ADVANCED CERAMIC METAL HALIDE ELECTRONIC BALLAST, DIMMABLE, MULTI-LAMP

ET10SCE1380 Report

Prepared by:

Design & Engineering Services
Customer Service Business Unit
Southern California Edison

December 24, 2010

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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 number ET10SCE1380. DES Jack Melnyk conducted this technology evaluation with overall guidance and management from Juan Menendez. For more information on this project, contact jack.melnyk@sce.com.

Disclaimer

ABBREVIATIONS AND ACRONYMS

AGI	AGI-32 is Lighting Simulation Software made by Lighting Analysts, Inc.
CMH	Ceramic Metal Halide
CRI	Color Rendering Index
CWA	Constant Wattage Autotransformer
eV	Electron Volt
fc	Foot-candle
HPS	High Pressure Sodium
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
lm/W	Lumens per watt
kW	Kilowatt
kWh	Kilowatt-hour
mA	Milli-Amp
N/A	Not Available
NIST	National Institute of Standards and Technology
PSMH	Pulse Start Metal Halide
RMS	Root Mean Square
SCE	Southern California Edison Company
SCLTC	Southern California Lighting Technology Center
W	Watt

CONTENTS

EXECUTIVE SUMMARY

Southern California Edison's (SCE) Emerging Technology Program assesses products that have the potential to reduce electric energy use. One class of emerging technology is dimmable multi-lamp electronic ballasted (EB) ceramic metal halide CMH. This CMH is a new high color rendering long-life derivative application of evolving pulse start metal halide (PSMH) technology whose potential energy savings have not been quantified to date. This project evaluates the amount of illumination delivered and the potential energy savings attributable to this type of CMH fixture.

Serving SCE there are approximately 500 electric distribution substations. About 98% are smaller in size, about 50K-sq ft each, the remaining 2% are about 15 million sq ft each. It is estimated these CMH area lights could satisfy about 40% of the total required lighting duty for safety. This is estimated at 7,900 CMH lights of the wattage tested and applied in this report. The rest of the duty to light the stations is estimated to be most effectively and efficiently done with LED floodlights, area lights, streetlights, and bollards.

The main objectives of this project are to determine the:

- Baseline electric demand of comparable Pulse Start Metal Halide (PSMH) area lights,
- Post-retrofit electric demand of the new CMH area lights in high and low modes,
- Light level outputs of the PSMH and CMH area lights,
- The potential energy savings achievable by operating CMH lights in bi-level mode.

In December of 2010, power and photometric measurements were performed on a sample of five new dimmable CMH /EDB fixtures incorporated in a pilot test of advanced lighting at SCE's Redlands and Mira Loma electric distribution substations.

Photometric, spectral, and power measurements were taken at the Southern California Lighting Technology Center (SCLTC) located in Irwindale, CA. These measurements determined a luminous efficacy at 100% power of 63 lumens/watt (LPW) for the CMH. The CMH fixture had a power requirement of 247 Watts (W) in high mode and 130W in low mode. These are about 9.9% higher than manufacturer catalog data because there is a step down transformer for the 277 electronic ballast so the fixture could be tested at the lab and site available voltages of 120V.

PROJECT FINDINGS/RESULTS

TABLE 1. RESULTS FROM TWO AGI-32 SIMULATIONS OF THE TEST AREA.

Luminaire	Average Light Level (fc)	Maximum Light Level (fc)	Minimum Light Level (fc)	Uniformity Ratio (Max/Min)	Annual Energy Usage (kWh)
Redlands CMH (Full –Light Output)	3.5	15.3	0.6	22:1	1080
Redlands PSMH	3.0	13.1	0.6	22:1	1,244

The results above indicate that the three-lamp (rotational as to least resistance-only one ON at a time) 210W (246.6W connected) CMH, operated on high are comparable in initial light to a 250W (284W connected) magnetic ballasted PSMH meeting CA Title 20 regulations. However, the multi-lamp CMH system runs far ahead in rated life hours at 72,000 vs. 10,000 to 15,000 for PSMH. Lifecycle cost of the CMH is expected to be lower. Vertical footcandle (FC) are by far the most important here and computer modeling portrays this later in this report.

The Illuminating Engineering Society of North America (IESNA) has not established Recommended Practice (RP) for Utility Electric Substation Switchrack Equipment. SCE is conducting a site field demonstration to measure, analyze, develop, and recommend adequate lighting (illumination in footcandles) levels for that task. The results are expected to be a major building block toward setting new RP. It is worthy of note that this CMH application does exceed current IESNA Recommended Maintained Horizontal and Vertical Illuminance Intensity Values (Basic) for Parking Lots (0.2 FC and 0.1 FC respectively).

The type specification, placement, and control of the fixtures will be such as to satisfy the lighting required.

The lab work and field installations of this new CMH technology indicate the desirability of dimmable CMH luminaires, for these electric substations, which predominantly deliver uplight for vertical tasks and safety, minimal sidelight so workers are not blinded, and low to moderate downlight for walkabout safety. Earlier designs focused to do this were available ending about 25 years ago. They were sourced with HPS in egg-shaped (ellipsoidal) luminaires. SCE is encouraging the design and deployment of new more efficient versions of the egg with this compact CMH technology to satisfy this duty. Envisioned is (of three-lamps) one in the down "hemisphere", the other two in the up "hemisphere", and available dimmable over the versatile family of wattages now extant (45-60-90-140-210-315). Perhaps dual or triple 45/60/90's down and triple 140/210/315's up).

INTRODUCTION

The purpose of this study is to characterize the lighting performance of bi-level ceramic metal halide (CMH) area lighting fixtures for substation uplight duty and to quantify the energy savings potential when compared to conventional pulse start metal halide (PSMH) area fixtures.

This market subset of the general outdoor lighting market was chosen to meet jointly the specific market and application of lighting electric substation switchracks for safety, i.e. workers operating switches typically 7- to 12-feet AFG and for walkabout in those zones.

BACKGROUND

Circa 2009 engineering and marketing agents of one large manufacturer presented this technology to SCE Design & Engineering Services (DES) and SCE Street lighting operations. SCE liked what they saw. DES requested prototypes and recommended the technology be considered on several customer applications. SCE initiated a pilot to upgrade lighting at its substations for safety in mid 2010 and proceeded to procure and install lights incorporating this CMH as well as light-emitting diode (LED) floodlights for the purpose of comparison.

High-pressure sodium (HPS) is no longer a viable baseline due to the improved visual acuity of white light sources such as metal halide in its key forms (PSMH and CMH). The compact lamps, the multi-lamp configuration, the excellent color rendition over PSMH (90 against 62), better lumen maintenance, and hundreds of thousands of CMH with electronic ballasts (EB's) deployed outdoors operating successfully led us to this CMH choice for this duty.

FIGURE 1. NEED A FIGURE CAPTION HERE

EMERGING TECHNOLOGY/PRODUCT

- This CMH is a derivative of current technology that steps out from a base of reliable EB adding dimmability and a rotational (three) lamp system thereby greatly extending life into and above the realm of LED life with moderate cost lamps.
- The key technology/product innovation is compelling the lamps to rotate regularly to that of least resistance in the triad. This occurs at startup and during even a series of power bumps. It assures even wear among the three and the claim is 72K-hour's life instead of a single 24.
- The incumbent technology is PSMH. To date PSMH per se is not field proven, for inside or outside duty, reliably dimmable above 150W. This CMH is part of a family of lamps and electronic ballasts deployed successfully in Europe and Asia for approximately six years with about 800,000 installations. This manufacturer has no current competitors in the multi-lamp rotational technology.

- The new CMH technology currently saves about 13% in connected load over comparable light PSMH. When EB are ready in 2011 to operate on 120 Volts (V) without a transformer, that savings will increase to about 21%. Color-rendering index (CRI) at full power is 90 for CMH vs. 62 for PSMH - a dramatic improvement. PSMH lamp life is 80% less than CMH - another dramatic improvement. Each CMH saves 620 kWh per year based on CMH lab results vs. PSMH (catalog information) at the duty intended: CMH @ 10% of dusk-dawn (4,380 hours) on high (100% power), remainder time (90%) on low power (50%). PSMH draws 284W fixed and CMH: 246.6W on high and 130.8W on low.
- The market barriers are twofold - lack of competitor technology of similar product, which may cause buyer reluctance, and LED efficacy (currently same range, LED may pull ahead in efficacy while its fixture costs (now about triple that of CMH) reduce over the next five years).

End users are currently meeting their needs for adequate safety light for this duty by doing without, using portable lights such as flashlights, operating relic incandescent systems, and combinations thereof.

ASSESSMENT OBJECTIVES

The main objectives of the project are to determine:

- Baseline electric energy usage of representative PSMH area lights,
- Post-retrofit electric energy usage of the new bi-level CMH area lights,
- Light level outputs of the PSMH in fixed high mode vs CMH area lights in high and low modes,
- The energy savings expected in the typical substation maintenance/repair duty cycle achieved by application of the new CMH lighting.

TECHNOLOGY/PRODUCT EVALUATION

The lab tests are included for the CMH. CMH and PSMH field performance for task was computer modeled. The PSMH results are a straightforward extrapolation from the CMH results using catalog data as the luminaire is identical for both sources.

- The character of the assessment, as described, was deemed sufficient and the best choice to compare the technologies.
- Field and lab assessments were performed.
- The field assessment covered the area lighting of part of a 66 kilo-Volt (kV) switchrack. Investigator and installer movements were stringently controlled continuously for safety.

TECHNICAL APPROACH/TEST METHODOLOGY

Using the framework of the Redlands substation, which is currently a test bed for the SCE WISER (define WISER, not a defined acronym) project, a multi-level CMH uplight was modeled to evaluate performance of Advanced Electronic Ballast Dimmable Multi-Lamp Ceramic Metal Halide (CMH). The luminaire layout and test-site area geometry of the Redlands WISER test site was used to create the test footprint used in creating the AGI modeling for this report.

The Advanced Electronic Ballast Dimmable Multi-Lamp CMH luminaires were also tested at the SCLTC for photometric, spectral, and power measurements.

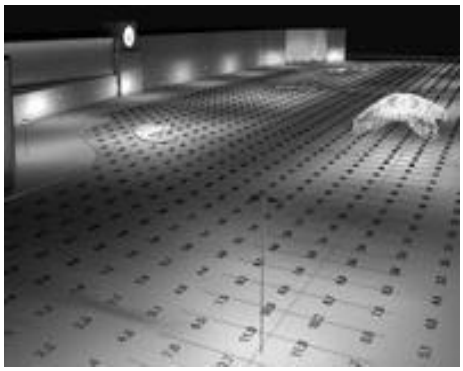
SIMULATED FIELD-TESTING OF TECHNOLOGY

The AGI-32 computer modeling software replicated the Redlands test site. Luminaires lamped with the specific technologies (electronic dimmable CMH and non-dimming PSMH) were placed into the Redlands model following the layout footprint established when creating the Redlands environment for the WISER test mock-up. Performance models were then run of each technology with the AGI-32 computer software.

AGI-32 LIGHTING SIMULATION SOFTWARE

The tool used to create computer models used in evaluating the technologies, legacy, baseline and advanced and emerging, is a recognized premier computer software program modeling tool for lighting design and evaluation. AGI-32 is first and foremost, a calculation tool for accurate photometric predictions. A technical tool that 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

With the ability to see results clearly for an entire project, AGI-32 becomes a mock-up substitute that can save time and money by creating a virtual model of a proposed design. It can reveal characteristics and effects that would be difficult to detect in anything short of the completed installation.

LIGHTING TECHNOLOGY TEST CENTER

Lab tests were conducted on the 210W CMH 3-lamp EONS system luminaire at the Southern California Edison (SCE) Lighting Technology Test Center (LTTC). A total of two different tests were performed. These tests were as follows:

- **Test 1** – One lamp tested with dimmable electronic ballast operating at 100% power (full output)
- **Test 2**– One lamp tested with dimmable electronic ballast operating at 50% power (reduced output)

Results of the AGI-32 modeling as well as the sphere tests conducted by LTTC are shown within the results section of the Advanced Electronic Ballast Dimmable Multi-Level Ceramic Metal Halide Luminaire report.

RESULTS

Lighting models, using AGI-32 computer modeling software, were run for a 210W three-lamp Advanced Electronic Ballast Dimmable Ceramic Metal Halide Luminaire and a fixed (non dimmable) 250W (284W connected) single lamp PSMH luminaire(the same as for the CMH). A recap of the results of these design models is shown within this section of the report. Also shown are the results of the sphere Tests conducted by SCE's Lighting Technology test Center (LTTC).

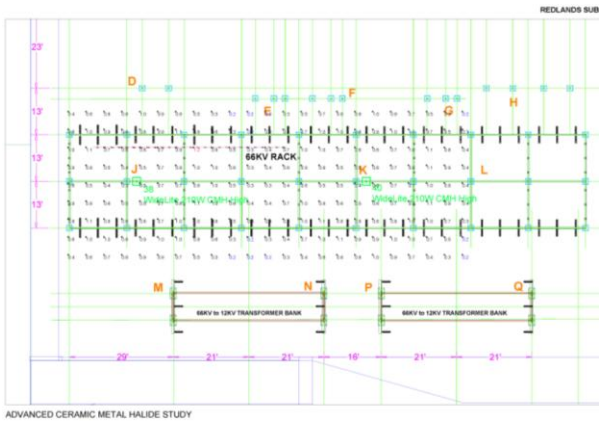
DATA ANALYSIS – AGI-32 MODELING

Details of the results gained from AGI-32 modeling of both the dimmable 210W CMH and the fixed 250W PSMH Start luminaire designs are presented in the following series of images and tables. Each model includes a computer generated rendering of the design model, a point-by-point illuminance map and table with performance data.

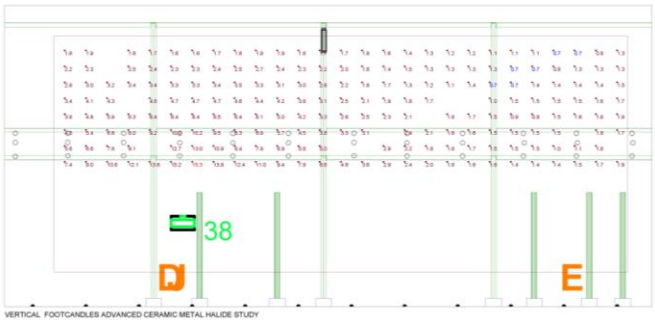
210W Ceramic Metal Halide Design

Advanced Technology Design – 3-210W Dimming & Rotating Lamp CMH Luminaires

210W CMH at REDLANDS SUBSTATION



ADVANCED CERAMIC METAL HALIDE STUDY



VERTICAL FOOTCANDLES ADVANCED CERAMIC METAL HALIDE STUDY

210W CERAMIC METAL HALIDE

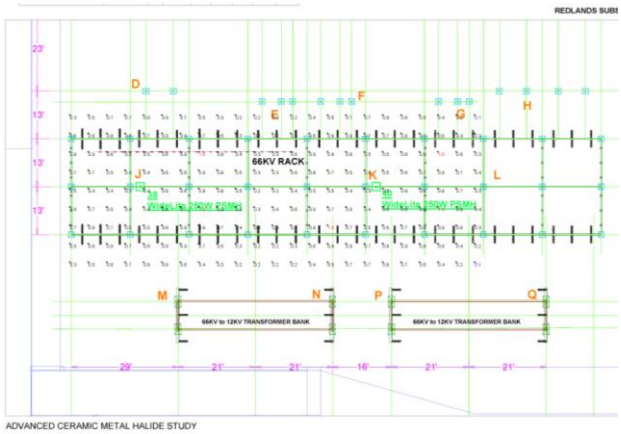
Luminaire Schedule											
Symbol	Qty	Label	Total Lamp Lumens	Lum. Eff.(%)	Lum. Lumens	Lum. Watts	LLD	LDD	BF	LLF	Description
+	2	WideLite 210W CMH High	24150	83	20068	225	0.800	0.900	1.000	0.720	RSPP-210-RG

Calculation Summary								
Label	CalcType	# Pts	Units	Avg	Max	Min	Avg/Min	Max/Min
Ground Surface_Upper Level	Illuminance	207	Fc	0.68	1.2	0.2	3.40	6.00
Vertical In 66 KV Rack	Illuminance	204	Fc	3.53	15.3	0.7	5.04	21.86

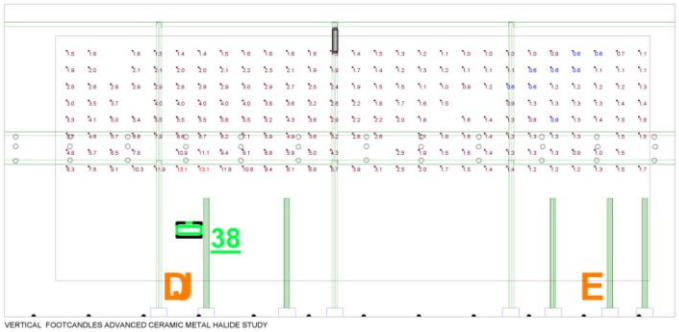
250W Pulse Start Metal Halide Design

Mainstream Design – Non - Dimming Single Lamp Luminaires

250W PULSE START METAL HALIDE at REDLANDS SUBSTATION



ADVANCED CERAMIC METAL HALIDE STUDY



VERTICAL FOOTCANDLES ADVANCED CERAMIC METAL HALIDE STUDY

250W PLUSE START METAL HALIDE

Luminaire Schedule											
Symbol	Qty	Label	Total Lamp Lumens	Lum. Eff.(%)	Lum. Lumens	Lum. Watts	LLD	LDD	BF	LLF	Description
	2	WideLite 250W PSMH	23700	83	19694	284	0.700	0.900	1.000	0.630	RSPP-210-RG

Calculation Summary								
Label	CalcType	# Pts	Units	Avg	Max	Min	Avg/Min	Max/Min
Ground Surface_Upper Level	Illuminance	207	Fc	0.58	1.0	0.1	5.80	10.00
Vertical In 66 KV Rack	Illuminance	204	Fc	3.03	13.1	0.6	5.05	21.83

DATA ANALYSIS – SCE LTTC SPHERE TESTS

Results form sphere test of the 210W three-lamp Advanced Electronic Ballast Dimmable Multi Level Ceramic Metal Halide Luminaire at 100% output, 60% output and 50% output are shown as follows:

Sphere Test at Full Output – 100% 1 of 5

lttc
Lighting Technology Test Center

Sphere-Spectroradiometer Test Report
ER00.30 – WideLight Metal Halide Area Light

General Information

Test number: 1 of 3
Test date: 12/10/2010
Manufacturer: WideLight
Model: 92893

Description: 210 W Ceramic Metal Halide Area Fixture with 3 Lamp EONS System (Please see attached EONS specifications sheet below)- Tested 1 Lamp on dimmable electronic ballast at 100% power

Results

Reading	Claimed	Measured
Light		
Radiant flux (mW)		61072.28
Luminous flux (lm)		15601.89
Correlated color temperature (K)		3647
Color rendering index (Ra)		91.6
Chromaticity (x)		0.3925
Chromaticity (y)		0.3724
Chromaticity (u)		0.2349
Chromaticity (v)		0.3343
Electrical		
Voltage (V rms for ac, V dc for dc)	N/A	119.88
Voltage THD (% for AC, N/A for dc)		0.47
Current (A rms for ac, A dc for dc)		2.0808
Current THD (% for ac, N/A for dc)		11.31
Power (W)		246.6
Power factor (PF for ac, N/A for dc)		-0.9886
Phase angle (° for ac, N/A for dc)		-8.67
Frequency (Hz for ac, N/A for dc)	N/A	59.999
Efficacy		
Efficacy (calculated lm/W)		63.26

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Sphere Test at Full Output – 100% 2 of 5

Sphere-Spectroradiometer Test Report

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

Parameters

Duration

From new to start of test (h:min):	0:00 estimated
From start of test to stabilization (h:min):	1:13
From stabilization to reading (h:min):	0:03
Total from new to reading (h:min):	1:16

Environment

Room thermostat set point (°F):	Heat off, Cool off
Ambient temperature at time of reading (°F):	80.45738
Sphere temperature at time of reading (°F):	78.83944

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:	Directional lens down
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:	12/8/2010

Electrical

Power supply:	Elgar CW1251P AC power source
Power meter:	Hioki 3390 power 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”.

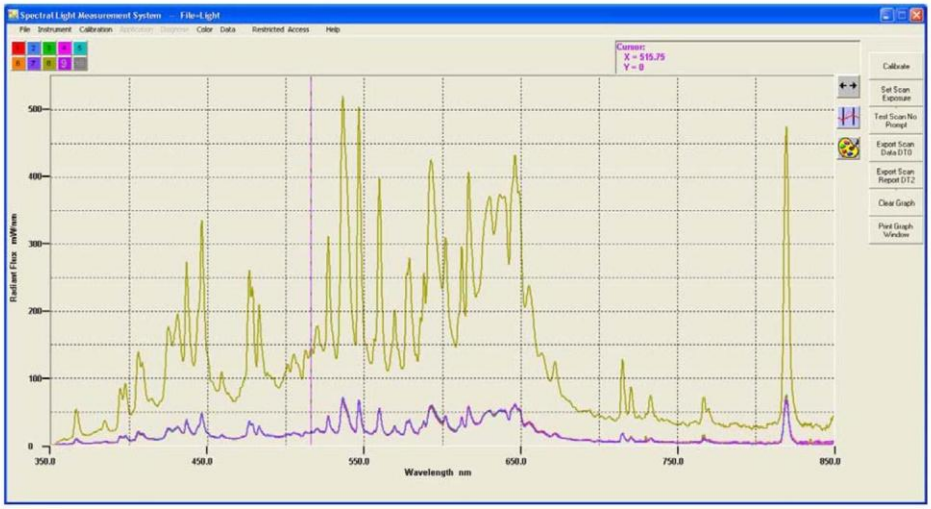
Notes

HVAC and Lights were turned off for lamp stabilization.

Sphere Test at Full Output – 100% 3 of 5

Sphere-Spectroradiometer Test Report

Images



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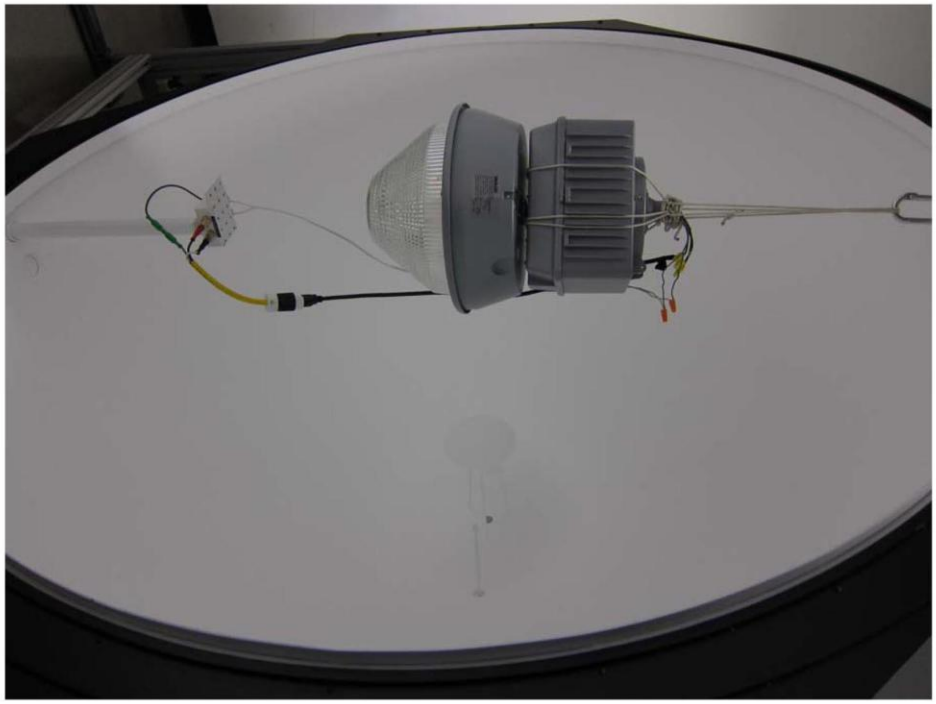
Page 3 of 5

Sphere Test at Full Output – 100%

Sphere-Spectroradiometer Test Report



Sphere Test at Full Output – 100%

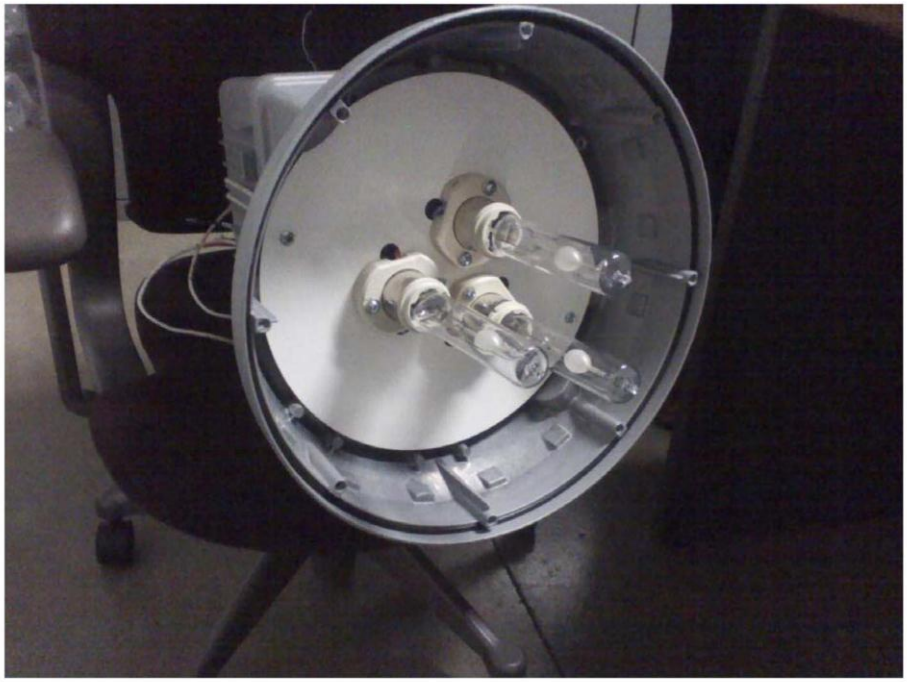
Sphere-Spectroradiometer Test Report

Attachments:

EONS System Specifications Sheet:

RSP-E Cosmo spec sheet-WLSP0320A08

EONS System Image:



Sphere Test at Lower Level Output – 60% 1 of 5

Lighting Technology Test Center

Sphere-Spectroradiometer Test Report
ER00.31 – WideLight Metal Halide Area Light

General Information

Test number: 2 of 3
Test date: 12/10/2010
Manufacturer: WideLight
Model: 92893

Description: 210 W Ceramic Metal Halide Area Fixture with 3 Lamp EONS System (Please see attached EONS specifications sheet below)- Tested 1 Lamp on dimmable electronic ballast at 60% power

Results

Reading	Claimed	Measured
Light		
Radiant flux (mW)		24287.55
Luminous flux (lm)		6870.129
Correlated color temperature (K)		4602
Color rendering index (Ra)		78.5
Chromaticity (x)		0.3587
Chromaticity (y)		0.3706
Chromaticity (u)		0.2132
Chromaticity (v)		0.3304
Electrical		
Voltage (V rms for ac, V dc for dc)	N/A	119.9
Voltage THD (% for AC, N/A for dc)		0.43
Current (A rms for ac, A dc for dc)		1.2791
Current THD (% for ac, N/A for dc)		16.08
Power (W)		149.1
Power factor (PF for ac, N/A for dc)		0.9719
Phase angle (° for ac, N/A for dc)		13.62
Frequency (Hz for ac, N/A for dc)	N/A	59.998
Efficacy		
Efficacy (calculated lm/W)		46.077

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Sphere Test at Lower Level Output – 60% 2 of 5

Sphere-Spectroradiometer Test Report

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

Parameters

Duration

From new to start of test (h:min):	0:00 estimated
From start of test to stabilization (h:min):	0:04
From stabilization to reading (h:min):	0:01
Total from new to reading (h:min):	0.05

Environment

Room thermostat set point (°F):	Heat off, Cool off
Ambient temperature at time of reading (°F):	80.55745
Sphere temperature at time of reading (°F):	78.94208

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:	Directional lens down
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:	12/8/2010

Electrical

Power supply:	Elgar CW1251P AC power source
Power meter:	Hioki 3390 power 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".

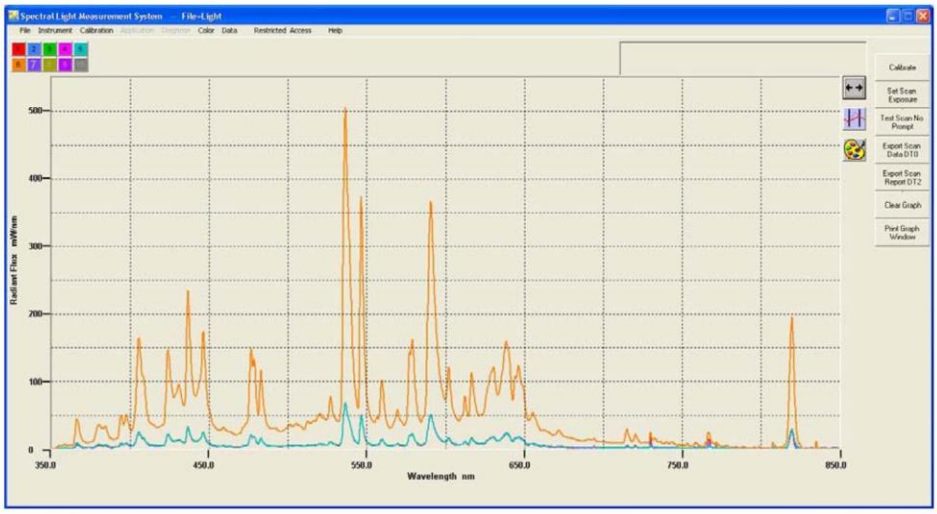
Notes

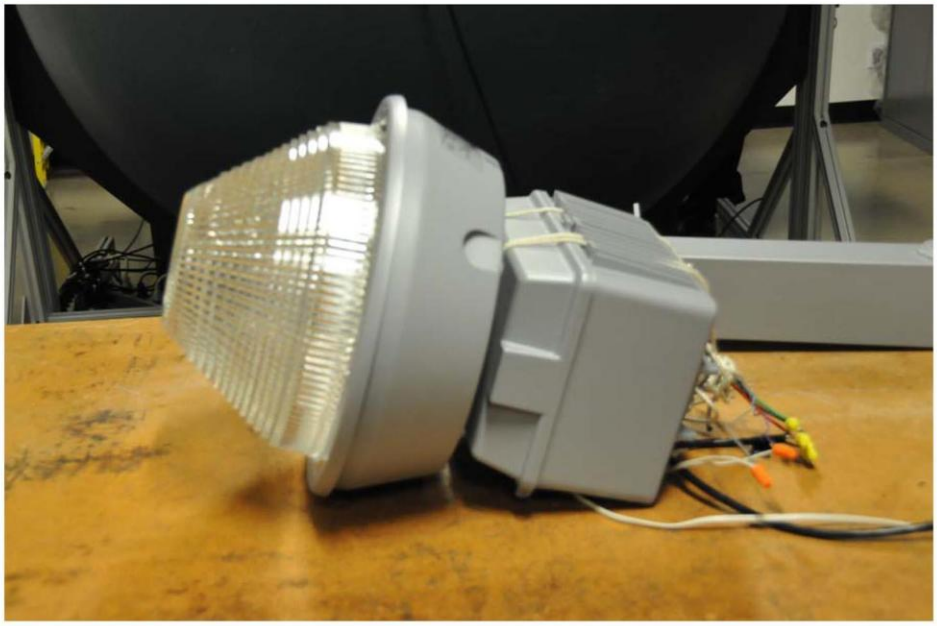
HVAC and Lights were turned off for lamp stabilization.

Sphere Test at Lower Level Output – 60% 3 of 5

Sphere-Spectroradiometer Test Report

Images





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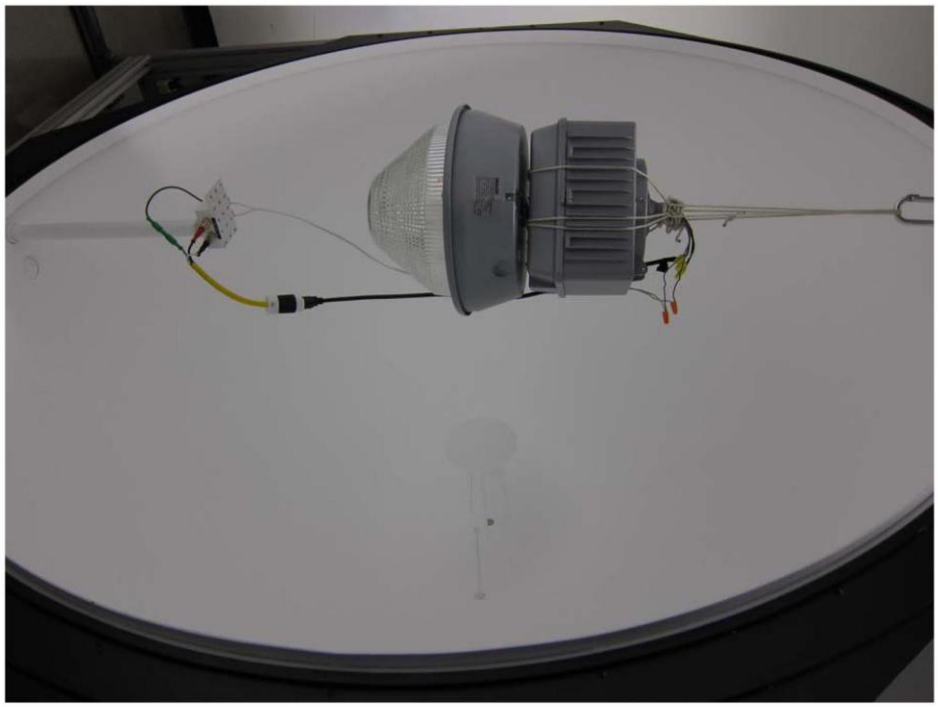
Page 3 of 5

Sphere Test at Lower Level Output – 60% 4 of 5

Sphere-Spectroradiometer Test Report



Sphere Test at Lower Level Output – 60% 5 of 5

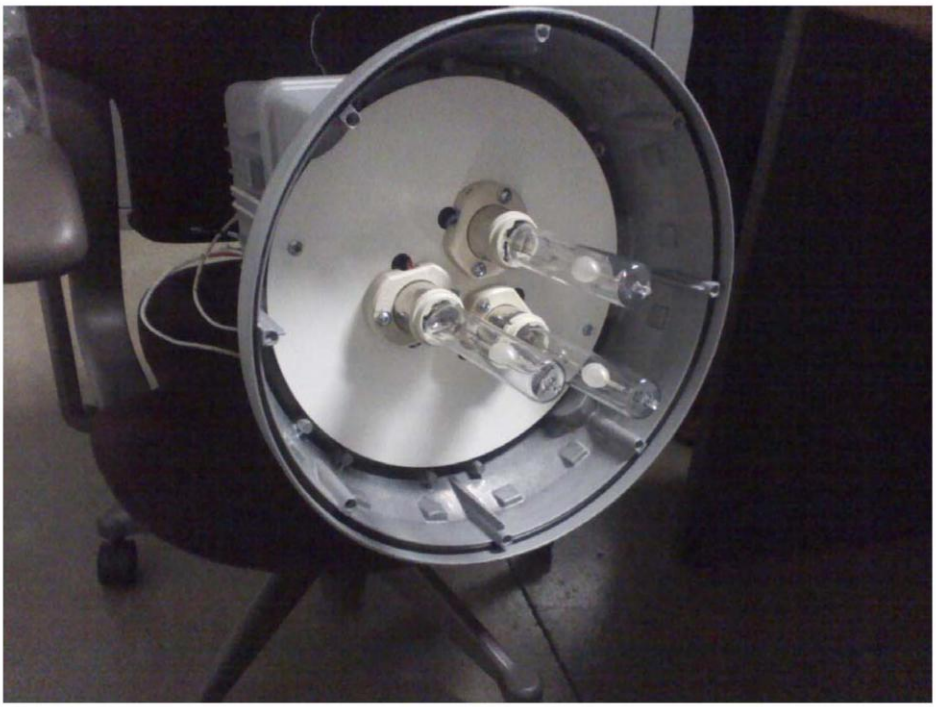
Sphere-Spectroradiometer Test Report

Attachments:

EONS System Specifications Sheet:

RSP-E Cosmo spec sheet-WLSP0320A08

EONS System Image:



Sphere Test at Lower Level Output – 50% 1 of 5

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Lighting Technology Test Center

Sphere-Spectroradiometer Test Report
ER00.33 – WideLight Metal Halide Area Light

General Information

Test number: 3 of 3
Test date: 12/10/2010
Manufacturer: WideLight
Model: 92893

Description: 210 W Ceramic Metal Halide Area Fixture with 3 Lamp EONS System (Please see attached EONS specifications sheet below)- Tested 1 Lamp on dimmable electronic ballast at 50% power

Results

Reading	Claimed	Measured
Light		
Radiant flux (mW)		18294.82
Luminous flux (lm)		5297.035
Correlated color temperature (K)		5006
Color rendering index (Ra)		69.3
Chromaticity (x)		0.347
Chromaticity (y)		0.3757
Chromaticity (u)		0.2037
Chromaticity (v)		0.3308
Electrical		
Voltage (V rms for ac, V dc for dc)	N/A	119.93
Voltage THD (% for AC, N/A for dc)		0.43
Current (A rms for ac, A dc for dc)		1.1299
Current THD (% for ac, N/A for dc)		18.08
Power (W)		130.8
Power factor (PF for ac, N/A for dc)		0.9649
Phase angle (° for ac, N/A for dc)		15.22
Frequency (Hz for ac, N/A for dc)	N/A	59.998
Efficacy		
Efficacy (calculated lm/W)		40.49

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Sphere Test at Lower Level Output – 50% 2 of 5

Sphere-Spectroradiometer Test Report

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

Parameters

Duration

From new to start of test (h:min):	0:00 estimated
From start of test to stabilization (h:min):	0:04
From stabilization to reading (h:min):	0:01
Total from new to reading (h:min):	0.05

Environment

Room thermostat set point (°F):	Heat off, Cool off
Ambient temperature at time of reading (°F):	80.26331
Sphere temperature at time of reading (°F):	78.60176

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:	Directional lens down
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:	12/8/2010

Electrical

Power supply:	Elgar CW1251P AC power source
Power meter:	Hioki 3390 power 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”.

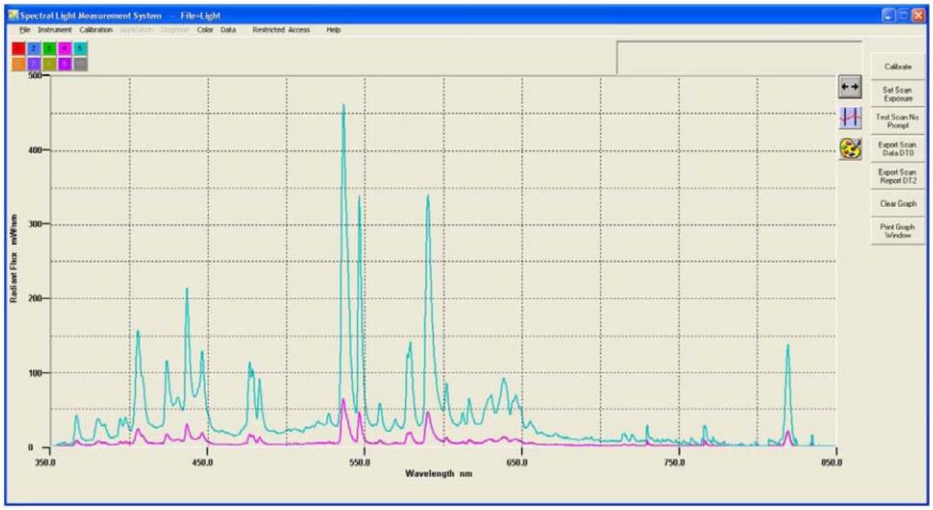
Notes

HVAC and Lights were turned off for lamp stabilization.

Sphere Test at Lower Level Output – 50% 3 of 5

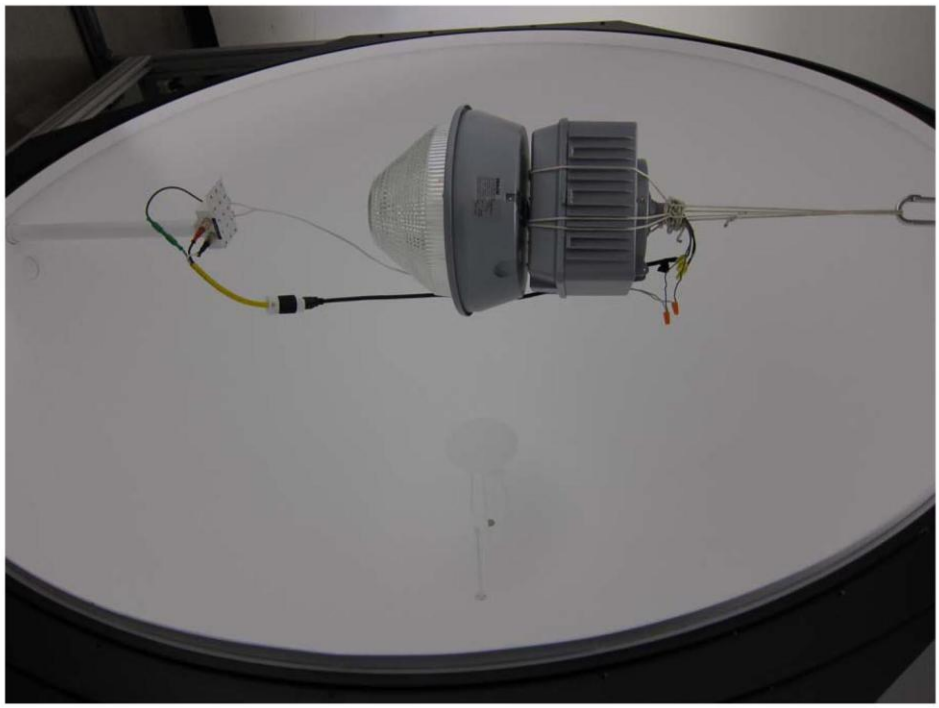
Sphere-Spectroradiometer Test Report

Images



Sphere Test at Lower Level Output – 50% 4 of 5

Sphere-Spectroradiometer Test Report



Sphere Test at Lower Level Output – 50% 5 of 5

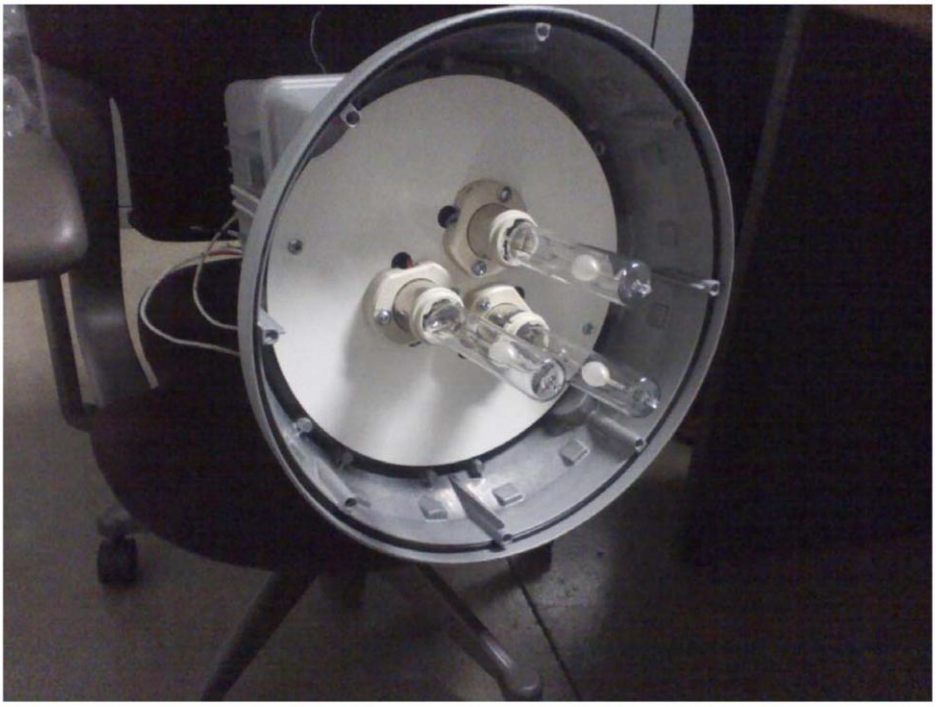
Sphere-Spectroradiometer Test Report

Attachments:

EONS System Specifications Sheet:

RSP-E Cosmo spec sheet-WLSP0320A08

EONS System Image:



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Page 5 of 5

EVALUATIONS

The CMH lab results met all performance expectations and manufacturer claims. The Lighting Project Manager in lab personally observed a successful demo of the rotational lamp system. No barriers were encountered.

- The new technology is superior to the incumbent technology as described earlier.
- See energy savings and demand reduction in Emerging Technology/Product above.
- Very low expected maintenance , moderate lamp costs projected (especially if applied in lower Cosmopolis (Cosmopolis family wattages are 45,60,90,140: Elite 210 and 315)) and, with this study's Elite ,very high CRI
- Cost is the barrier favoring PSMH but this CMH has the much higher CRI and rated life. LED has much higher (2 times) 1st cost.

RECOMMENDATIONS

Additional ET assessments made over a range of wattages would be desirable. This study draws on interim results of a much larger lab and site study establishing the ability to accommodate changing/advancing lighting technologies periodically to establish substation lighting standards. Paper project studies similarly designed and setup for dynamic periodic inputs of advancing technology such as this CMH are recommended for streetlighting and open lot area lighting applications.

- Current compliance tools are unable to simulate this technology.

With proper engineering analysis and controls CMH can be used as a standard going forward in substation lighting design and implementation.