

PHOTOMETRIC TESTING & EVALUATION TO IES LM-79-08

Sample Tested
Circular 4 inch

Prepared for:


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**Technical Report Number
2744065-02**

July 14, 2014

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Program Description

Photometric and electrical testing of a “Circular 4 inch” fixture to IES LM-79-08.

Executive Summary

Sample Tested = **Circular 4 inch**

Luminous Efficacy* (Lumens/Watt)	Luminous Flux* (Lumens)	Input Power* (Watts)	Power Factor*
70.62	2405	34.057	0.9709

CCT (K)*	CRI*	Stabilization Time (Light & Power)
3017	82.7	60 minutes

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

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Sample

The following sample was submitted for evaluation:

3form: Circular 4 inch

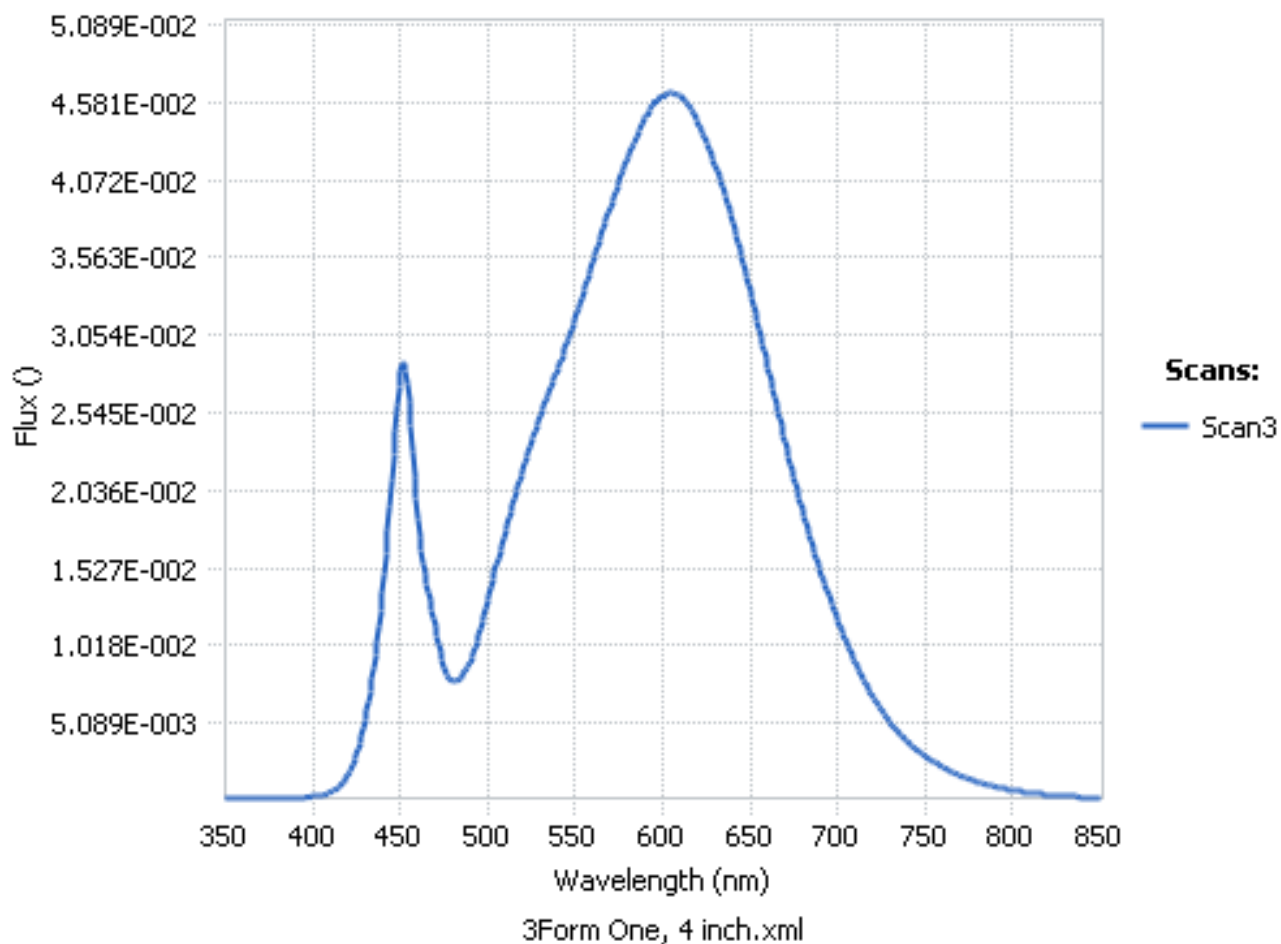


Circular 4 inch

Test Results –								
The following results were measured after stabilization of the sample in the Integrating Sphere (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							
	Circular 4 inch							
	Integrating Sphere				Goniophotometer			
Luminous Efficacy (Lumens/Watt)	70.62				69.38			
Total Luminous Flux (Lumens)	2405				2362.84			
Total Radiant Flux (Watts)	7.805							
Correlated Color Temperature (CCT)	3017							
Color Rendering Index (CRI) (Ra)	82.7							
R1 thru R7 Value	81.2	89.3	94.9	80.2	80.3	84.8	85.6	
R8 thru R14 Value	65.6	21.2	74.1	77.4	65.6	82.8	96.9	
Chromaticity (Chroma x / Chroma y)	0.4331 / 0.3985							
Chromaticity (Chroma u / Chroma v)	0.2505 / 0.3457							
Chromaticity (Chroma u' / Chroma v')	0.2505 / 0.5286							
Duv Value	0.00453							
Stabilization Time (Light and Power)	Approx. 60 minutes							
Total Run Time – Integrating Sphere	64 minutes							
Total Run Time – Goniophotometer	60 minutes							
Spacing Criteria	1.24 (0° – 180°) / 1.26 (90° – 270°)							
Scotopic/Photopic ratio $\Phi(v')/\Phi(v)$	1.320							
Electrical Input Results:	Sample Reference							
	Circular 4 inch							
Input Power (Watts)	34.057							
Input Voltage (Volts AC)	120.04							
Input Current (Amps)	0.29223							
Input Frequency (Hertz)	60							
Power Factor	0.9709							
Total Harmonic Distortion (%THD V/A)	0.09 / 10.86							
Additional Information	Sample Reference							
	Circular 4 inch							
Ambient Temperature	24.6°C							
Integrating Sphere Detector	CDS 1100 Spectroradiometer							
Absorption Correction used?	Yes							

Spectral Flux

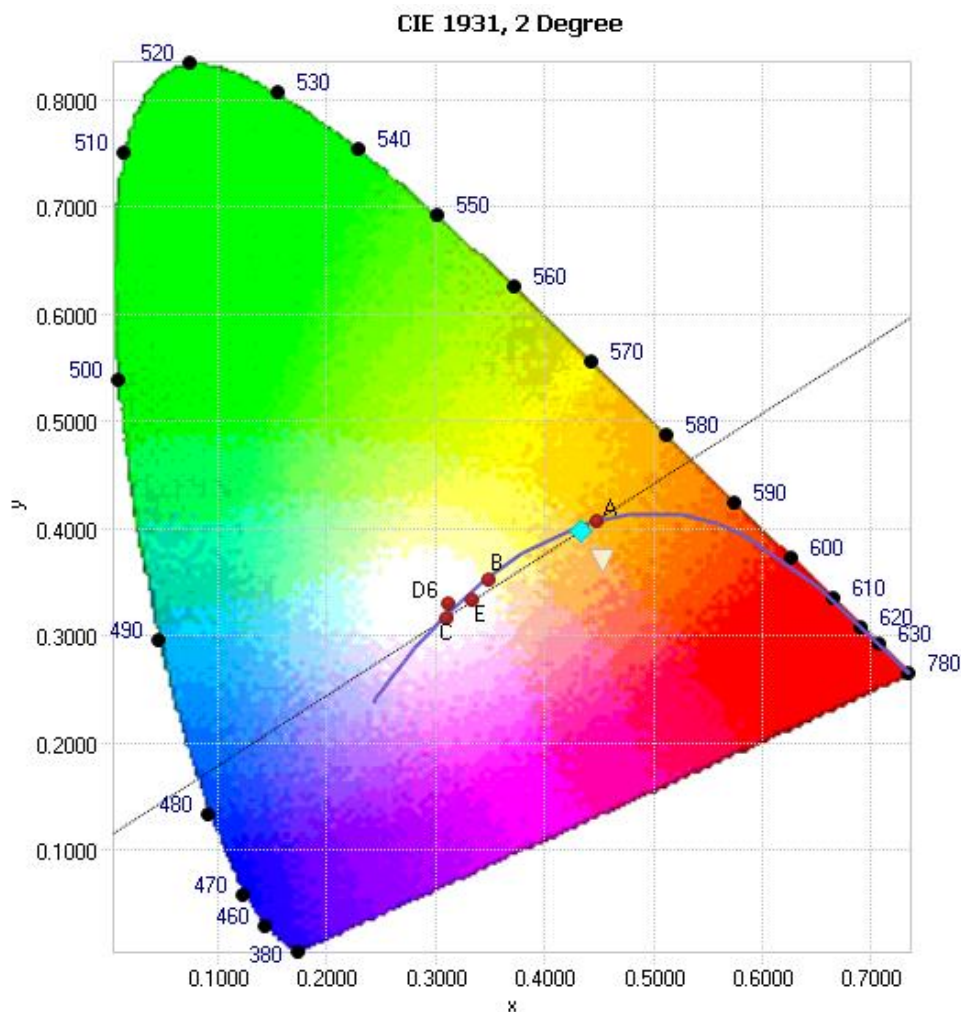
The following graph shows the spectral response curve of the radiant flux for the sample:



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 = 0.4331 / 0.3985

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

Test Results – Flux Distribution – Zonal Lumen Summary

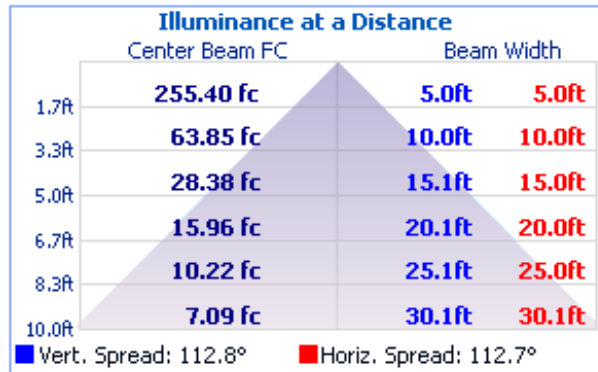
The following table depicts the zonal lumen distribution for the sample:

Zone	Lumens	% Total
0 - 10	67.1	2.80%
10 - 20	191.9	8.10%
20 - 30	289.9	12.30%
30 - 40	348.5	14.70%
40 - 50	361.3	15.30%
50 - 60	330.4	14.00%
60 - 70	261.3	11.10%
70 - 80	166	7.00%
80 - 90	63.9	2.70%
90-100	29.8	1.30%
100-110	37	1.60%
110-120	42.3	1.80%
120-130	43.3	1.80%
130-140	40.6	1.70%
140-150	35	1.50%
150-160	28.6	1.20%
160-170	19.3	0.80%
170-180	6.6	0.30%
Total	2362.8 LUMENS	100.0%

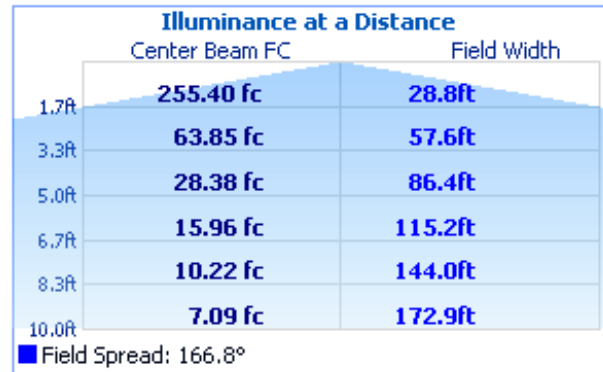
Zone		
0-60	1,589.10	67.30%
60-90	491.2	20.80%
0-90	2,080.30	88%
90-180	282.6	12%
0-180	2,362.80	100%

Test Results – Illuminance Plots

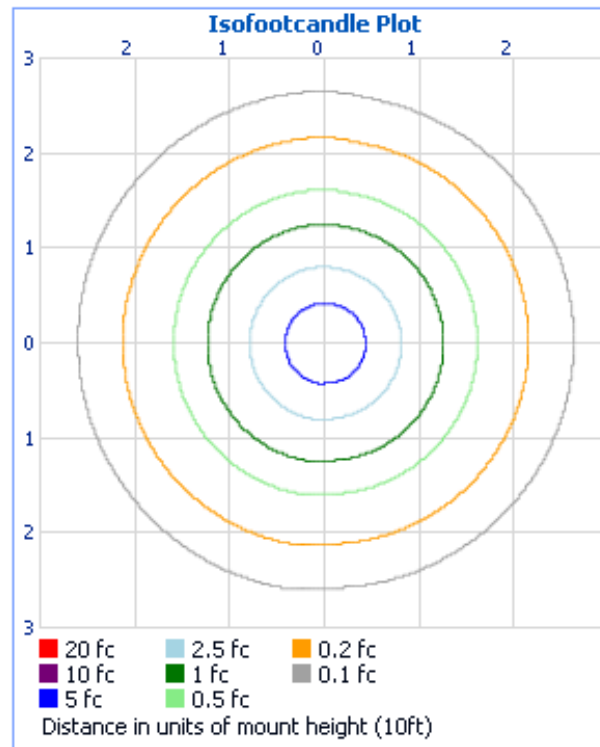
The following images depict the illuminance characteristics of the luminaire.



Beam Angle



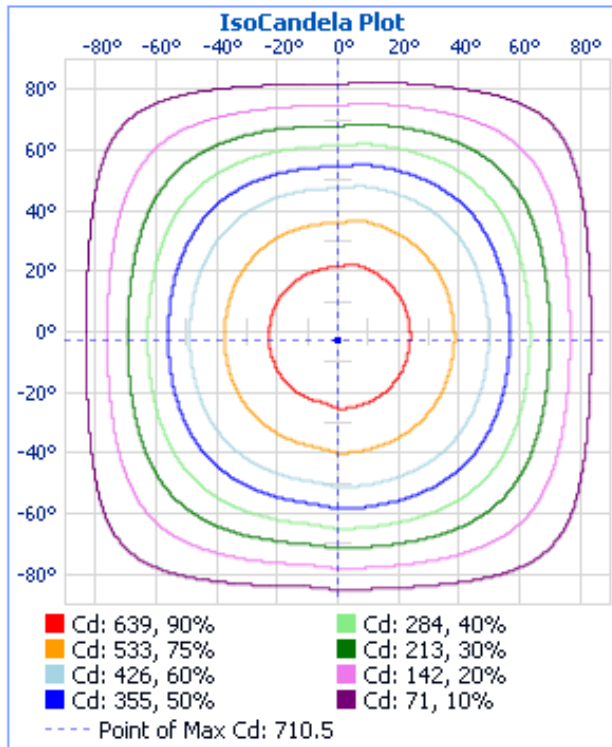
Field Angle



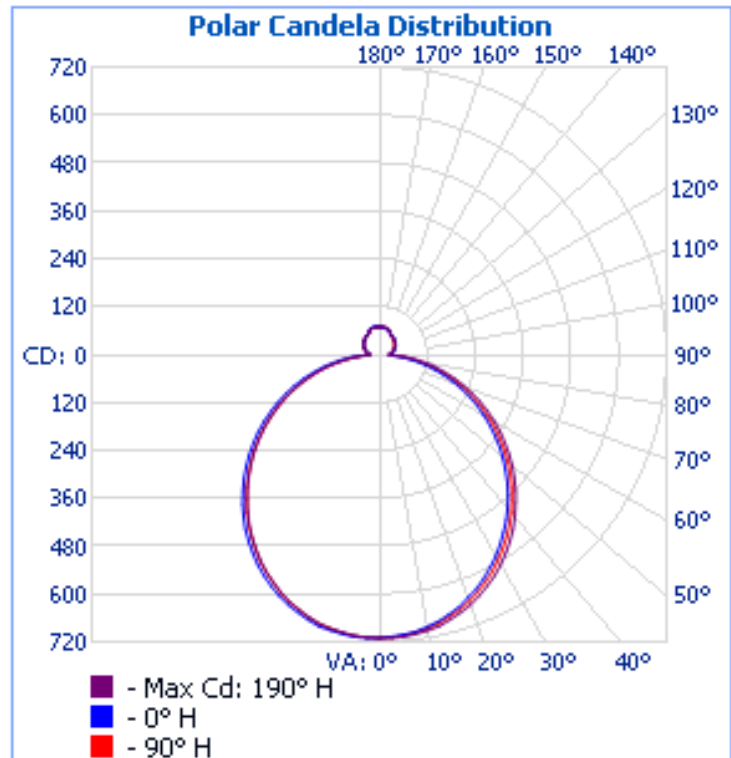
Illuminance Plot (Footcandles)

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%																							
RCC %:		80				70				50				30				10				0			
RW %:		70	50	30	0	70	50	30	0	50	30	20	50	30	20	50	30	20	50	30	20	0			
0		1.16	1.16	1.16	1.16	1.12	1.12	1.12	.88	1.04	1.04	1.04	.97	.97	.97	.91	.91	.91	.88						
1		1.05	1.01	.96	.92	1.02	.97	.93	.73	.91	.87	.84	.85	.82	.80	.79	.77	.75	.72						
2		.96	.87	.80	.74	.92	.84	.78	.61	.79	.74	.69	.74	.70	.66	.69	.66	.63	.60						
3		.87	.76	.68	.62	.84	.74	.66	.52	.69	.63	.58	.65	.60	.55	.61	.57	.53	.50						
4		.80	.68	.59	.52	.76	.65	.57	.44	.61	.54	.49	.58	.52	.47	.54	.49	.45	.43						
5		.73	.60	.51	.45	.70	.58	.50	.38	.55	.48	.42	.52	.46	.41	.49	.43	.39	.37						
6		.67	.54	.45	.39	.65	.53	.44	.34	.50	.42	.37	.47	.40	.36	.44	.39	.34	.32						
7		.62	.49	.40	.34	.60	.48	.39	.30	.45	.38	.33	.43	.36	.32	.40	.35	.31	.28						
8		.58	.45	.36	.30	.56	.43	.35	.27	.41	.34	.29	.39	.33	.28	.37	.31	.27	.25						
9		.54	.41	.33	.27	.52	.40	.32	.24	.38	.31	.26	.36	.30	.25	.34	.29	.25	.23						
10		.51	.38	.30	.25	.49	.37	.29	.22	.35	.28	.24	.33	.27	.23	.32	.26	.22	.21						

Effective Floor Cavity Reflectance: 20%

Test Results – Candela Tabulation

The following table provides the tabulated Candela measurements:

Candela Table - Type C

	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	709	709	709	709	709	709	709	709	709	709	709	709	709	709	709	709	709	709	709	709	709	709	709	709	709	709	709	709	709	709	709	709	709	709	709	709	709	709
2.5	707	708	708	709	708	709	709	708	709	709	709	709	710	709	709	710	709	710	710	710	710	710	710	710	710	710	710	710	710	710	710	710	710	710	710	710	710	710
5	704	704	705	704	705	705	705	706	706	706	707	707	707	708	707	706	707	707	709	709	709	709	709	708	708	707	708	707	707	707	707	706	705	706	706	706	706	704
7.5	700	699	699	699	699	700	701	702	701	701	702	702	702	703	704	703	702	702	706	705	705	705	705	705	705	705	705	703	703	703	702	700	702	701	702	701	701	700
10	692	692	693	693	694	695	695	695	696	697	696	697	698	697	697	698	698	698	701	701	701	700	700	699	699	699	697	697	697	692	696	697	697	695	696	696	692	
12.5	684	684	685	685	686	687	686	688	689	689	690	691	690	691	690	691	691	691	697	696	696	695	694	694	692	692	691	691	691	684	690	689	688	689	689	689	684	
15	673	673	674	674	675	676	677	679	678	679	680	681	681	682	682	681	681	688	687	687	687	686	685	685	683	683	682	681	677	680	679	680	680	679	680	673		
17.5	663	662	663	664	664	666	667	667	668	669	669	670	671	671	671	672	671	678	677	676	676	675	674	673	674	671	670	670	669	668	668	669	668	668	668	663		
20	648	650	650	651	652	653	654	655	656	657	658	659	659	659	659	660	660	667	667	666	665	664	663	661	660	660	659	658	657	657	656	656	656	657	657	648		
22.5	634	635	635	636	638	638	640	642	641	643	645	645	645	646	646	646	646	655	654	654	653	651	650	649	647	647	646	644	644	644	642	641	643	642	643	634		
25	619	618	620	621	622	623	625	626	627	628	629	630	631	631	632	632	631	640	639	638	637	636	634	634	632	631	630	629	628	628	627	627	627	627	627	619		
27.5	601	602	604	605	605	607	608	609	611	612	613	614	615	615	615	616	616	625	625	623	622	621	619	618	617	615	614	613	612	611	611	611	611	611	601			
30	583	584	585	586	588	589	590	592	593	594	596	597	597	599	598	598	598	609	608	606	605	604	603	601	600	598	597	596	595	595	593	593	593	594	594	583		
32.5	563	564	566	567	568	570	572	573	574	575	576	577	579	579	580	580	579	590	589	588	586	585	583	582	580	579	578	576	575	575	574	574	574	574	575	563		
35	542	545	546	548	549	551	552	553	555	556	558	558	560	559	560	560	560	571	570	568	566	566	564	563	561	559	558	557	555	555	555	555	555	554	555	555	542	
37.5	522	524	525	527	528	529	530	533	534	535	537	538	538	539	540	539	540	539	551	550	549	547	546	544	542	541	539	538	536	536	534	533	534	534	535	522		
40	500	500	502	503	504	506	508	511	512	514	515	516	517	517	518	518	517	529	528	526	525	524	522	522	519	518	515	513	514	513	511	511	511	512	512	500		
42.5	476	479	479	482	483	485	486	487	489	490	492	491	493	494	493	495	493	494	507	505	505	502	500	499	494	494	492	491	491	488	488	488	488	488	488	476		
45	453	456	456	457	460	461	463	465	466	468	470	471	471	472	472	472	472	484	483	482	478	478	477	474	472	471	469	468	467	466	465	465	466	465	466	453		
47.5	429	431	432	434	435	437	439	441	442	445	445	446	448	448	449	448	447	460	458	457	455	454	451	450	448	446	445	443	442	442	441	440	441	442	429			
50	404	406	409	409	411	413	414	416	418	420	421	422	424	424	424	424	424	435	434	433	431	430	428	425	424	422	420	419	418	417	417	417	416	417	417	404		
52.5	380	381	382	384	386	388	390	392	393	394	396	397	398	399	399	398	399	411	410	408	407	404	403	401	399	397	396	394	393	392	391	391	392	392	392	380		
55	353	355	357	359	360	362	364	366	368	369	370	371	373	373	373	374	373	385	384	382	380	378	376	374	373	370	369	368	367	366	366	366	366	367	353			
57.5	328	330	332	333	335	337	338	340	342	343	346	347	346	347	347	347	360	359	357	354	354	351	349	347	345	344	343	341	341	340	341	340	341	328				
60	302	303	305	307	308	310	312	314	315	317	318	319	321	321	322	321	320	333	332	330	329	327	324	323	321	318	317	315	315	313	313	313	312	314	315	302		
62.5	275	277	279	280	282	285	285	288	289	291	293	293	295	295	295	295	294	306	305	303	302	300	297	296	294	292	290	288	288	287	287	286	287	288	275			
65	249	251	252	253	256	258	259	262	263	265	266	267	268	268	268	268	267	280	278	276	275	273	271	269	266	266	264	262	261	260	260	259	260	260	261	249		
67.5	222	224	226	227	229	231	233	234	236	238	239	240	241	241	242	242	241	253	251	250	248	245	244	242	239	238	236	235	234	233	233	233	233	233	222			
70	196	198	199	200	202	205	206	208	209	211	213	214	215	216	215	215	215	226	224	222	220	219	217	215	213	211	209	207	207	206	206	206	207	207	196			
72.5	170	171	173	173	176	178	179	181	183	184	186	187	188	189	189	188	188	197	197	195	194	192	190	188	185	184	182	181	180	179	179	178	179	179	170			
75	144	145	146	148	149	152	153	155	157	158	159	160	161	162	162	162	161	172	170	168	167	164	163	161	159	157	156	155	153	152	153	152	153	153	154	144		
77.5	118	119	120	122	124	126	127	129	131	132	133	134	135	136	136	136	135	145	144	142	140	138	136	134	132	130	129	128	127	126	127	126	127	128	118			
80	92	93	94	96	98	100	101	103	105	106	108	109	109	110	110	110	109	109	119	118	115	114	112	110	108	106	105	103	102	101	101	101	101	102	92			
82.5	67	68	70	72	74	75	76	78	80	81	82	83	84	85	85	85	84	94	92																			

150	57	57	57	56	56	56	56	56	55	56	57	57	57	57	57	56	56	56	59	59	59	58	58	58	58	59	58	58	57	58	58	58	58	59	60	60	57
152.5	59	59	59	59	59	59	59	59	59	59	60	60	60	60	60	59	59	58	60	60	60	60	60	60	59	59	59	59	58	58	59	60	60	60	61	61	59
155	62	62	63	63	63	63	63	63	63	63	64	63	63	63	63	63	62	62	62	63	62	62	62	62	61	61	61	61	61	61	61	62	63	62	62	62	
157.5	65	65	65	66	66	66	65	65	65	65	66	66	65	66	66	66	65	66	66	66	65	65	65	65	65	64	64	64	64	64	64	64	65	64	65	65	
160	66	66	67	68	68	67	67	67	66	66	66	66	67	67	67	68	67	67	69	68	68	67	66	67	67	66	66	67	66	66	66	66	66	65	66	66	
162.5	67	67	68	69	68	68	68	67	67	67	67	67	68	68	69	69	68	70	69	69	68	68	68	67	67	67	67	68	68	68	67	67	66	66	67		
165	67	68	69	69	69	68	68	68	68	68	68	68	69	69	69	69	69	70	70	70	69	68	68	68	68	68	68	68	69	69	69	68	68	66	67	67	
167.5	68	68	69	69	69	68	68	68	68	68	68	68	69	69	70	70	69	69	71	70	70	70	69	69	69	68	68	69	69	70	70	69	68	68	67	67	68
170	68	69	70	70	69	69	68	68	68	68	68	68	69	70	70	70	69	69	71	71	70	70	70	70	69	69	68	69	69	70	70	70	69	69	68	68	68
172.5	69	70	70	70	69	69	68	68	68	68	68	69	69	70	70	70	69	69	71	71	71	70	70	70	69	68	68	69	69	70	70	69	69	69	68	69	
175	70	70	70	70	69	69	68	68	68	68	68	69	70	70	70	69	69	69	71	71	71	70	70	70	69	68	68	68	69	70	70	70	70	69	69	69	70
177.5	70	71	71	70	70	69	69	68	68	68	69	69	70	70	70	70	69	69	71	71	71	70	70	70	69	68	68	68	69	69	70	70	70	69	70	69	70
180	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	70	

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 “ 4π 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 1st 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
National Voluntary Laboratory Accreditation Program
(NVLAP)200732-0

Equipment List: Goniophotometer Type C (Mirror 1)			
Description	Manufacturer and Model Number	CSA Instrument Reference Number	Calibration Due Date
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
Equipment List: Sphere B Equipment			
Description	Manufacturer and Model Number	CSA Instrument Reference Number	Calibration Due Date
Integrating Sphere 76"	Labsphere LMS760	SPH200	N/A
Spectroradiometer	Labsphere CDS600	CDS600B	N/A
Auxiliary Lamp PSU	Labsphere LPS100	LPS100	N/A
Power Analyzer	Yokogawa WT210	PA112	2/2015
Regulated Power Supply	Chroma Instruments 61603	AC303	N/A

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