PHOTOMETRIC TESTING & EVALUATION TO IES LM-79-08

Sample Tested
Casper 12

Prepared for:

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Technical Report Number
2751122

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Program Description

Photometric and electrical testing of a “Casper 12” fixture to IES LM-79-08.

Executive Summary

Sample Tested = **Casper 12**

Luminous Efficacy* (Lumens/Watt)	Luminous Flux* (Lumens)	Input Power* (Watts)	Power Factor*
80.91	3311	40.923	0.9797

CCT (K)*	CRI*	Stabilization Time (Light & Power)
3042	82.5	45 minutes

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

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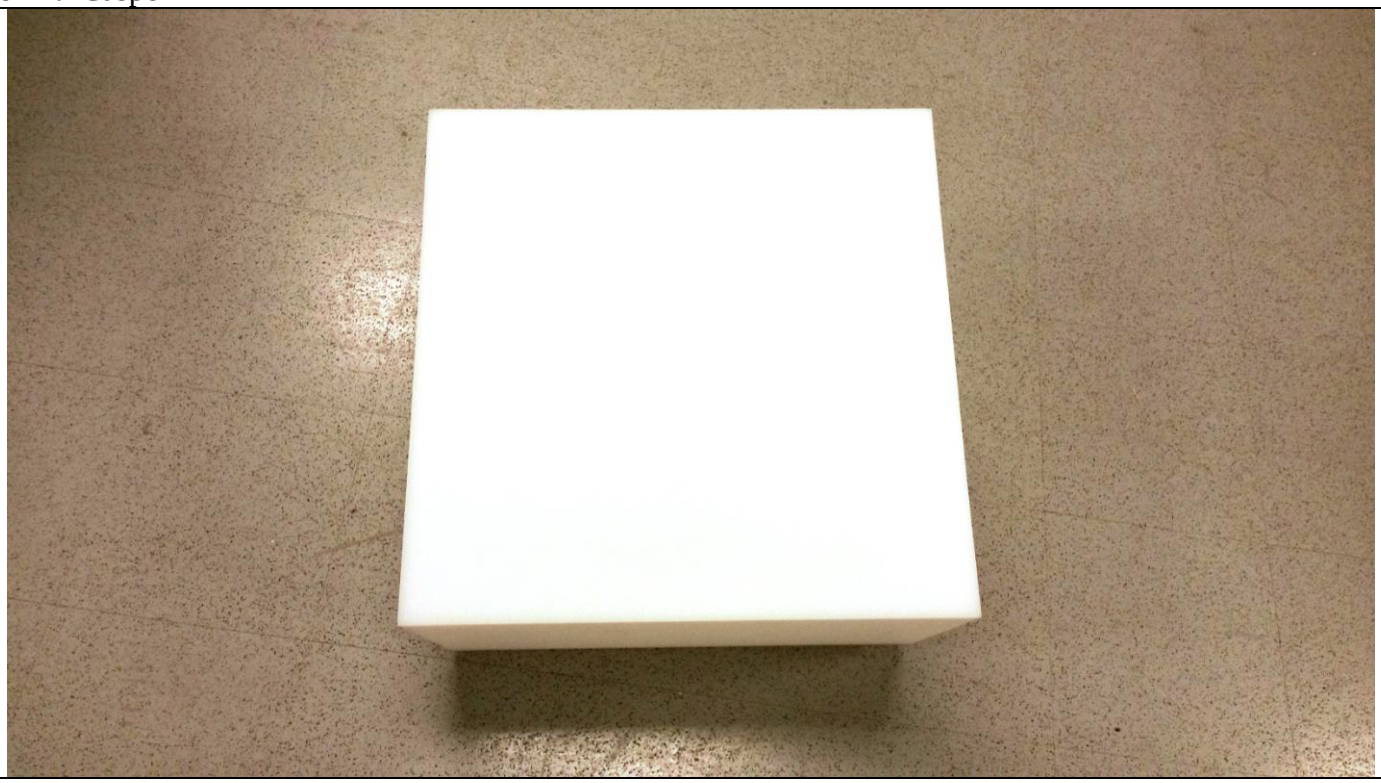
Sample
The following sample was submitted for evaluation:
3form: Casper 12

Casper 12

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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**						
	Casper 12						
	Integrating Sphere				**Goniophotometer**		
Luminous Efficacy (Lumens/Watt)	**80.91**				**79.76**		
Total Luminous Flux (Lumens)	**3311**				**3264.03**		
Total Radiant Flux (Watts)	**10.62**						
Correlated Color Temperature (CCT)	**3042**						
Color Rendering Index (CRI) (Ra)	**82.5**						
R1 thru R7 Value	**80.7**	**88.8**	**95.2**	**80.2**	**79.8**	**84.5**	**86.1**
R8 thru R14 Value	**65.2**	**19.2**	**73.5**	**77.4**	**64**	**82.2**	**97.1**
Chromaticity (Chroma x / Chroma y)	**0.4341 / 0.4035**						
Chromaticity (Chroma u / Chroma v)	**0.2490 / 0.3471**						
Chromaticity (Chroma u' / Chroma v')	**0.2490 / 0.5207**						
D_{uv} Value	**0.00014**						
Stabilization Time (Light and Power)	**Approx. 45 minutes**						
Total Run Time – Integrating Sphere	**49 minutes**						
Total Run Time – Goniophotometer	**48 minutes**						
Spacing Criteria	**1.44 (0° – 180°) / 1.46 (90° – 270°)**						
Scotopic/Photopic ratio $\Phi(v')/\Phi(v)$	**1.324**						
Electrical Input Results:	**Sample Reference**						
	Casper 12						
Input Power (Watts)	**40.923**						
Input Voltage (Volts AC)	**120.09**						
Input Current (Amps)	**0.34786**						
Input Frequency (Hertz)	**60**						
Power Factor	**0.9797**						
Total Harmonic Distortion (%THD V/A)	**0.07 / 8.94**						
Additional Information	**Sample Reference**						
	Casper 12						
Ambient Temperature	**24.9°C**						
Integrating Sphere Detector	**CDS 1100 Spectroradiometer**						
Absorption Correction used?	**Yes**						

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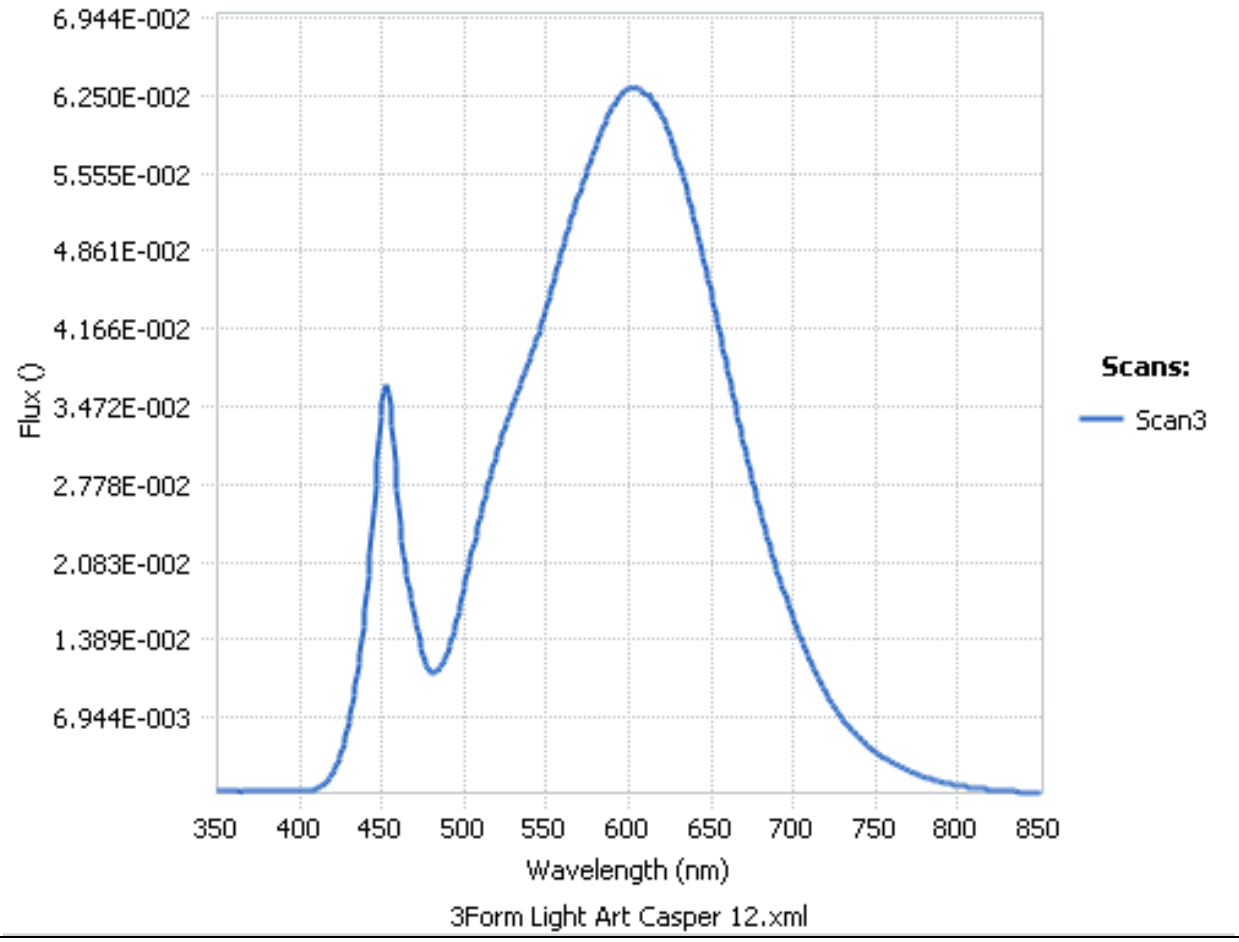
Spectral Flux

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).

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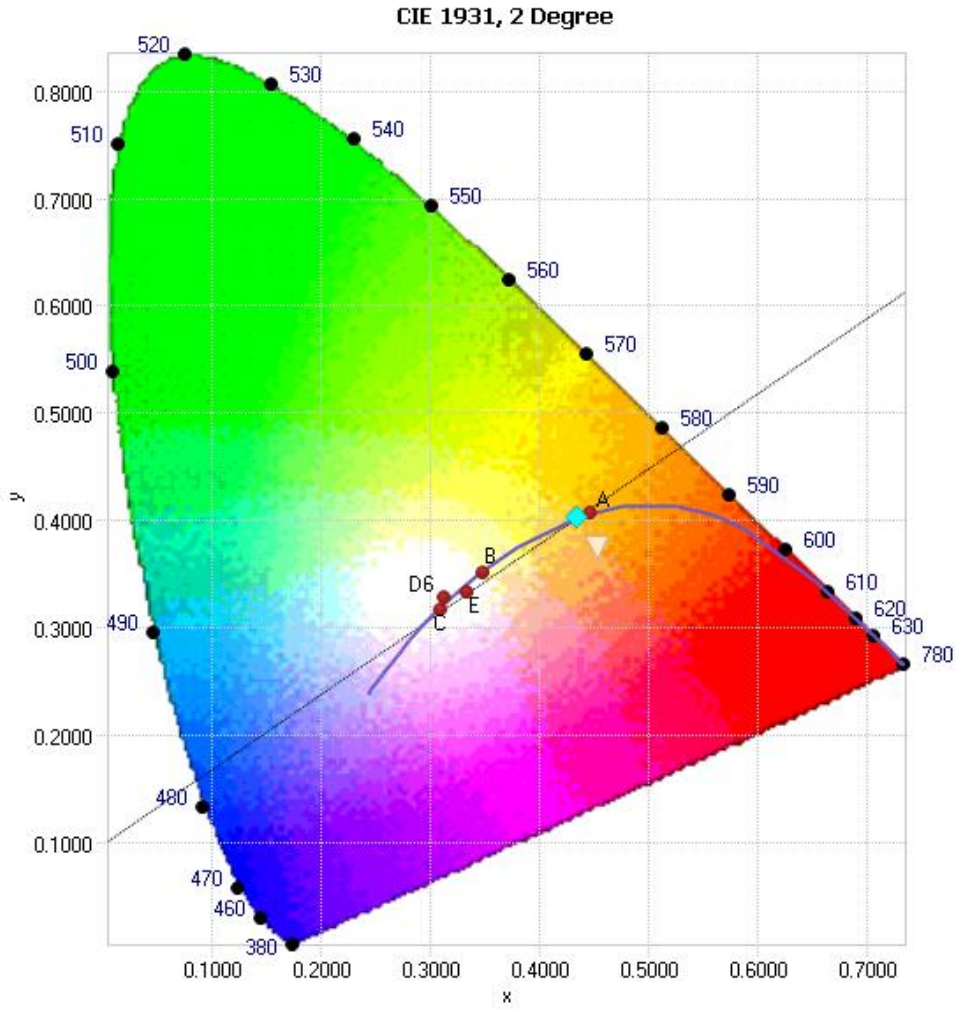
Chromaticity Diagram

The following image shows the chromaticity diagram for the sample:



Tristimulus values (from page 6):
x / y = 0.4341 / 0.4035

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

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Test Results – Flux Distribution – Zonal Lumen Summary		
The following table depicts the zonal lumen distribution for the sample:		
Zone	**Lumens**	**% Total**
0 - 10	**44.5**	**1.40%**
10 - 20	**133.8**	**4.10%**
20 - 30	**216.2**	**6.60%**
30 - 40	**282.5**	**8.70%**
40 - 50	**326.6**	**10.00%**
50 - 60	**344.7**	**10.60%**
60 - 70	**335.6**	**10.30%**
70 - 80	**300.9**	**9.20%**
80 - 90	**248.3**	**7.60%**
90-100	**223.7**	**6.90%**
100-110	**210.7**	**6.50%**
110-120	**185.9**	**5.70%**
120-130	**152.1**	**4.70%**
130-140	**113.8**	**3.50%**
140-150	**76.1**	**2.30%**
150-160	**44.1**	**1.40%**
160-170	**19.8**	**0.60%**
170-180	**4.6**	**0.10%**
Total	**3264.0 LUMENS**	**100.0%**
Zone		
0-60	**1,348.30**	**41.30%**
60-90	**884.8**	**27.10%**
0-90	**2,233.00**	**68.40%**
90-180	**1,031.00**	**31.60%**
0-180	**3,264.00**	**100%**

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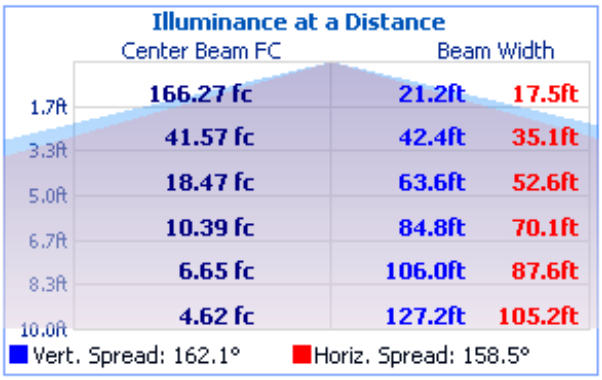
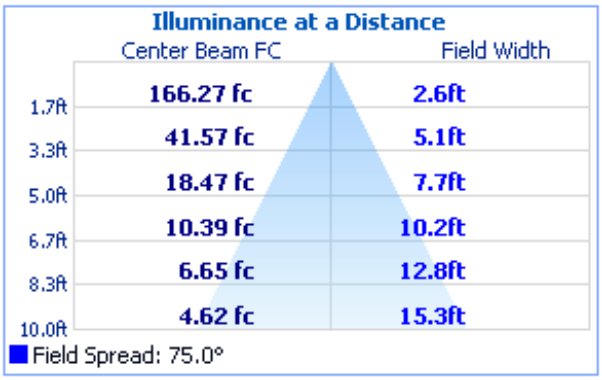
Test Results – Illuminance Plots

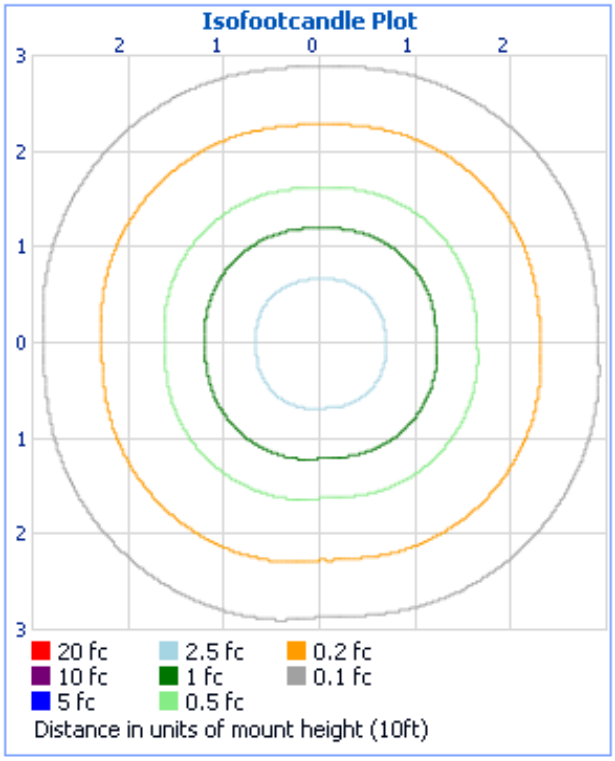
The following images depict the illuminance characteristics of the luminaire.



Beam Angle



Field Width



Illuminance Plot (Footcandles)

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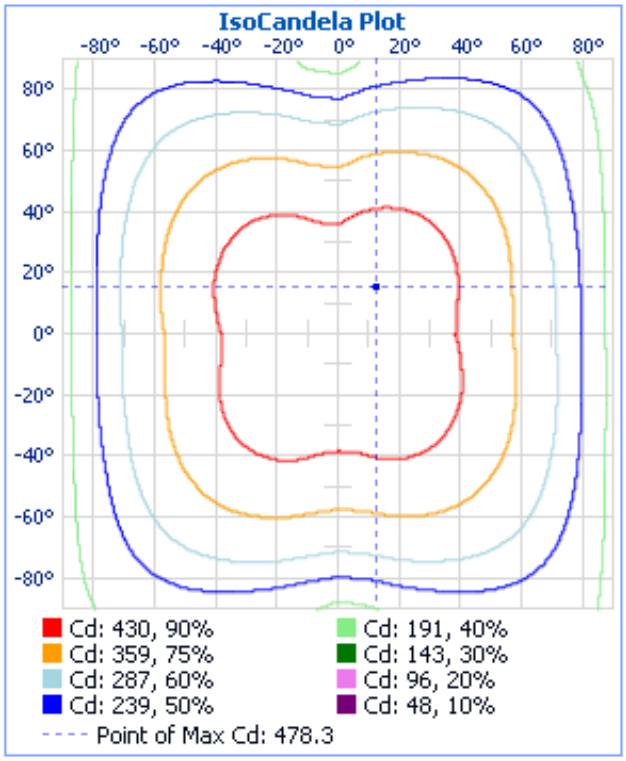
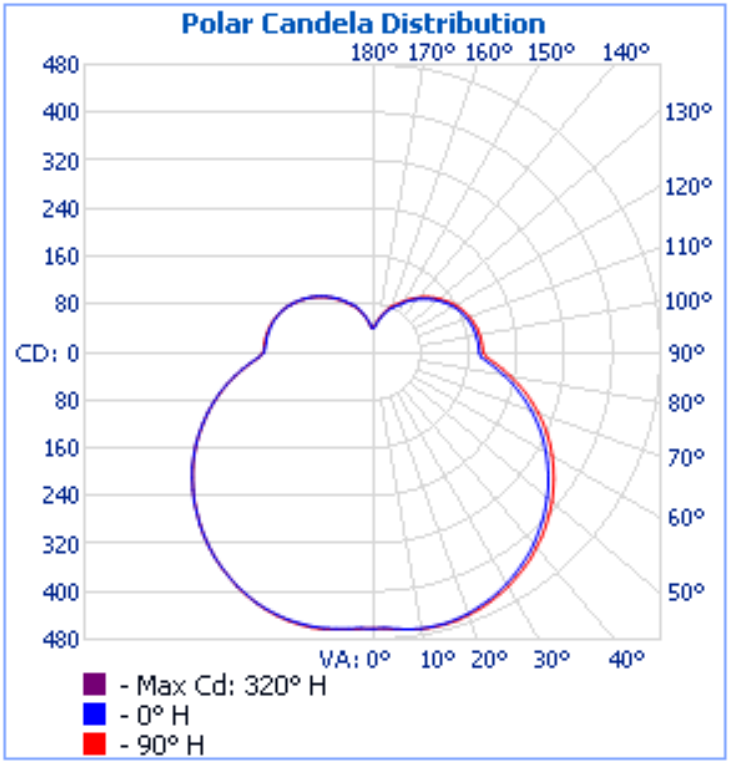
Test Results – Candela Plots

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	0
RCR: 0	1.12	1.12	1.12	1.12	1.05	1.05	1.05	.68	.94	.94	.94	.83	.83	.83	.73	.73	.73	.68
1	.98	.92	.87	.82	.92	.87	.82	.51	.77	.73	.69	.67	.64	.62	.59	.57	.54	.50
2	.88	.78	.71	.64	.82	.74	.67	.40	.65	.59	.55	.57	.53	.49	.50	.46	.43	.39
3	.79	.68	.59	.52	.74	.64	.56	.33	.56	.50	.44	.49	.44	.40	.43	.39	.35	.31
4	.72	.59	.50	.43	.67	.56	.47	.27	.49	.42	.37	.43	.37	.33	.38	.33	.29	.26
5	.66	.52	.43	.36	.61	.49	.41	.23	.44	.37	.31	.38	.32	.28	.33	.29	.25	.22
6	.61	.47	.37	.31	.57	.44	.36	.20	.39	.32	.27	.34	.29	.24	.30	.25	.21	.19
7	.56	.42	.33	.27	.52	.40	.31	.18	.35	.28	.23	.31	.25	.21	.27	.22	.19	.16
8	.52	.38	.29	.23	.48	.36	.28	.16	.32	.25	.20	.28	.23	.18	.25	.20	.17	.14
9	.48	.35	.26	.21	.45	.33	.25	.14	.29	.23	.18	.26	.20	.16	.23	.18	.15	.13
10	.45	.32	.24	.19	.42	.30	.23	.13	.27	.21	.16	.24	.19	.15	.21	.17	.13	.11

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	462	462	462	462	462	462	462	462	462	462	462	462	462	462	462	462	462	462	462	462	462	462	462	462	462	462	462	462	462	462	462	462	462	462	462	462	462
2.5	461	462	462	462	462	462	461	462	462	462	462	462	462	461	461	464	461	461	461	462	462	461	461	461	462	462	462	463	462	462	462	462	462	461	462	462	461
5	464	465	465	464	463	463	463	463	464	465	465	464	463	462	463	466	463	463	463	463	462	462	462	463	463	464	464	465	464	464	464	463	463	463	463	465	464
7.5	467	467	467	467	467	468	467	466	466	467	467	467	466	466	466	468	465	466	465	466	465	465	466	466	466	466	467	467	468	467	467	468	468	467	467	467	467
10	469	469	469	470	471	472	471	470	469	470	469	469	469	470	470	470	467	467	468	468	468	470	470	470	469	469	469	470	469	469	471	471	472	471	470	469	469
12.5	469	469	470	472	474	474	474	472	470	470	471	471	472	473	473	472	470	468	469	468	470	472	473	473	473	471	470	471	471	471	474	475	475	474	472	471	469
15	469	469	470	474	476	477	475	474	471	470	470	471	474	475	475	474	471	468	469	469	472	474	475	475	475	473	470	471	471	473	475	477	477	476	474	471	469
17.5	467	468	470	474	476	477	477	474	471	470	470	471	474	476	476	474	471	467	468	468	471	475	477	477	475	473	470	470	469	472	476	477	478	477	474	471	467
20	465	465	469	473	476	477	476	473	469	467	467	470	474	476	476	474	471	466	466	466	471	475	477	477	475	472	468	468	468	472	476	478	**478**	477	474	470	465
22.5	461	462	467	472	475	476	476	472	468	465	465	469	473	475	475	472	469	464	464	465	470	473	476	476	475	472	467	466	465	470	474	477	478	476	473	468	461
25	457	458	464	469	473	474	474	470	465	461	462	467	471	474	474	471	467	460	461	461	467	472	474	475	473	469	464	461	462	468	473	475	476	475	470	466	457
27.5	452	453	460	467	471	472	471	467	461	457	457	463	469	471	471	469	464	457	456	457	464	469	472	472	471	466	460	457	458	465	470	473	473	471	467	461	452
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32.5	440	442	451	458	463	465	463	459	452	446	448	455	461	464	464	461	456	448	445	447	454	461	464	465	462	458	451	445	447	456	461	465	465	463	458	451	440
35	433	436	445	453	457	460	458	455	447	440	441	450	456	459	459	456	450	442	439	441	449	456	459	460	458	453	445	439	441	450	456	460	461	458	453	445	433
37.5	426	429	439	447	452	454	453	449	441	433	435	444	451	454	454	450	445	435	432	434	443	451	454	455	453	447	439	432	434	443	451	454	455	453	447	439	426
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42.5	409	412	423	433	439	441	440	435	427	418	420	430	438	441	441	437	431	421	416	420	429	437	441	442	440	434	424	416	419	429	437	441	442	439	433	424	409
45	399	403	416	425	432	433	432	427	419	409	412	423	430	435	434	431	424	413	407	411	421	429	434	435	432	425	416	407	410	421	429	434	434	432	425	416	399
47.5	390	394	407	417	423	426	424	419	410	399	403	414	422	426	426	423	415	404	397	402	413	420	426	427	424	417	408	397	402	413	420	425	426	423	417	406	390
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62.5	321	328	343	354	361	364	362	357	346	333	338	352	361	365	366	361	353	341	332	337	351	360	365	366	364	356	345	332	336	349	359	364	365	361	354	342	321
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67.5	294	301	317	329	336	339	337	331	320	307	312	327	336	341	341	337	328	315	306	312	325	335	340	342	339	331	319	305	311	325	334	339	340	336	328	316	294
70	280	288	304	315	323	326	324	318	307	293	299	314	323	328	328	323	315	302	292	298	313	322	328	329	326	319	306	292	297	311	321	325	327	323	315	302	280
72.5	266	273	290	301	309	312	310	304	293	279	285	299	309	315	314	310	301	288	278	285	299	309	314	315	313	305	293	278	284	298	307	312	313	309	302	289	266
75	252	259	275	288	295	298	296	290	279	264	271	285	295	300	300	296	287	274	264	270	285	295	300	301	299	291	279	263	269	283	293	298	299	295	288	275	252
77.5	237	244	261	273	281	283	282	275	265	250	256	271	281	286	286	282	273	259	249	255	270	280	286	288	284	277	265	249	254	269	279	284	284	282	273	260	237
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82.5	207	216	232	244	251	255	253	246	234	219	226	241	251	257	257	253	244	230	219	225	241	251	257	259	255	247	234	218	224	239	249	254	256	252	244	230	207
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87.5	181	188	205	218	225	227	225	218	205	190	197	212	223	228	229	225	216	202	190	197	212	223	228	230	227	218	206	189	195	210	221	227	228	224	216	203	181
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92.5	177	184	201	213	220	222	220	212	199	183	190	205	216	222	223	218	209	195	179	186	202	213	220	221	219	211	198	181	188	203	214	220	221	217	209	195	177
95	177	184	201	213	219	222	219	211	198	182	189	205	215	221	222	218	208	194	179	185	201	213	219	221	218	210	197	181	187	202	213	219	221	217	209	195	177
97.5	175	183	200	212	219	221	218	210	198	182	188	204	215	220	221	217	207	194	178	184	200	212	219	221	218	210	197	180	186	201	212	218	220	216	208	194	175
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102.5	173	181	197	209	216	218	215	207	194	179	185	200	211	218	218	214	203	191	176	182	197	209	216	218	215	207	194	178	183	198	209	216	217	213	205	191	173
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107.5	169	177	192	204	211	213	210	202	189	174	181	196	206	212	213	209	200	187	173	178	193	205	211	213	210	202	189	174	179	194	205	211	212	209	200	187	169
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112.5	164	171	186	197	204	206	203	195	183	169	175	190	200	206	206	203	194	181	168	173	188	198	205	207	204	196	184	168	173	188	198	205	206	202	194	182	164
115	161	168	183	194	200	202	199	192	180	166	172	186	196	202	203	199	190	178	165	170	185	195	202	203	200	193	181	166	170	185	194	201	202	199	191	179	161
117.5	158	164	179	189	196	197	195	188	176	162	168	182	192	198	198	194	187	174	162	167	181	191	198	199	197	189	177	162	167	181	191	196	198	195	187	175	158
120	154	160	174	185	191	193	190	184	172	158	163	177	187	193	193	190	182	170	158	163	177	187	193	195	192	184	173	158	163	177	187	192	193	190	182	171	154
122.5	150	155	169	180	186	188	186	179	167	154	159	172	182	188	189	186	178	165	155	159	173	183	188	190	187	180	168	154	158	172	182	187	188	185	178	166	150
125	145	150	164	174	181	183	180	173	162	149	154	167	177	182	183	180	173	160	150	154	167	178	184	185	182	174	163	149	154	167	178	182	183	180	172	161	145
127.5	141	146	159	169	175	177	175	168	156	145	149	161	171	176	178	175	167	155	146	149	162	172	178	179	176	169	158	145	149	162	172	177	178	175	167	156	141
130	136	140	153	163	169	171	169	162	151	140	144	156	165	170	172	168	162	150	141	145	157	166	172	173	171	163	153	140	144	156	165	171	172	169	161	151	136
132.5	131	136	147	157	162	165	162	155	145	135	139	150	159	164	165	163	155	144	136	139	151	160	165	167	164	157	148	136	138	150	159	165	166	163	156	146	131
135	126	130	141	150	156	158	156	149	139	130	133	144	153	157	159	156	149	138	132	134	145	154	159	160	158	152	142	131	133	144	153	158	159	157	150	140	126
137.5	121	124	135	144	149	150	149	142	133	125	128	138	146	150	152	149	142	132	127	129	139	148	153	153	152	146	136	125	127	138	146	151	152	150	144	134	121
140	115	119	129	137	142	144	141	135	126	119	122	131	139	143	144	142	135	125	121	123	133	141	146	146	144	139	130	120	122	131	140	144	145	143	138	128	115
142.5	110	113	122	130	134	136	134	128	120	113	116	125	132	136	137	135	128	119	116	117	126	134	138	140	137	133	124	115	116	125	132	137	138	136	131	122	110
145	104	106	116	123	127	128	127	120	113	108	110	119	125	129	129	127	120	112	111	111	119	127	131	132	130	126	118	109	110	118	125	130	131	129	124	116	104
147.5	98	100	110	117	120	121	119	113	106	102	104	112	119	122	122	120	113	105	105	105	112	119	124	125	123	120	112	104	104	111	118	123	123	122	118	110	98

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150	92	95	103	109	113	114	111	105	99	96	99	106	112	115	116	112	105	98	100	99	105	112	117	118	116	113	106	99	98	104	110	115	116	114	111	104	92
152.5	87	90	96	102	107	108	104	98	92	91	93	99	105	109	110	105	98	92	95	94	98	105	110	111	109	105	99	93	92	97	103	108	110	107	104	98	87
155	83	84	90	96	100	101	97	91	86	87	87	93	99	102	102	98	91	87	90	88	92	98	103	104	103	99	93	88	86	90	96	101	103	101	97	91	83
157.5	79	79	85	90	93	93	90	85	82	82	83	88	93	94	94	90	86	83	85	84	86	91	95	97	96	93	88	83	82	84	89	93	95	94	91	86	79
160	75	75	79	83	85	85	82	79	78	78	78	81	85	87	86	83	79	77	81	80	81	84	87	89	89	86	82	79	78	79	82	86	88	87	85	80	75
162.5	69	69	72	76	77	77	75	72	72	72	72	74	78	79	78	75	73	71	75	75	74	77	80	81	81	79	75	73	73	72	74	77	80	79	78	74	69
165	64	63	65	68	70	69	67	65	65	66	66	68	70	72	70	67	66	65	69	69	68	69	71	74	73	72	68	68	67	66	68	70	72	72	70	68	64
167.5	58	58	59	61	62	61	59	59	60	61	61	61	63	63	62	60	60	60	63	63	63	63	64	66	66	64	62	62	62	61	61	62	64	64	63	62	58
170	53	53	52	54	55	53	52	53	54	55	55	55	56	56	54	53	54	54	58	58	57	56	57	58	58	57	56	56	56	55	54	55	57	57	56	56	53
172.5	48	48	47	47	47	46	47	48	49	50	49	49	49	48	47	47	48	49	52	52	52	50	50	50	51	50	50	51	51	50	48	48	49	50	50	50	48
175	43	43	42	42	41	41	42	44	44	45	44	44	44	42	41	42	43	44	47	47	46	45	44	43	44	44	45	46	46	46	44	42	42	43	44	45	43
177.5	40	40	41	40	40	39	40	41	41	41	41	41	41	39	39	40	40	40	42	42	42	42	40	40	40	41	41	41	41	42	41	39	39	40	41	41	40
180	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40

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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).

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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.

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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 D Equipment			
Description	**Manufacturer and Model Number**	**CSA Instrument Reference Number**	**Calibration Due Date**
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	PA118	12/2014
Regulated Power Supply	Chroma Instruments 61603	N/A	N/A

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

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