

**PHOTOMETRIC TESTING & EVALUATION TO IES LM-79-08**Sample Tested  
**Zero S**

Prepared for:

**Bruce Clark**3form  
4770 Ohio Ave S. SuiteA  
Seattle, WA 98134

Phone: 206-890-0995

**Technical Report Number  
2686504-01**

December 16, 2013

**Prepared by:**

James E. Berkeley, Program Manager

**Approved by:**

Wensheng Xu, Technical Advisor

## Program Description

Photometric and electrical testing of a “Zero S” replacement Lamp to IES LM-79-08.

## Executive Summary

Sample Tested = **Zero S**  
Mfg’r: **Lightart**

<b>Luminous Efficacy*</b> <b>(Lumens/Watt)</b>	<b>Luminous Flux*</b> <b>(Lumens)</b>	<b>Input Power*</b> <b>(Watts)</b>	<b>Power Factor*</b>
<b>77.99</b>	<b>1045</b>	<b>13.40</b>	<b>0.832</b>

<b>CCT (K)*</b>	<b>CRI*</b>	<b>Stabilization Time</b> <b>(Light &amp; Power)</b>
<b>2949</b>	<b>83.1</b>	<b>60 minutes</b>

\* The above results are recorded / derived from measurements made using an Integrating Sphere

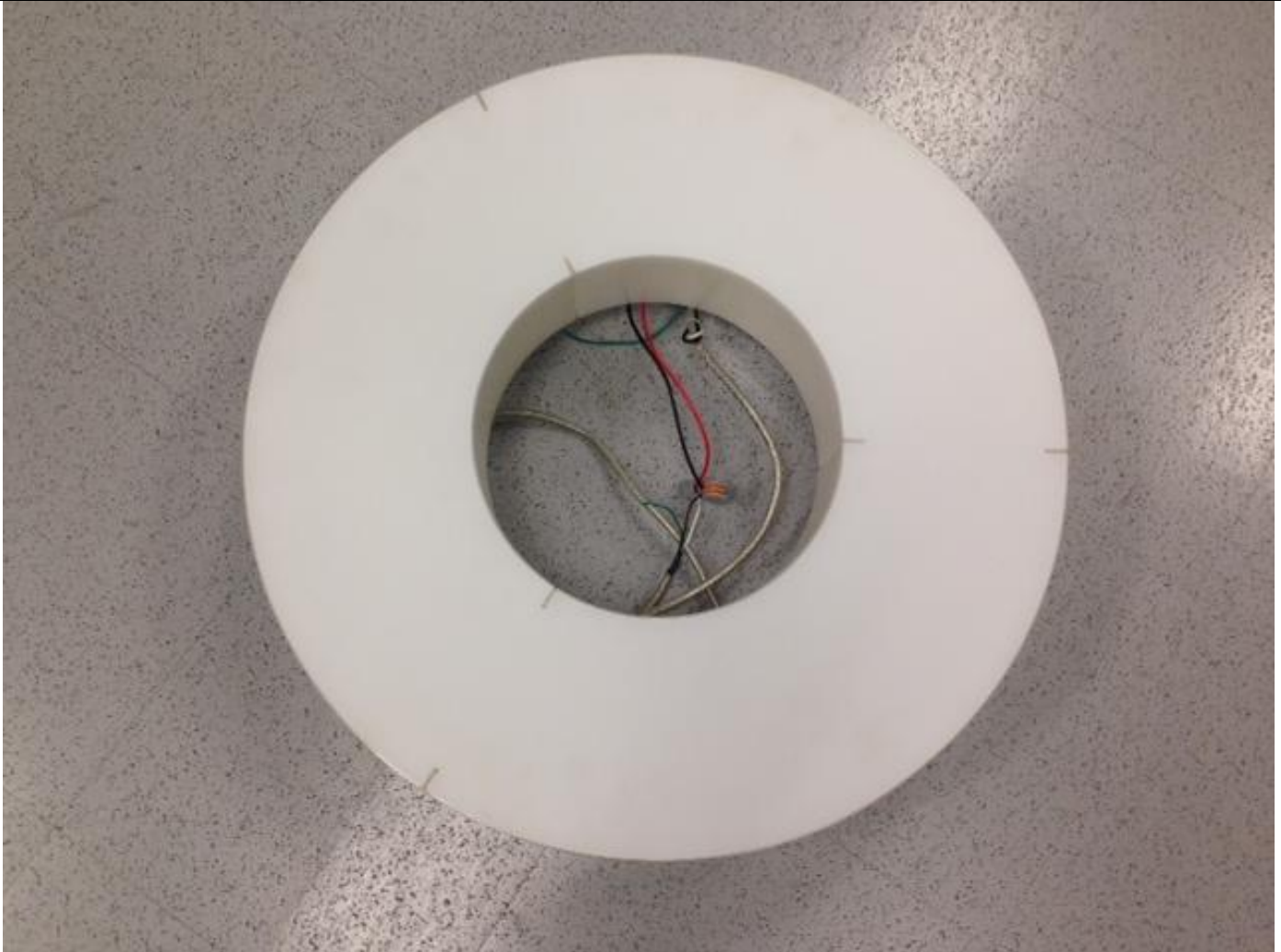
## TABLE OF CONTENTS

Sample.....	4
Test Results .....	5
Spectral Flux .....	6
Chromaticity Diagram .....	7
Flux Distribution – Zonal Lumen Summary.....	8
Illuminance Plots .....	9
Candela Plots .....	10
Candela Tabulation .....	11
Photometric Testing Information .....	13
Equipment List:.....	15

### Sample

The following sample was submitted for evaluation:

**3form:** Zero S

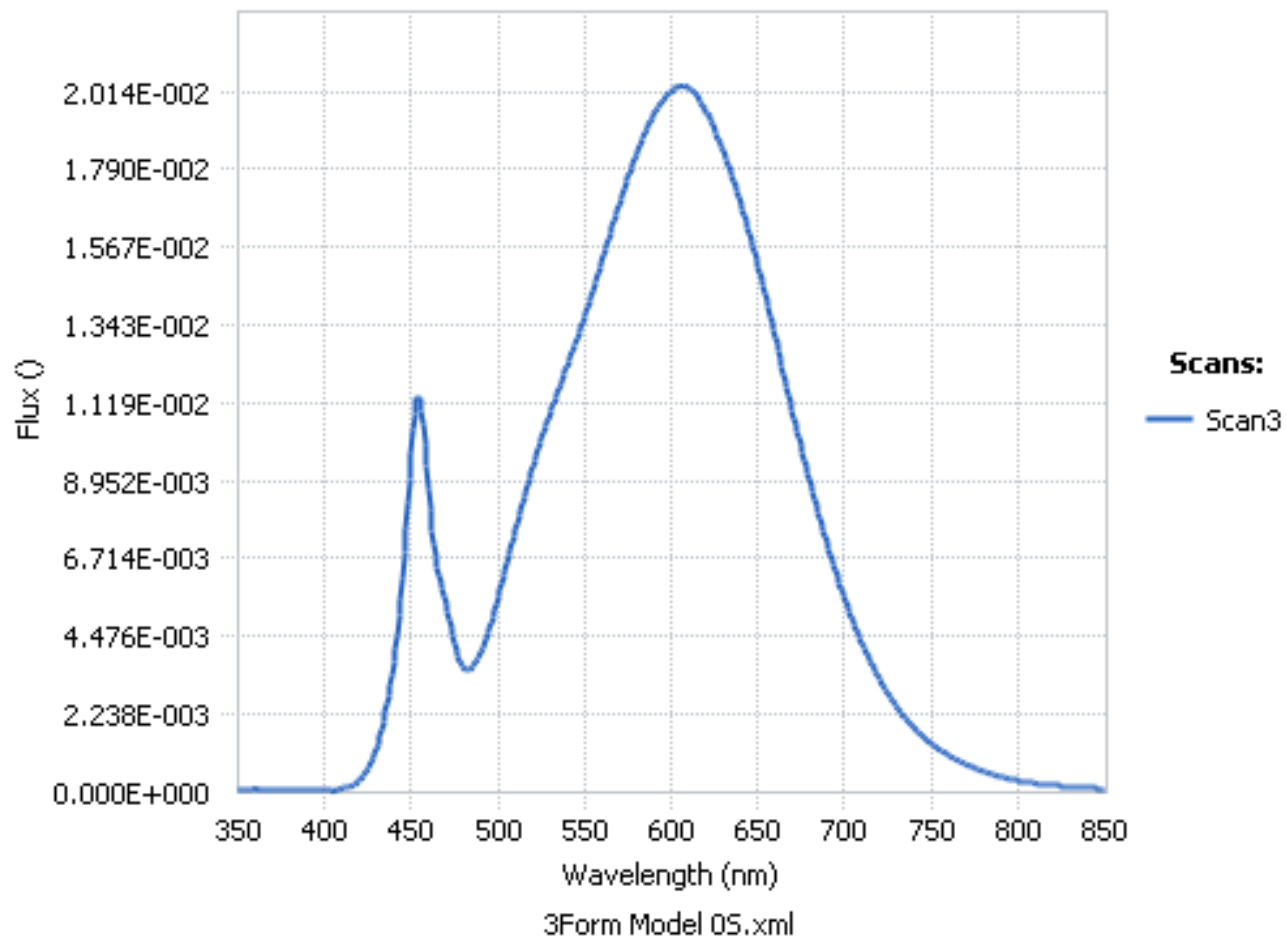


**Zero S**

Test Results –								
The following results were measured after stabilization of the sample in the <b>Integrating Sphere</b> (unless otherwise stated). Stability is reached when the variation of 3 readings of light output and electrical power, taken 15 minutes apart, is less than 0.50% (in accordance with IES LM-79-08).								
Key Photometric Results	Sample Reference							
	Zero S							
	Integrating Sphere				Goniophotometer			
Luminous Efficacy (Lumens/Watt)	77.99				75.69			
Total Luminous Flux (Lumens)	1045				1020.32			
Total Radiant Flux (Watts)	3.399							
Correlated Color Temperature (CCT)	2949							
Color Rendering Index (CRI) (Ra)	83.1							
R1 thru R7 Value	81.3	89.6	95.9	80.2	80.2	85.4	86.5	
R8 thru R14 Value	66	22.5	75.1	77.2	63.5	82.9	97.4	
Chromaticity (Chroma x / Chroma y)	0.4415 / 0.4075							
Chromaticity (Chroma u / Chroma v)	0.2521 / 0.3489							
Chromaticity (Chroma u’ / Chroma v’)	0.2521 / 0.5234							
Duv Value	0.00072							
Stabilization Time (Light and Power)	Approx. 60 minutes							
Total Run Time – Integrating Sphere	64 minutes							
Total Run Time – Goniophotometer	46 minutes							
Spacing Criteria	1.28 (0° – 180°) / 1.28 (90° – 270°)							
Scotopic/Photopic ratio $\Phi(v')/\Phi(v)$	1.293							
Electrical Input Results:	Sample Reference							
	Zero S							
	Integrating Sphere				Goniophotometer			
Input Power (Watts)	13.40				13.48			
Input Voltage (Volts AC)	120.0				120.22			
Input Current (Amps)	0.13				0.13			
Input Frequency (Hertz)	60.0				60.0			
Power Factor	0.832				0.832			
Total Harmonic Distortion (%THD V/A)	0.08 / 22.32							
Additional Information	Sample Reference							
	Zero S							
Ambient Temperature	24.1°C							
Integrating Sphere Detector	CDS 600 Spectroradiometer							
Absorption Correction used?	Yes							

## Spectral Flux

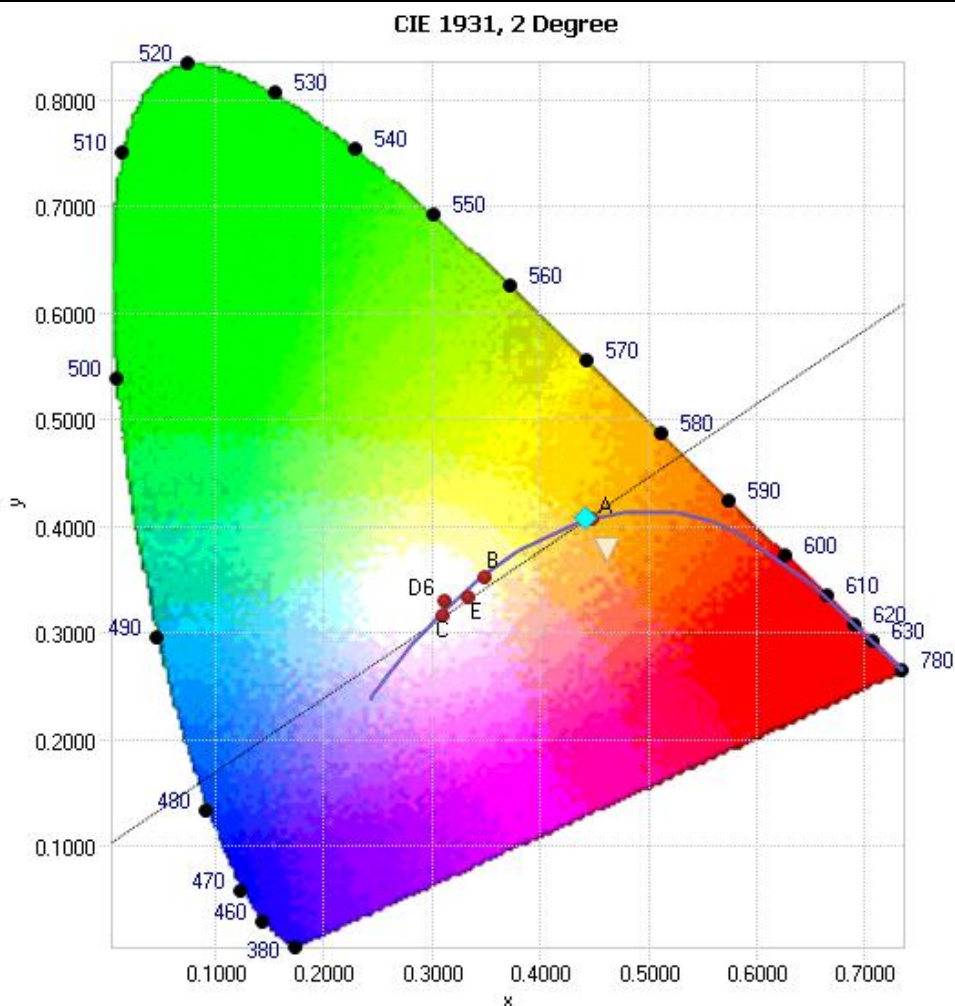
The following graph shows the spectral response curve of the radiant flux for the sample:



**Spectral response of the Radiant Flux**  
(350nm to 850nm – calibrated range of the Spectroradiometer).

## Chromaticity Diagram

The following image shows the chromaticity diagram for the sample:



**Tristimulus values (from page 6):**  
**x / y = 0.4415 / 0.4075**

The locations on the diagram of the tristimulus coordinates are indicated by the blue diamond.

**Test Results – Flux Distribution – Zonal Lumen Summary**

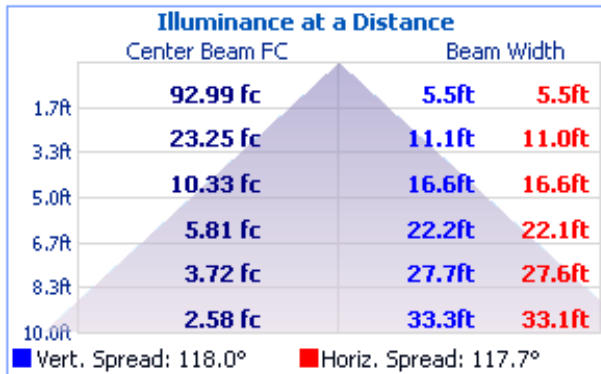
The following table depicts the zonal lumen distribution for the sample:

<b>Zone</b>	<b>Lumens</b>	<b>% Total</b>
0 - 10	24.5	2.40%
10 - 20	70.4	6.90%
20 - 30	107.1	10.50%
30 - 40	130.3	12.80%
40 - 50	137.4	13.50%
50 - 60	128.4	12.60%
60 - 70	104.7	10.30%
70 - 80	69	6.80%
80 - 90	28.6	2.80%
90-100	24.5	2.40%
100-110	70.4	6.90%
110-120	107.1	10.50%
120-130	130.3	12.80%
130-140	137.4	13.50%
140-150	128.4	12.60%
150-160	104.7	10.30%
160-170	69	6.80%
170-180	28.6	2.80%
<b>Total</b>	<b>1020.3 LUMENS</b>	
<b>Zone</b>		
0-60	598.1	58.60%
60-90	202.3	19.80%
0-90	800.4	78.50%
90-180	219.9	21.50%
0-180	1,020.30	100%

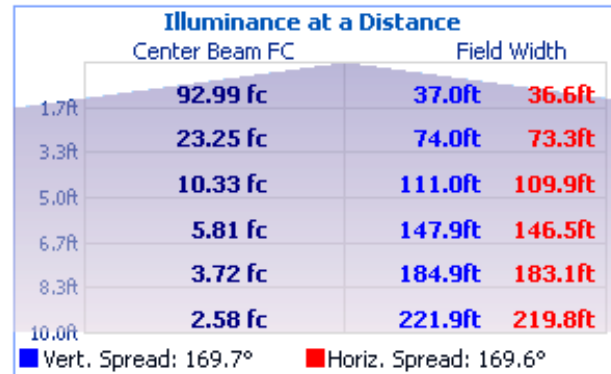


### Test Results – Illuminance Plots

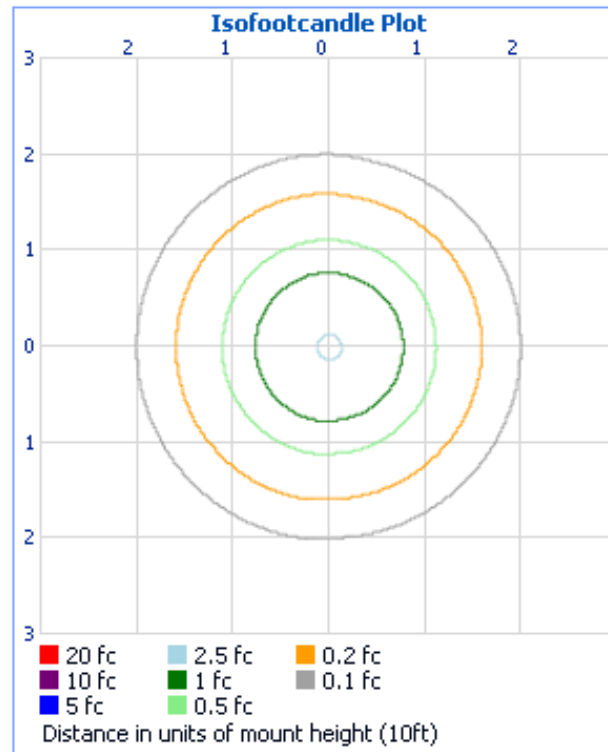
The following images depict the illuminance characteristics of the luminaire.



Beam Angle



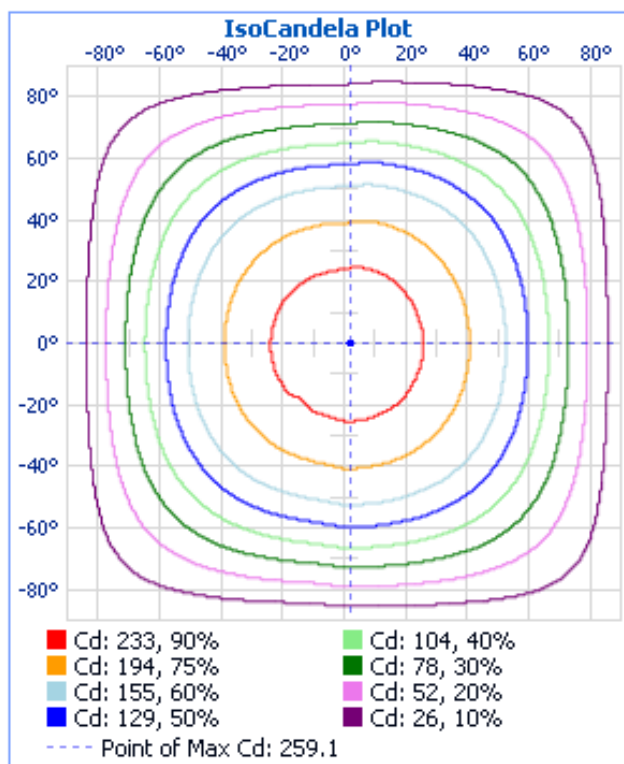
Field Angle



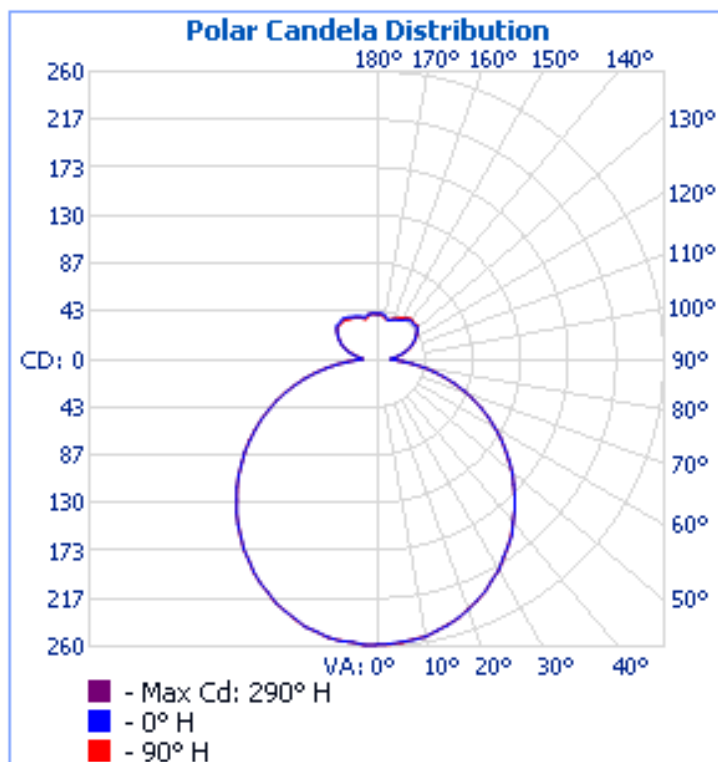
Illuminance Plot (Footcandles)

## Test Results – Candela Plots

The following images depict the luminous intensity distribution characteristics of the luminaire.



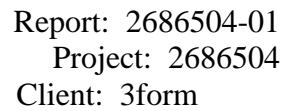
Isocandela Plot



Polar Candela Distribution

## Coefficients Of Utilization - Zonal Cavity Method

		Effective Floor Cavity Reflectance: 20%															
		80				70				50				30			
RCC %:		70	50	30	0	70	50	30	0	50	30	20		50	30	20	
RW %:																	
RCR: 0	1.14	1.14	1.14	1.14	1.09	1.09	1.09	.78	.99	.99	.99	.90	.90	.90	.82	.82	.82
1	1.03	.98	.94	.90	.98	.94	.90	.65	.86	.82	.80	.78	.76	.73	.71	.69	.64
2	.93	.85	.78	.72	.89	.81	.75	.54	.74	.69	.65	.68	.64	.60	.62	.59	.56
3	.85	.74	.66	.60	.81	.71	.64	.45	.65	.59	.54	.59	.54	.50	.54	.50	.44
4	.77	.66	.57	.50	.74	.63	.55	.39	.58	.51	.46	.53	.47	.43	.48	.44	.37
5	.71	.58	.49	.43	.67	.56	.48	.33	.51	.44	.39	.47	.41	.37	.43	.38	.35
6	.65	.52	.43	.37	.62	.50	.42	.29	.46	.39	.34	.43	.37	.32	.39	.34	.30
7	.61	.47	.39	.33	.58	.45	.37	.26	.42	.35	.30	.39	.33	.28	.36	.31	.27
8	.56	.43	.35	.29	.54	.41	.34	.23	.38	.32	.27	.35	.30	.25	.33	.28	.24
9	.52	.39	.31	.26	.50	.38	.30	.21	.35	.29	.24	.33	.27	.23	.30	.25	.21
10	.49	.36	.28	.23	.47	.35	.28	.19	.32	.26	.22	.30	.25	.21	.28	.23	.19



The following table provides the tabulated Candela measurements:

	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300	310	320	330	340	350	360	
0	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258
2.5	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258	258
5	257	257	257	257	256	257	258	257	257	258	257	258	257	258	257	256	258	257	258	258	258	258	258	258	257	258	258	257	258	257	258	257	258	257	258	259	257	257
7.5	256	255	257	256	256	257	256	256	257	255	256	255	257	255	256	256	256	255	257	256	256	257	256	256	257	256	255	256	257	256	257	257	257	257	257	256	257	256
10	255	255	254	254	254	254	254	254	254	255	255	255	254	254	253	254	254	254	255	255	255	255	254	255	255	255	255	255	255	256	255	256	255	255	255	255	256	255
12.5	251	251	251	252	251	252	252	252	252	252	251	252	251	252	249	251	251	251	252	253	253	254	254	253	254	253	253	254	253	253	252	254	253	254	254	254	253	251
15	249	249	249	249	249	249	248	249	249	248	249	248	249	248	245	249	249	248	251	250	249	250	249	249	249	250	249	250	251	250	251	250	251	250	250	250	251	249
17.5	245	245	245	245	245	245	246	245	244	246	245	246	244	246	241	244	244	245	246	247	247	246	247	247	246	247	247	247	247	247	247	247	247	247	247	248	247	245
20	241	241	241	242	241	242	241	240	241	241	240	241	240	236	241	240	240	243	242	243	242	243	243	243	243	242	243	242	243	242	243	243	244	244	244	243	243	241
22.5	236	237	237	237	237	237	236	236	237	237	237	237	237	236	232	236	237	236	239	238	238	238	238	238	238	239	238	238	239	239	239	238	239	238	239	240	236	
25	232	231	231	232	231	231	232	231	231	232	231	232	231	232	228	231	230	231	233	233	234	234	234	234	233	234	234	233	234	233	234	233	234	233	234	235	235	234
27.5	225	226	226	227	226	226	225	226	226	225	226	225	226	225	224	226	226	225	228	228	227	228	228	228	229	228	228	228	229	228	229	228	229	229	228	229	228	225
30	220	22																																				

150	41	42	42	42	43	42	43	43	44	43	43	43	43	43	43	42	43	44	45	44	44	44	44	43	43	43	43	43	43	44	43	43	43	43	41		
152.5	40	41	41	41	42	41	42	42	43	42	42	42	42	42	42	42	42	44	44	44	43	43	43	43	42	42	42	43	43	43	43	43	42	42	42	40	
155	39	40	40	40	40	41	41	41	41	41	41	41	41	41	41	41	41	42	43	44	43	42	43	42	42	42	42	42	42	42	41	42	41	39			
157.5	39	39	40	39	39	40	40	41	40	39	40	40	40	40	40	40	39	42	42	43	43	42	42	42	41	41	41	41	42	42	41	41	40	40	39		
160	38	38	39	38	39	40	40	39	39	38	39	39	39	39	40	40	39	38	41	42	43	43	42	41	41	40	40	40	41	42	42	41	40	39	39	40	38
162.5	37	38	38	38	39	39	39	38	38	37	38	38	38	39	39	39	38	37	40	40	42	42	42	42	41	40	39	38	40	41	41	41	39	39	38	37	
165	37	38	39	39	39	39	38	38	36	37	37	38	39	39	39	38	37	36	39	40	41	42	42	42	41	40	38	38	39	40	41	41	40	39	38	37	
167.5	39	40	40	40	40	39	39	38	37	38	38	39	39	40	40	39	38	38	40	41	42	42	43	43	42	40	39	39	41	42	41	41	40	40	39	39	
170	40	41	42	41	41	40	39	38	38	38	39	40	40	40	40	39	39	38	42	41	41	42	42	43	43	43	42	41	41	41	41	41	41	41	40	40	40
172.5	41	42	42	42	41	40	39	38	39	40	41	41	41	41	40	40	39	39	41	41	41	41	42	42	42	42	42	41	41	41	41	41	41	41	41	41	41
175	41	42	42	41	41	40	39	39	40	41	41	41	41	41	40	39	39	39	42	41	41	41	41	42	42	42	42	41	41	41	41	41	41	40	41	41	
177.5	41	41	41	41	40	40	40	40	40	41	41	41	41	41	40	39	39	39	42	41	41	41	41	41	41	41	41	41	41	41	41	41	40	40	40	41	
180	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	

Continued.....

**Photometric Testing Information**

The sample was evaluated for photometric and electrical characteristics using an integrating sphere and a goniophotometer, each located in purpose-built, temperature and humidity-controlled, draft free environments.

The integrating sphere is by Labsphere which exhibits a “ $4\pi$  geometry” configuration according to IES LM-79-08 and is applicable for all types of LED products (directional and non-directional light projections). Its spectroradiometer is an array-type detector manufactured and calibrated by Labsphere.

The integrating sphere uses self-absorption correction to eliminate errors due to mismatches between the standard reference lamp and the test samples being measured. The auxiliary lamp used to perform this task is a halogen type lamp powered by a calibrated *Lamp Power Supply* manufactured and calibrated by Labsphere. Ambient temperature (for photometric analysis) is measured using a “J-Type” thermocouple located inside the integrating sphere at the same height as the sample under test and not more than 1 meter in horizontal distance away from the sample. The thermocouple is located behind the baffle of the photo detector in order to eliminate any direct optical radiation from the sample under test.

**Luminaire Stabilization.**

The sample was placed inside the integrating sphere and powered by a regulated and conditioned Voltage alternating current supply. The correlated color temperature, color rendering index, chromaticity coordinates and electrical power measurements contained in this report are the numeric **averages** of the three readings upon which stabilization is verified. The stabilization times shown on the results pages of this report denote the time of the 1<sup>st</sup> measurement (of the 3 consecutive readings) since this is the minimum time that the sample is assumed to have taken to reach stabilization.

The integrating sphere is calibrated using a quartzline halogen lamp with the following specifications:

Manufacturer: Sylvania

Model# 75Q/CL-28V

Voltage = 28.0 Volt

Wattage = 75.0 Watts

Calibration Current = 2.679 Amperes

Luminous Flux = 1538.8 Lumens

Calibration Date = 8-18-2005 (calibrated by Labsphere – NIST traceable).

Continued.....

**Photometric Testing Information (continued)**

The goniophotometer Mayer Engineering Type C is calibrated using a frosted tungsten filament FDS/DZE lamp with the following specifications:

Manufacturer: GE  
Part Number: DZE 88  
Bulb Number: 114-A  
Voltage: 16.59 Volts DC reference  
Calibration Current: 4.810 Amperes  
Luminous Intensity: 154.7 Candelas  
Calibration Date: 7/12/12 (NIST traceable)

Manufacturer: GE  
Part Number: DZE 88  
Bulb Number: 114-B  
Voltage: 16.61 Volts DC reference  
Calibration Current: 4.819 Amperes  
Luminous Intensity: 150.6 Candelas  
Calibration Date: 7/12/12(NIST traceable)

Manufacturer: GE  
Part Number: DZE 88  
Bulb Number: 114-C  
Voltage: 16.66 Volts DC reference  
Calibration Current: 4.815 Amperes  
Luminous Intensity: 155.4 Candelas  
Calibration Date: 7/12/12 (NIST traceable)

A Yokogawa WT210 Power Analyzer was used to measure all electrical characteristics of the sample.

CSA is an accredited Test Laboratory (TL-430)  
to IESNA LM79-08 by IAS (International Accreditation  
Service)  
National Voluntary Laboratory Accreditation Program  
(NVLAP)200732-0

<b>Equipment List: Goniophotometer Type C (Mirror 1)</b>			
<b>Description</b>	<b>Manufacturer and Model Number</b>	<b>CSA Instrument Reference Number</b>	<b>Calibration Due Date</b>
Optometer	Gigahertz Optik P9801	N/A	N/A
Regulated Power Supply	Chroma Instruments 61602P-80-60	DCP401	N/A
Regulated Power Supply	Chroma Instruments 61602	DCP301	N/A
Power Analyzer	Yokogawa WT210	POA400	11/2014
<b>Equipment List: Sphere D Equipment</b>			
<b>Description</b>	<b>Manufacturer and Model Number</b>	<b>CSA Instrument Reference Number</b>	<b>Calibration Due Date</b>
Integrating Sphere 109"	Labsphere LMS760	SPH400	N/A
Spectroradiometer	Labsphere CDS1100	N/A	N/A
Auxiliary Lamp PSU	Labsphere LPS100	LPS100	N/A
Power Analyzer	Yokogawa WT210	PA111	1/2014
Regulated Power Supply	Chroma Instruments 61603	N/A	N/A

All equipment is calibrated to ISO / IEC 17025-2005 guidelines.