancy Sensor Coupled LED Lighting

Cold Case (ceiling mounted(mtd)) Refrigerator and Freezer & Exterior (pole & structure mtd) Parking Lot

Life Cycle Costs for 20 years of operation

JMM 12 19 11

cold case PSMH based on 70 hours per week & 50 weeks/year=	3500	op hours	existing
exterior PSMH based on dusk-to-dawn op hours=	4380	op hours	existing
cold case LED based on 70 hours per week & 50 weeks/year * 60% ON=	2100	op hours	LED
exterior LED based on dusk-to-dawn op hours (30% high/70% low)=	4380	op hours	LED
average interior cold case LED connected load is 0.60*172 = 103.2 watts			
average exterior LED connected load is 0.30*204+0.70*38.76=61.2+27.1 = 88.3 watts			

AVG $/kWh	0.20		
20yr op hrs	70000	cold case	PSMH
20yr op hrs	87600	exterior	PSMH
20yr op hrs	42000	cold case	LED(hi/off)
20yr op hrs	87600	exterior	LED(hi/low)

ALL INVESTMENT $ ARE NET TO CUSTOMER AND INCLUDE **MATERIAL ONLY.**
NO LABOR COSTS ARE INCLUDED.

the LCC engine>

The comparison is PSMH against LED.

	SOURCE	# of FXTS	Nominal lamp watts (W)	Connected W/FXT (on high)	Average CONN W/FXT	Initial K-lumens	INV: $ per FXT (1)	Annual ENERGY/ FXT	Annual maintenance/ FXT	LCC 5,20 ($)	Simple payback (yrs) (2)	ROI (%) = 1/spybk
Baseline fixed magnetic ballast cold case	PSMH	1	400	453	453	43	439	317	13	4552	NA	NA
New LED with integral occ sensor cold case	LED	1	115	172	103	13	1287	72	0	2184	3.5	28.9%
Baseline fixed magnetic ballast exterior	PSMH	1	400	453	453	43	439	397	15	5573	NA	NA
New dimmable LED with integral occ sensor exterior	LED	1	138	204	88.3	14	1430	77	13	2552	3.1	32.2%

PSMH	MEANS	pulse start metal halide
LED	MEANS	light emitting diode
FXT	MEANS	light fixture
INV	MEANS	investment
NA	MEANS	not applicable
LCC	MEANS	life cycle cost
occ	MEANS	occupancy
ROI	MEANS	return on investment

Notes

1 includes:mfg list x distributor mkup x contr mkup x tax @ 10%

2 incremental initial inv/incremental annual savings

FIGURE 30. LCC TABLE FOR COLD CASE AND EXTERIOR PARKING LOTS

	Equipment 1	Equipment 2
Investment, including installation cost	1287	1430
Estimated maintenance cost per year	0	13
Estimated energy cost per year	72	77
Salvage value (Equipment value final year)	0	0
Net discount rate (percent)	5%	5%
Years of operation for the equipment	20	20
LCC Life Cycle Cost	**2184**	**2552**

The life-cycle cost is calculated using the formula:

LCC = Capital Cost + Present worth of Maintenance and Energy Cost - Present worth of Salvage value

The capital cost of a project includes the initial capital expense for equipment, the system design, engineering, and installation.
This cost is always considered as a single payment occurring in the initial year of the project, regardless of how the project is financed.

Maintenance is the sum of all yearly operation and maintenance costs. Fuel or equipment replacement costs are not included.
Costs include such items as an operator's salary, inspections, insurance, property tax, and all scheduled maintenance.

The energy cost of a system is the sum of the yearly fuel cost.

The salvage value of a system is its net worth in the final year of the life-cycle period.
It is common practice to assign a salvage value of 20 percent of original cost for mechanical equipment that can be moved.

Net Discount Rate is expected inflation subtracted from nominal investment rate, use the default value or ask your financial officer for advice

Unhide rows 9-11 to reveal the formulas

 LCC Engine.xlsx	LCC engine can be accessed by clicking on the excel icon to the left - Use LCC engine to calculate life cycle of your own design options	 Coldcase Life Cycle Cost Comparison 12 :	The complete LLC analysis for sensor coupled LED lighting can be accessed by clicking on excel icon to the left

FIGURE 31. LCC ENGINE FOR LCC CALCULATIONS & LINKS TO EXCEL SPREADSHEET

Sphere-Spectroradiometer Test Report

Parameters

Duration

From new to start of test (h:min):	0:00
From start of test to stabilization (h:min):	2:05
From stabilization to reading (h:min):	0:00
Total from new to reading (h:min):	2:05

Environment

Room thermostat set point (°F):	Heat ON, Cool ON
Ambient temperature at time of reading (°F):	75.20
Sphere temperature at time of reading (°F):	75.07

Equipment

Equipment varies depending on the nature of the test. Descriptions and specifications are available upon request.

Light

Method:	Sphere-spectroradiometer
System:	Labsphere SLMS LED 7650
Geometry:	4pi
Mount:	Rigging from top
Orientation:	Select one...
Spectroradiometer bandwidth (nm):	350 to 850
Averaged scans per reading:	4
Self-absorption correction (auxiliary lamp):	Yes
Standard lamp (calibration reference):	Labsphere CSFS-1400 E64
Calibration date:	10/14/2011

Electrical

Power supply:	Elgar CW1251P AC power source
Power meter:	Fluke 435 power quality analyzer

Temperature

System:	NI cDAQ-9172, 9211 compact data aquisition

Procedure

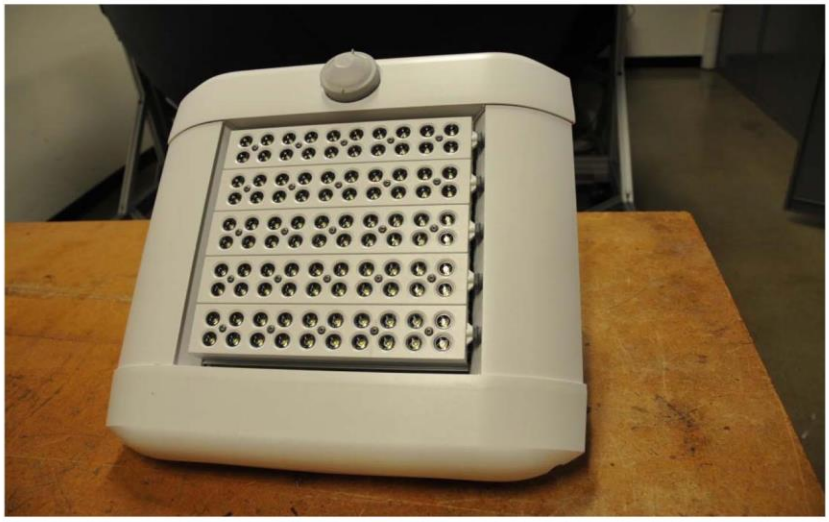
Procedure varies depending on the nature of the test. Descriptions and specifications are available upon request. Most solid-state lighting tests comply with the “IES Approved Method for the Electrical and Photometric Measurements of Solid-State Lighting Products” (IES LM-79-08), excluding section “2.2 Air Temperature”.

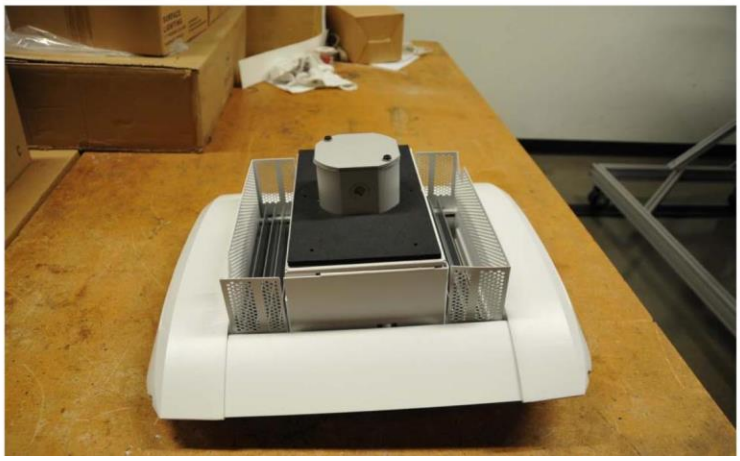
Notes

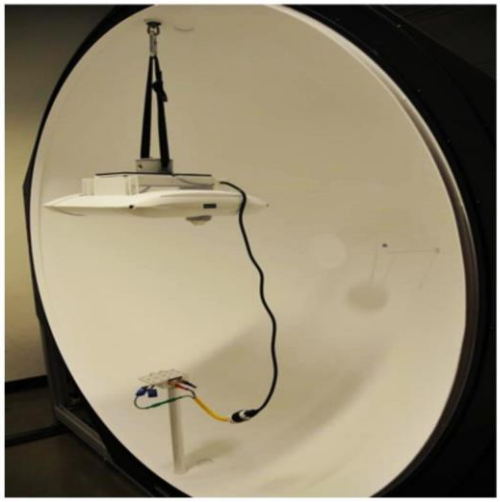
Lamp tested at full power (525 mA). For each scan sphere was closed.

Sphere-Spectroradiometer Test Report

Images







ltc
Lighting Technology Test Center

Sphere-Spectroradiometer Test Report
ER3995 – Two LED Lights Tested in Large Integrating Sphere

General Information

Test number: 3 of 4
Test date: 10/25/2011
Manufacturer: BetaLED
Model:

Description: Area Edge model 6 LED bars of 20 LEDs each.

Results

Reading	Claimed	Measured
Light		
Radiant flux (mW)		44.91
Luminous flux (lm)		14610
Correlated color temperature (K)		4235
Color rendering index (Ra)		74.645
Chromaticity (x)		0.3259
Chromaticity (y)		0.3472
Chromaticity (u)		0.2001
Chromaticity (v)		0.3198
Electrical		
Voltage (V rms for ac, V dc for dc)	N/A	119.94
Voltage THD (% for AC, N/A for dc)		0.209
Current (A rms for ac, A dc for dc)		1.625
Current THD (% for ac, N/A for dc)		7.030
Power (W)		193.497
Power factor (PF for ac, N/A for dc)		0.99
Phase angle (° for ac, N/A for dc)		8.11
Frequency (Hz for ac, N/A for dc)	N/A	59.998
Efficacy		
Efficacy (calculated lm/W)		75.505

Blank cells indicate claims not provided by the manufacturer. Additional results may be available in accompanying files or upon request.

Sphere-Spectroradiometer Test Report

Parameters

Duration

From new to start of test (h:min):	0:00
From start of test to stabilization (h:min):	2:05
From stabilization to reading (h:min):	0:00
Total from new to reading (h:min):	2:05

Environment

Room thermostat set point (°F):	Heat ON, Cool ON
Ambient temperature at time of reading (°F):	75.20
Sphere temperature at time of reading (°F):	75.07

Equipment

Equipment varies depending on the nature of the test. Descriptions and specifications are available upon request.

Light

Method:	Sphere-spectroradiometer
System:	Labsphere SLMS LED 7650
Geometry:	4pi
Mount:	Rigging from top
Orientation:	Select one...
Spectroradiometer bandwidth (nm):	350 to 850
Averaged scans per reading:	4
Self-absorption correction (auxiliary lamp):	Yes
Standard lamp (calibration reference):	Labsphere CSFS-1400 E64
Calibration date:	10/14/2011

Electrical

Power supply:	Elgar CW1251P AC power source
Power meter:	Fluke 435 power quality analyzer

Temperature

System:	NI cDAQ-9172, 9211 compact data aquisition

Procedure

Procedure varies depending on the nature of the test. Descriptions and specifications are available upon request. Most solid-state lighting tests comply with the “IES Approved Method for the Electrical and Photometric Measurements of Solid-State Lighting Products” (IES LM-79-08), excluding section “2.2 Air Temperature”.

Notes

Lamp tested at full power (525 mA). For each scan sphere was closed.

ltc
Lighting Technology Test Center

Sphere-Spectroradiometer Test Report
ER3995 – Two LED Lights Tested in Large Integrating Sphere

General Information

Test number: 4 of 4
Test date: 10/28/2011
Manufacturer: BetaLED
Model:

Description: Area Edge model 6 LED bars of 20 LEDs each.

Results

Reading	Claimed	Measured
Light		
Radiant flux (mW)		7.48
Luminous flux (lm)		2505
Correlated color temperature (K)		5568
Color rendering index (Ra)		69.314
Chromaticity (x)		0.3308
Chromaticity (y)		0.3565
Chromaticity (u)		0.2
Chromaticity (v)		0.3233
Electrical		
Voltage (V rms for ac, V dc for dc)	N/A	119.999
Voltage THD (% for AC, N/A for dc)		0.110
Current (A rms for ac, A dc for dc)		0.324
Current THD (% for ac, N/A for dc)		12.735
Power (W)		36.405
Power factor (PF for ac, N/A for dc)		0.936
Phase angle (° for ac, N/A for dc)		20.637
Frequency (Hz for ac, N/A for dc)	N/A	59.998
Efficacy		
Efficacy (calculated lm/W)		68.809

Blank cells indicate claims not provided by the manufacturer. Additional results may be available in accompanying files or upon request.

Sphere-Spectroradiometer Test Report

Parameters

Duration

From new to start of test (h:min):	3:00 estimated
From start of test to stabilization (h:min):	
From stabilization to reading (h:min):	
Total from new to reading (h:min):	

Environment

Room thermostat set point (°F):	Heat ON, Cool ON
Ambient temperature at time of reading (°F):	76.88
Sphere temperature at time of reading (°F):	76.33

Equipment

Equipment varies depending on the nature of the test. Descriptions and specifications are available upon request.

Light

Method:	Sphere-spectroradiometer
System:	Labsphere SLMS LED 7650
Geometry:	4pi
Mount:	Rigging from top
Orientation:	Select one...
Spectroradiometer bandwidth (nm):	350 to 850
Averaged scans per reading:	4
Self-absorption correction (auxiliary lamp):	Yes
Standard lamp (calibration reference):	Labsphere CSFS-1400 E64
Calibration date:	10/14/2011

Electrical

Power supply:	Elgar CW1251P AC power source
Power meter:	Fluke 435 power quality analyzer

Temperature

System:	NI cDAQ-9172, 9211 compact data aquisition

Procedure

Procedure varies depending on the nature of the test. Descriptions and specifications are available upon request. Most solid-state lighting tests comply with the “IES Approved Method for the Electrical and Photometric Measurements of Solid-State Lighting Products” (IES LM-79-08), excluding section “2.2 Air Temperature”.

Notes

Lamp tested at low power (75 mA). For each scan sphere was closed. Power did not stablize. Average power at time of reading was used.

Sphere-Spectroradiometer Test Report

Images