THERMAL
ELECTRICAL
MECHANICAL
PHOTOMETRIC
OPTICAL

CREE SERVICES
TEMPO TESTING AND EVALUATION

July 25, 2016
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Title:

TEMPO 24 Report

Prepared for:

Econex

Prepared by:

Cree Durham Technology Center (DTC)

Ticket Number:

18734-T-B

Table of Contents

NVLAP lab code 500070-0

The Cree Durham Technology Center (NVLAP lab code 500070-0) has been accredited by NVLAP to satisfy the requirements of ISO/IEC 17025:2005, IES LM-79-08 and LM-58-94

This report contains data sets that are not covered by NVLAP accreditation.

The measurement data sets contained in this report are related only to the items tested. This report must not be used by the customer to claim product certification, approval or endorsement by NVLAP, NIST or any agency of the federal government.

This report was generated for:

Econex
400007 ul. Vershinina
Volgograd 22
Russia

This report was generated by:

The Cree Durham Technology Center
4600 Silicon Dr
Durham, NC 27703

TEMPO 24 Checklist

Thermal

✓	In-situ Temperature Measurement Test (ISTMT)*
✓	Thermal Imaging With IR Camera*

Electrical

✓	Driver Efficiency*
✓	Transient Analysis*
✓	Source Start Time Test
✓	Power Analysis (PF, aTHD) (Per IES LM-79-08, sections 7 and 8)
n/a	Dimmer Compatibility Test*
✓	Dielectric Breakdown (Hi-pot)*
✓	Vf/Current Balancing (Parallel Arrays Only)*
n/a	Electrolytic Capacitor Testing*

Mechanical

✓	Qualitative Construction Analysis*
✓	Chemical compatibility Analysis*
n/a	X-ray of Printed Circuit Board*

Photometric and Optical

✓	Luminous Intensity Distribution (Per IES LM-79-08, section 9.3)
n/a	Spatial Non-uniformity of Chromaticity (Per IES LM-79-08, section 12.5)
✓	Luminous Flux (Per IES LM-79-08, section 9.1 and/or section 9.3)
✓	Radiant Flux (Per IES LM-79-08, section 9.1 and/or section 9.3)
✓	Chromaticity (CRI, CCT, x-y, u-v, u’-v’, Duv, Per IES LM-79-08, section 9.1)
✓	Spectral Power Distribution (Visible Range, Per IES LM-79-08, section 9.1)
✓	Luminaire Efficacy (lm/W, Per IES LM-79-08, section 11)
✓	Illuminance (ft-cd or lux, derived from IES LM-63-02 electronic file)
✓	Optical Efficiency*
n/a	Component Binning and Color Point Evaluation*
✓	Additional Photometric Analysis for Luminaire Type (e.g. Indoor, Roadway, etc.)*
✓	Visible Flicker Test*

✓	Review Against DesignLights™ Consortium (DLC) criteria*
✓	LED Lumen Maintenance Estimate (per TM-21)*

** Data sets that are not covered by NVLAP accreditation.*

Executive Summary

The Econex Econex PowerX uses 1 XLamp® CXB3590 LED. The luminaire produces 13,449 lumens with a 4762K CCT while consuming 113.8W of power. With an optical efficiency of 93% the luminaire delivers 118 lumens per watt.

Cree Services' TEMPO24 Evaluation process is a thorough multi-point evaluation and analysis of a customer's lighting product. Cree Application Engineering personnel perform a battery of thermal, electrical, mechanical and photometric tests and provide a comprehensive report that includes all relevant data necessary to confirm the performance of the product.

In addition to this standard set of tests, products will also be reviewed against appropriate Energy Star or DesignLights™ Consortium (DLC) criteria, TM-21 LED Lifetime estimates, and LM-79 conformant tests where applicable. Table 1 below provides a quick summary of the test data. Additional detailed test results are covered in the following pages.

Criteria	Result	Test Compliance
Total Luminous Flux (lm)	13,449	IES LM-79-08
Power (W)	113.8	
Tc(°C)[1]	62.4	
Power Factor	0.988	
Lumens Per Watt (LPW)	118.2	IES LM-79-08
Optical Efficiency (%)	93	
Driver Efficiency (%)	90	
CCT (K)	4762	IES LM-79-08
CRI (Ra)	75	IES LM-79-08
Chromaticity (x-coord)	0.3533	IES LM-79-08
Chromaticity (y-coord)	0.3666	IES LM-79-08
LED Lumen Maintenance	Reported L_{70}(6k) :> 44,400	IES TM-21

Table 1: Summary of Test Results

[1]*Measured at ambient temperature of 22.5ºC and normalized to 25ºC*

Incoming Inspection

All samples are subjected to a visual, physical inspection to ensure that the product was not damaged during shipping. Two samples were received as shown in Figure 1. The sample used in this report outer housing was received damaged as shown in Figure 1 and Figure 2. The sample was powered and appeared to be operating normally.

As Received Pictures

Figure 1: As-Received Picture #1

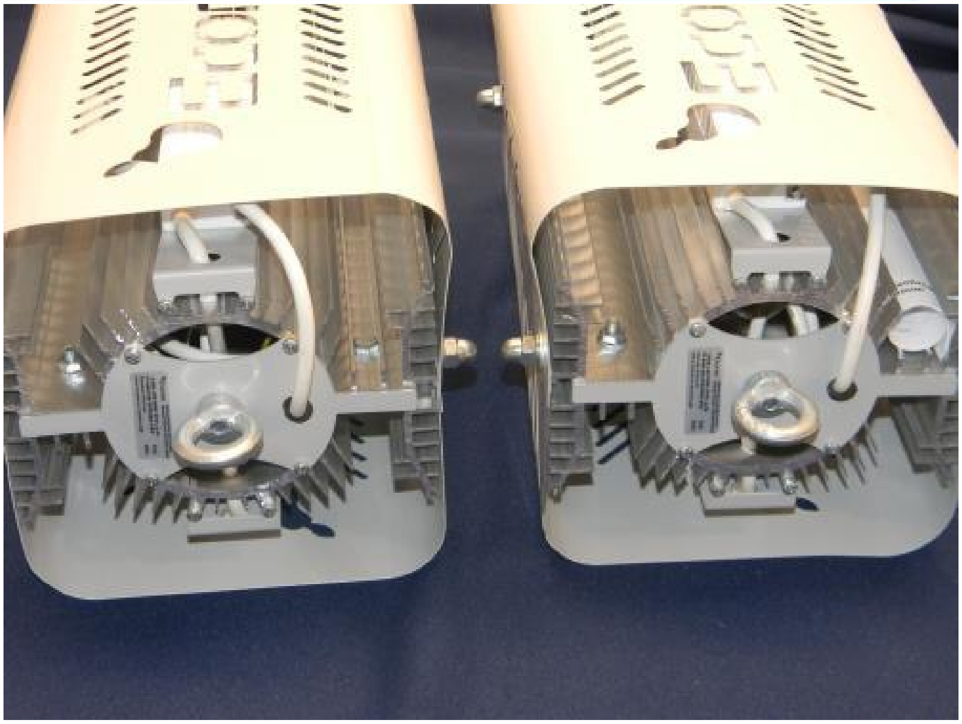

Figure 2: As-Received Picture #2

Photometric Testing

Photometric testing includes luminous flux, radiant flux, chromaticity, correlated color temperature (CCT) and color rendering index (CRI) measurements. Measurements are made at Cree's photometric testing lab in Durham, NC on two test systems: a 2-meter (2m) Labsphere integrating sphere and a Type C Goniophotometer.

This 2m sphere is a Labsphere model CSLMS-7660 using the 4π geometry measurement method with a Photal (Otsuka Electronics) MC 9801 spectroradiometer. Testing is performed per Cree standard photometric testing protocols, which follow IES LM-79-08[2] sections 9.1 and 9.3 and includes procedures such as performing absorption correction using a NIST traceable lamp and aligning the emission plane of the device under test with the sphere's sensor baffle. The sample is powered using a programmable regulated AC Power Source (or DC when applicable) and a Xitron model 2801 power analyzer is used to measure the electrical characteristics. Figure 3 is a photograph of the sample mounted in the sphere.

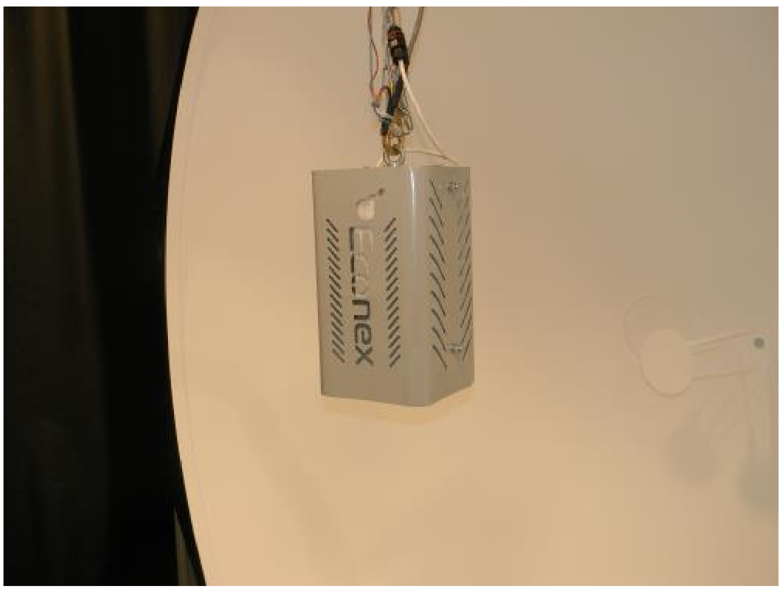

Figure 3: Sample in 2m Integrating Sphere

[2] *IES LM-79-08, Electrical and Photometric Measurements of Solid State Lighting Products*

Luminaire evaluation on a goniophotometer system was performed at Cree's photometric testing lab in Durham, NC on a type C goniophotometer This goniophotometer is a UL/Lighting Sciences Inc. model 6440T utilizing, an Inphora photocell (model PDET 11), an AC power supply (or DC supply when applicable) and a power meter. A Gooch & Housego spectroradiometer (model 770VIS/NIR) also allows for spectral irradiance data to be measured over the range of 380 to 780 nm. The testing distance is 28.5 feet (8.69 meters).

The illuminance calibration on the type C goniophotometer is performed utilizing 3 STD-EHD Lamps with a 500 Watt rating. The initial values for illuminance are measured with a Spectroradiometer, STS Certificate of Calibration #2082. The lamp serial numbers are: 12C066, 12C067, and 12C068. The lamps that are utilized at Cree were generated on 11, February 2013.

To calibrate color on the Type C goniophotometer, a single STD-EHD 120V spectral irradiance calibration lamp with a 500 Watt rating is used. The lamp (Serial Number: 13C072) is positioned with the serial number facing away from the spectroradiometer just like the intensity standards. This lamp must operate base down and at the specified amperes noted on STS Certificate of Calibration #2084. Figure 4is a photograph of a fixture under test on this type C Goniophotometer.

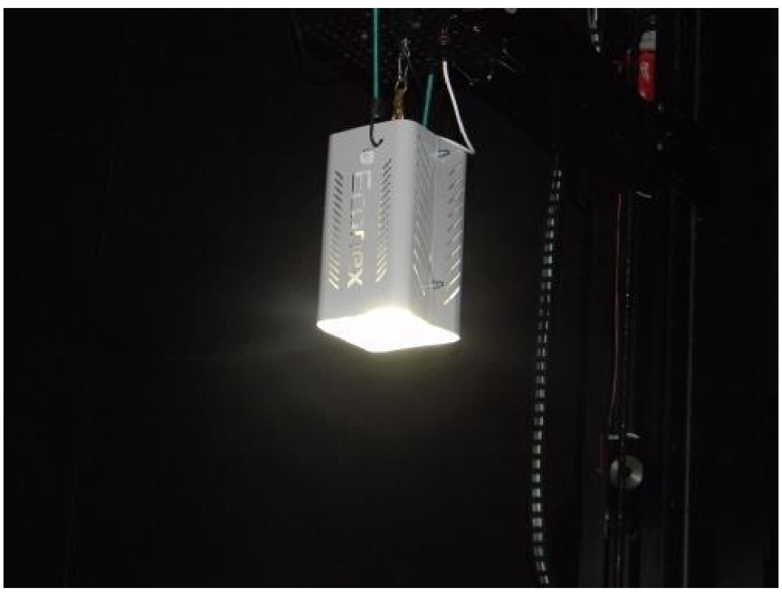

Figure 4: Sample Mounted on Type C Goniophotometer

Tests	Date	Ambient Temp. (°C)	Input Voltage (Volts AC)	Frequency (Hz)
Luminous Flux, Radiant Flux, Chromaticity, Color Rendering, Spectral Power Distribution, Luminaire Efficacy	27-May-2016	25.5	220	50
Luminous Intensity	26-May-2016	25	220	50

Table 2: Photometric Test Conditions

Luminous Flux, Radiant Flux

Radiant flux is a measure of the total power of electromagnetic radiation emitted from the luminaire or lamp, while luminous flux is a measurement that is weighted based on human visual perception. Measurements are recorded once per minute over a sufficient period of time to allow the sample to reach thermal equilibrium. In the case of this luminaire, it took approximately 1.48 hours to stabilize.

Parameter	Stable Data
Radiant Flux (watts)	40.1
Photopic Luminous Flux (lumens)	13,449
Scotopic Luminous Flux (lumens)	23,769
S/P ratio	1.77

Table 3: Luminaire Radiometric and Photometric Output

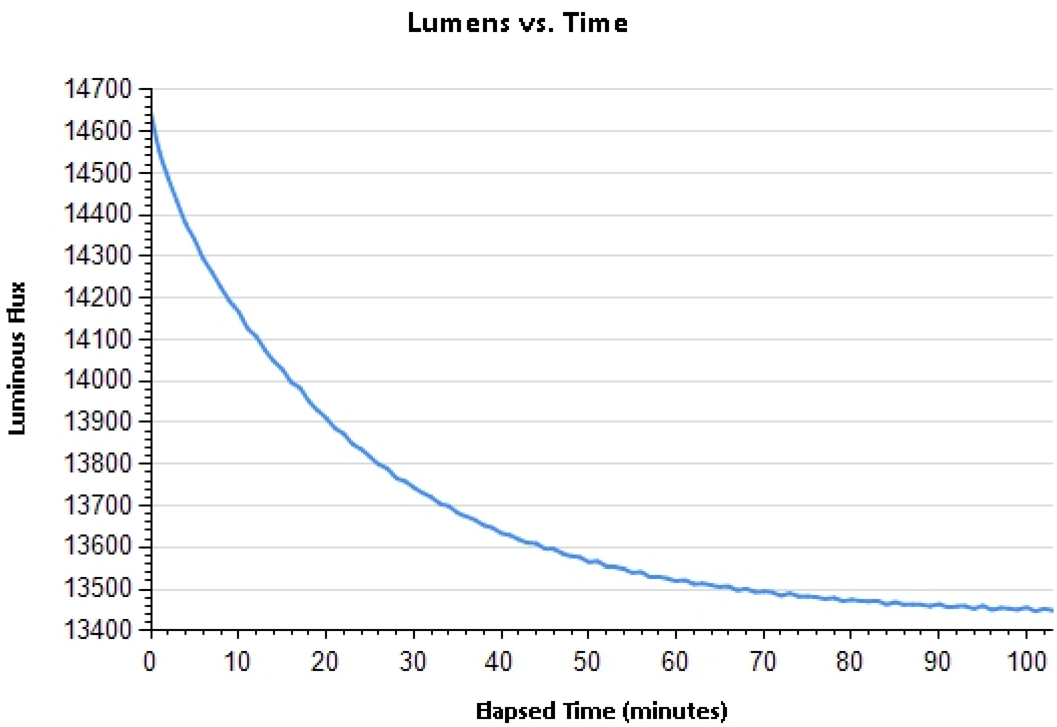

Chart 1: Luminous Flux Stabilization Over Time

Luminaire Chromaticity and Color Rendering

Parameter	Stable Data
x coordinate	0.3533
y coordinate	0.3666
u' coordinate	0.2112
v' coordinate	0.4930
Correlated Color Temperature	4762
Duv	0.0042

Table 4: Measured Chromaticity and Correlated Color Temperature (CCT) Data

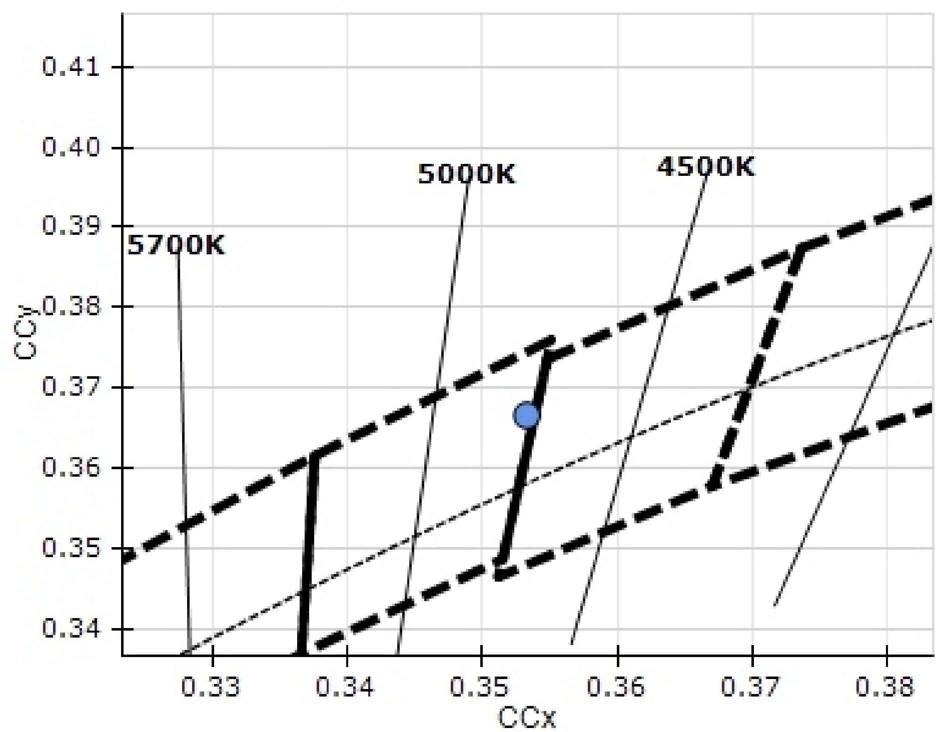

Chart 2: Plot of x-y Coordinates on ANSI C78.377A Diagram

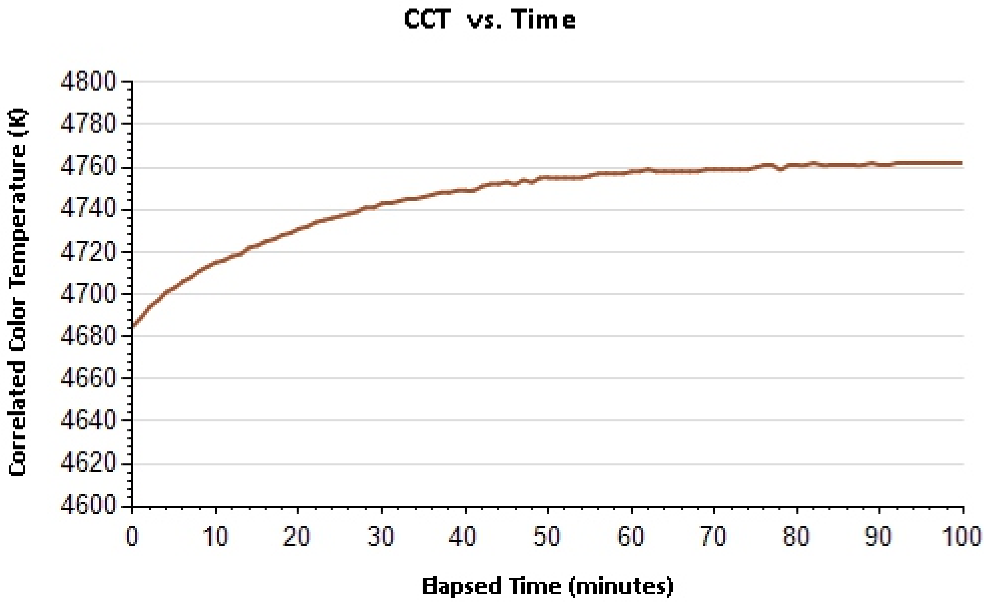

Chart 3: Correlated Color Temperature Stabilization Over Time

Color Rendering Index (CRI)	Value
Average (RA)	75
CRI (R1)	72
CRI (R2)	81
CRI (R3)	87
CRI (R4)	72
CRI (R5)	71
CRI (R6)	72
CRI (R7)	85
CRI (R8)	59
CRI (R9)	-18
CRI (R10)	53
CRI (R11)	66
CRI (R12)	39
CRI (R13)	74
CRI (R14)	92

Table 5: Measured Color Rendering Index

Luminaire Spectral Distribution

Parameter	Stable Data
Peak Wavelength (nm)	454
Dominant Wavelength (nm)	572

Table 6: Peak and Dominant Wavelength

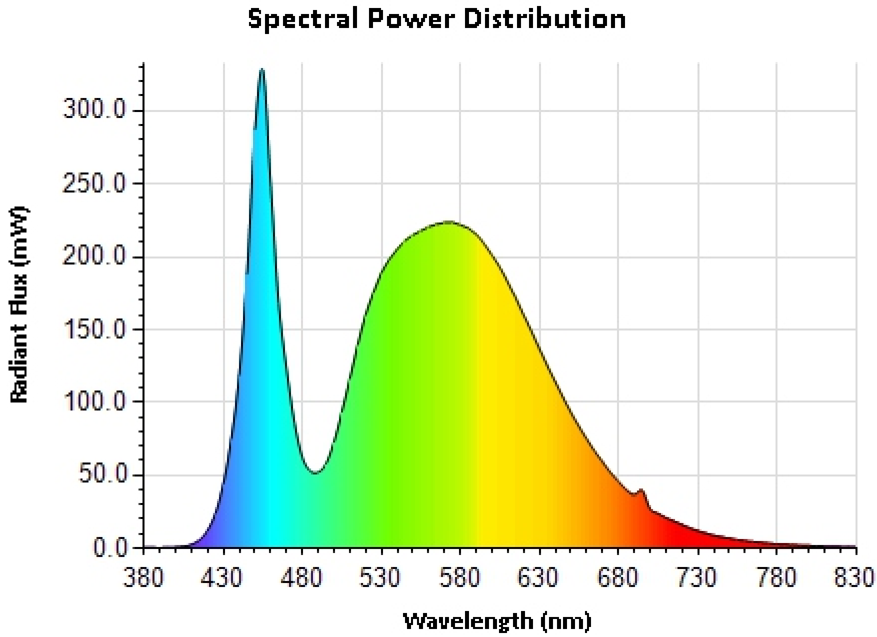

Chart 4: Measured Spectral Power Distribution

nm	mW/nm	nm	mW/nm	nm	mW/nm	nm	mW/nm
380	0.6	490	51.7	600	200.9	710	21.1
385	0.6	495	57.9	605	192.6	715	18.7
390	0.5	500	72.8	610	182.3	720	16.1
395	0.6	505	93.6	615	171.8	725	13.9
400	0.8	510	116.2	620	159.7	730	11.9
405	1.3	515	139.6	625	148.6	735	10.3
410	2.4	520	160.1	630	136.6	740	8.9
415	5.8	525	175.6	635	125.2	745	7.8
420	12.2	530	189.0	640	114.2	750	6.7
425	24.2	535	198.2	645	103.1	755	5.9
430	44.3	540	205.2	650	92.7	760	5.1
435	75.0	545	211.0	655	83.3	765	4.6
440	118.7	550	215.0	660	74.6	770	3.9
445	188.5	555	217.8	665	66.2	775	3.4
450	287.5	560	220.6	670	58.8	780	2.9
455	327.4	565	222.3	675	51.6	785	2.7
460	247.7	570	223.5	680	45.5	790	2.3
465	167.9	575	223.5	685	39.9	795	2.0
470	122.7	580	221.7	690	36.5	800	1.9
475	85.4	585	219.6	695	39.4	805	1.6
480	61.9	590	215.4	700	27.0	810	1.5
485	52.7	595	208.9	705	23.9	815	1.2

Table 7: SPD Numerical Data

Overall Luminaire Efficacy

The overall luminaire efficacy, also referred to as “wall plug efficacy”, is a metric of how well a luminaire or lamp converts electrical energy into photons. The input power was measured at an input voltage of 220 VAC.

Efficacy (at steady state) = Lumens / Total Input Power

= 13,449 / 113.8

= 118.2 lm/W

Goniophotometer Data

Characteristics	Result
CIE Class	Direct
Cutoff Class	Cutoff
Luminaire Lumens	13,383.00
Max. Candela	13,422
Max. Candela Angle	180H2.5V
Input Wattage	113.8

Table 8: Luminaire Summary Data

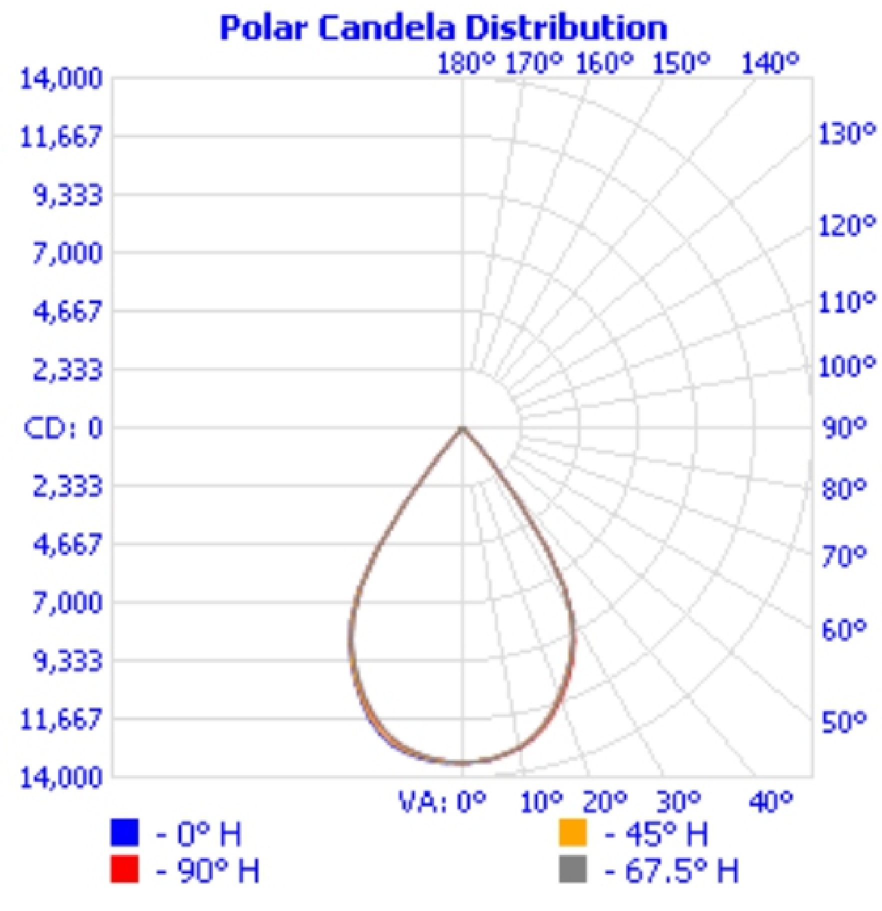

Chart 5: Intensity Distribution

Zone	Lumens	% Luminaire
0-30	9,470.4	70.8
0-40	12,898.8	96.4
0-60	13,270.2	99.2
60-90	86.1	0.6
70-100	43	0.3
90-120	2.5	0
0-90	13,356.3	99.8
90-180	26.7	0.2
0-180	13,383	100

Table 9: Zonal Lumen Summary

Zone	Lumens	% Total
0-10	1,262.6	9.4
10-20	3,493.6	26.1
20-30	4,714.2	35.2
30-40	3,428.4	25.6
40-50	315.5	2.4
50-60	55.9	0.4
60-70	43	0.3
70-80	33	0.2
80-90	10	0.1
90-100	6.9	0

Table 10: Lumens Per Zone, 10 degree Increments

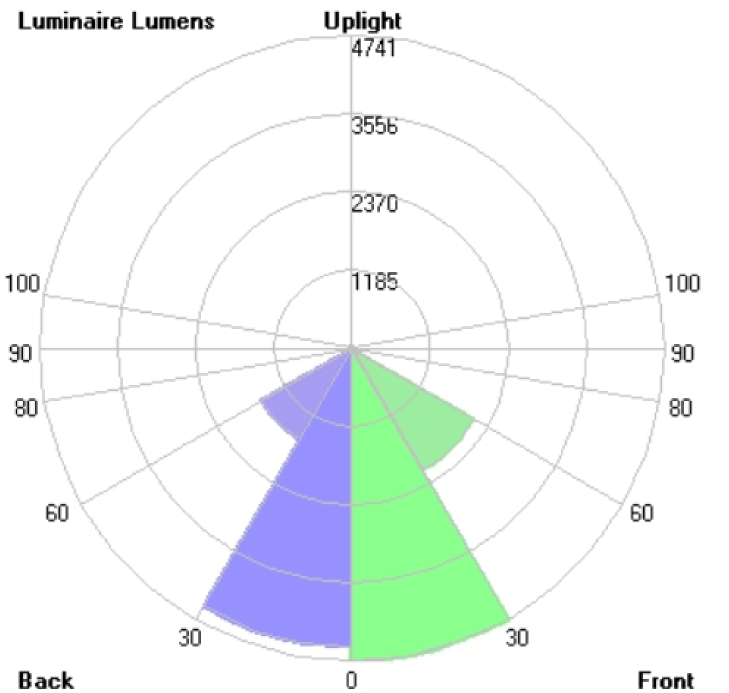

Chart 6: LCS Graph

Illuminance

The sample was measured on a type C goniophotometer and illuminance measurements were calculated from the IES-63 electronic file using Photometrics Pro software. The results are shown in Charts 7 and 8.

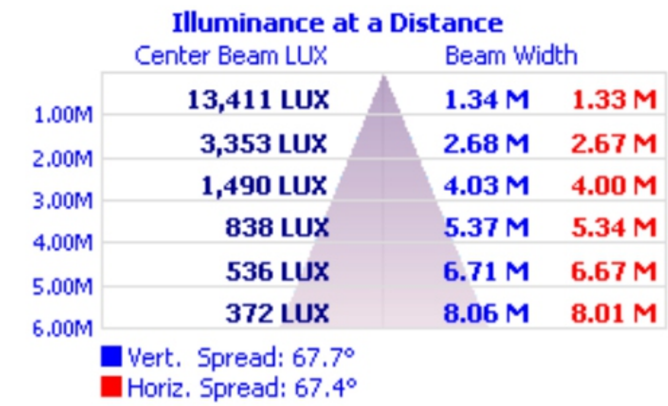

Chart 7: Cone of Light Diagram

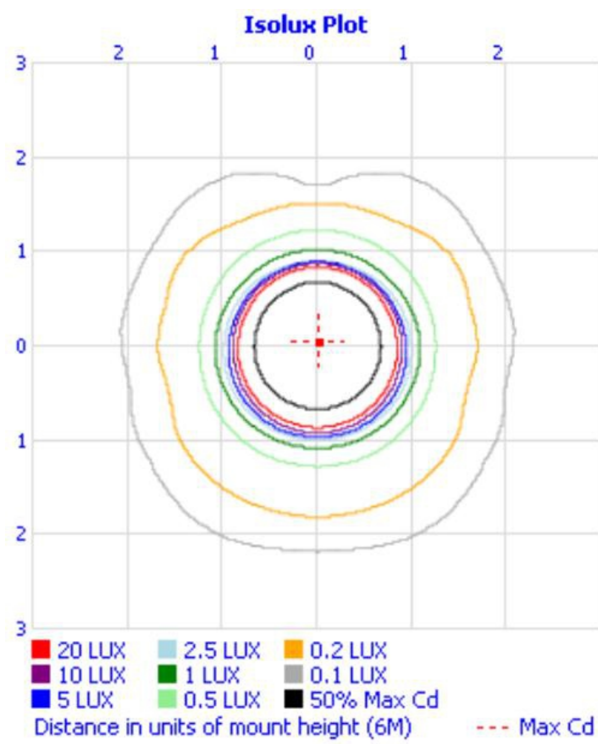

Chart 8: Isolux Plot

Component Binning and Color Point Evaluation

Component binning was performed on this luminaire due to CXB could not be removed from heat sink.

Optical Efficiency Calculation

The sample was tested with and without optics and the results are shown below in Table 11. Using this data, the optical efficiency can be calculated. The initial lumen values were used to avoid any effects due to thermal differences with the optics removed.

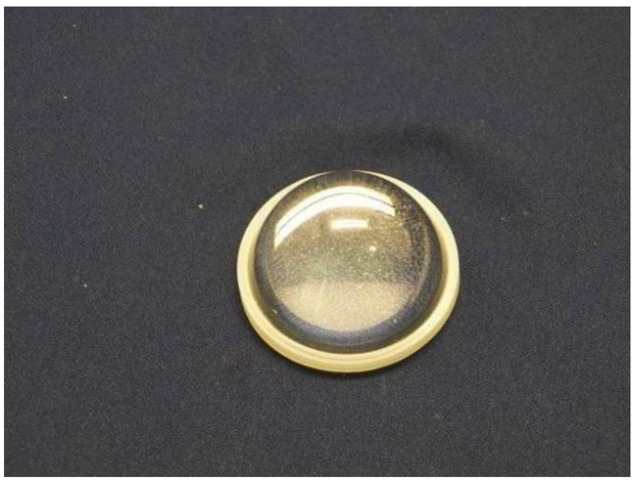

Figure 5: Optical Components

Condition	Radiant Flux (Watts)	Luminous Flux (lumens)	% Loss (overall)
With Optics	43.7	14,784	7.2%
No Optic No Case	47.3	15,936	--

Table 11: Measured Optical Efficiency

Optical Efficiency = Lumens With Optic / Lumens Without Optic

= 14,784 / 15,936

= 92.8%

Visible Flicker Test

Visible Flicker is defined by the rapid fluctuation of light output in a cyclical manner[3] The sample was tested with a photodetector to measure the amount of light modulation, or flicker. The detector output was captured using an oscilloscope, and the result is shown in Figure 6.

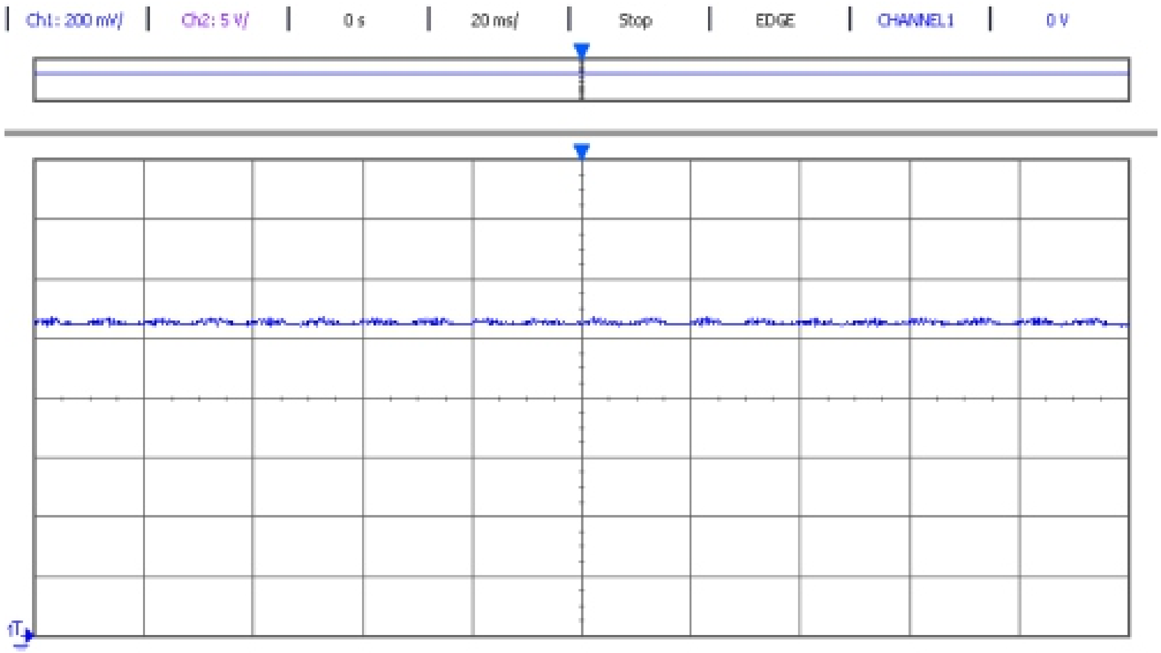

Figure 6: Visible Flicker

Where the percentage of modulation, referred to as flicker, varies from 0% to 100% as defined by the equation:

Flicker (%) = 100 * (max – min) / (max + min)

For this sample the flicker (%) is:

100 * (1.08 – 1.04) / (1.08 + 1.04) = 1.9%

The flicker index is 0.0021 at a frequency of 223 Hz.

As a reference point, a 60W incandescent lamp operating at 60Hz AC voltage has a flicker percentage of 8%. Flicker greater than 50% and at a frequency of less than 150Hz is generally considered unacceptable, while any percentage of flicker at frequencies above 1500 Hz cannot be detected by the human eye.

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[3]Alliance for Solid-State Illumination Systems and Technologies (ASSIST). 2012 ASSIST recommends…Flicker Parameters for Reducing Stroboscopic Effects from Solid-state Lighting Systems. Vol 11, Issue 1. Troy, NY Lighting Research Center http://www.lrc.rpi.edu/programs/solidstate/assist/recommends/flicker.asp

A summary of the frequency and percentage flicker that is considered acceptable by most observers is presented in Chart 9, and the measured result from the sample (the blue data point) is plotted on this chart. The position of the data point within the shaded regions corresponds to an acceptability number between +2 to -2. The lower the number, the less acceptable the level of flicker is to an observer and values below zero are considered unacceptable to most observers.

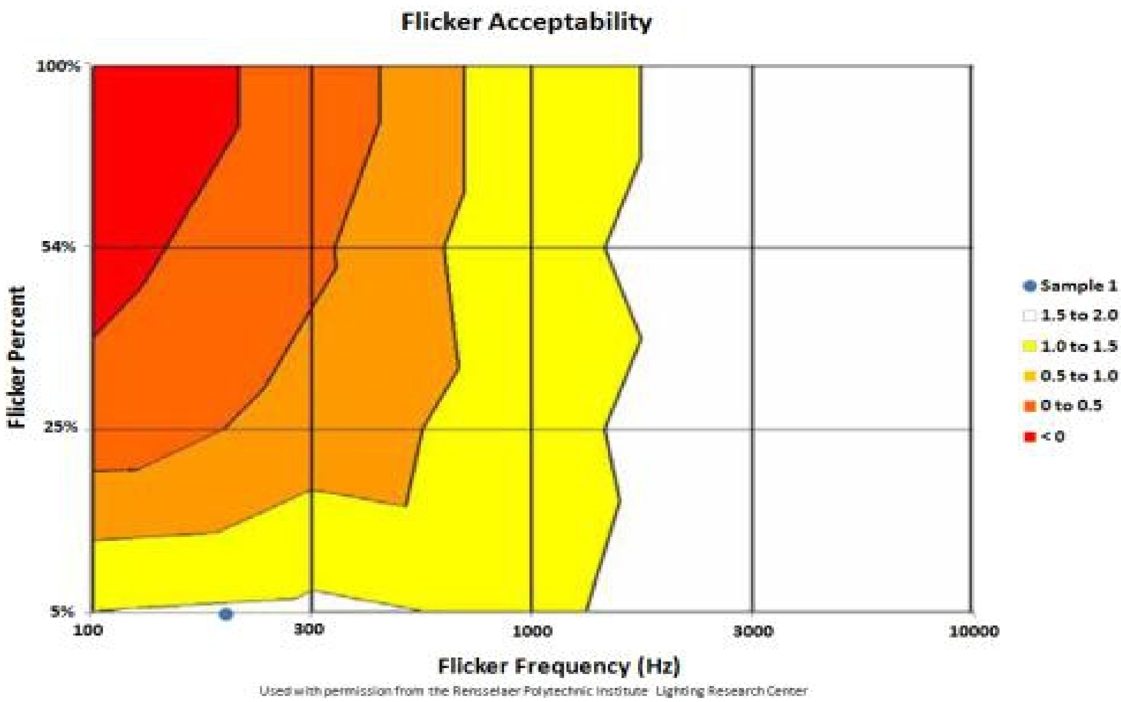

Chart 9: Calculated Flicker Acceptability for Measured Sample

Electrical Testing

Driver Efficiency

Driver efficiency is calculated by dividing the electrical output power supplied to the LEDs by the total input power to the fixture. The output power to the LEDs is the sum of the product of the forward voltage and current for each LED. The input power was measured at an input voltage of 220VAC

Driver Efficiency = LED power / Total input power
Driver Efficiency = (Vf * If) / Pin

Driver Efficiency = (76.5 * 1.411) / 119.3

Driver Efficiency = 90.5 %

Power Factor and Harmonic Distortion

Power factor (PF) is an important metric for LED driver performance, and certain regulations may require that luminaires or lamps have power factor greater than some specified value. In general the closer the value is to 1, the better the performance.

Total harmonic distortion (THD) is defined as the ratio of the sum of the powers of all harmonic components to the power of the fundamental frequency. Harmonic currents are a concern because they can produce problems such as noise interference and overheating of electrical distribution system wiring.

The measured PF and THD results are shown in Table 12.

Figure 7: Picture of LED driver

Power Results

Parameter	Stable Data at 220VAC
Total Wattage	113.8
Power Factor	0.988
Input Voltage (Vac)	220
Input Frequency (Hz)	50.0
Input Current(A)	0.52
vTHD (Voltage Total Harmonic Distortion)	0.06%
aTHD (Current Total Harmonic Distortion)	10.99%

Table 12: Measured Power Test Results

Transient Analysis

Hot plugging and turn-on electrical overstress is occasionally seen with LED Drivers. See Cree Application Note Electrical Overstress for further information on the effects this has on LED performance and lifetime. The driver output current was measured with a current probe and oscilloscope and the waveforms were captured in the following figures. Figure 8 shows the initial inrush current which reaches a maximum amplitude of 1.49A. Figure 9 shows the continuous output current which has a peak-to-peak ripple of .130A with a maximum of 1.49A. Hot-plugging was not tested on this luminaire as it was not a concern due to the configuration of the circuit.

The maximum continuous current rating of the CXB3590 is 1.8A ; therefore, based on this result, the risk of EOS Low.

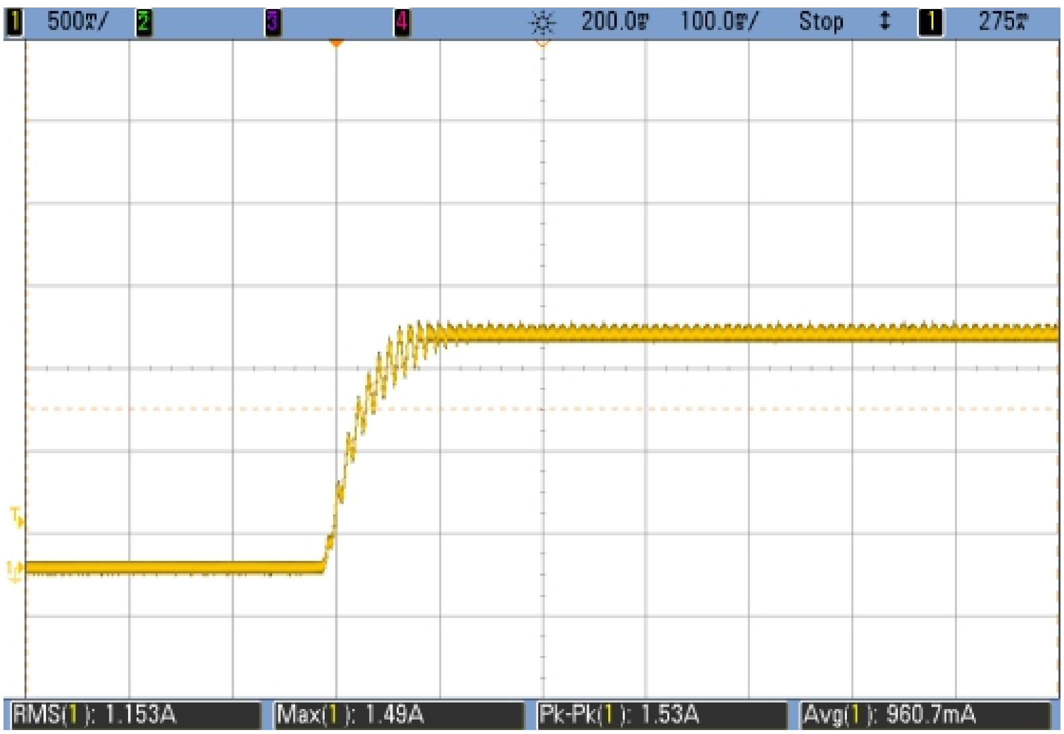

Figure 8: Initial Turn-on (inrush) Current

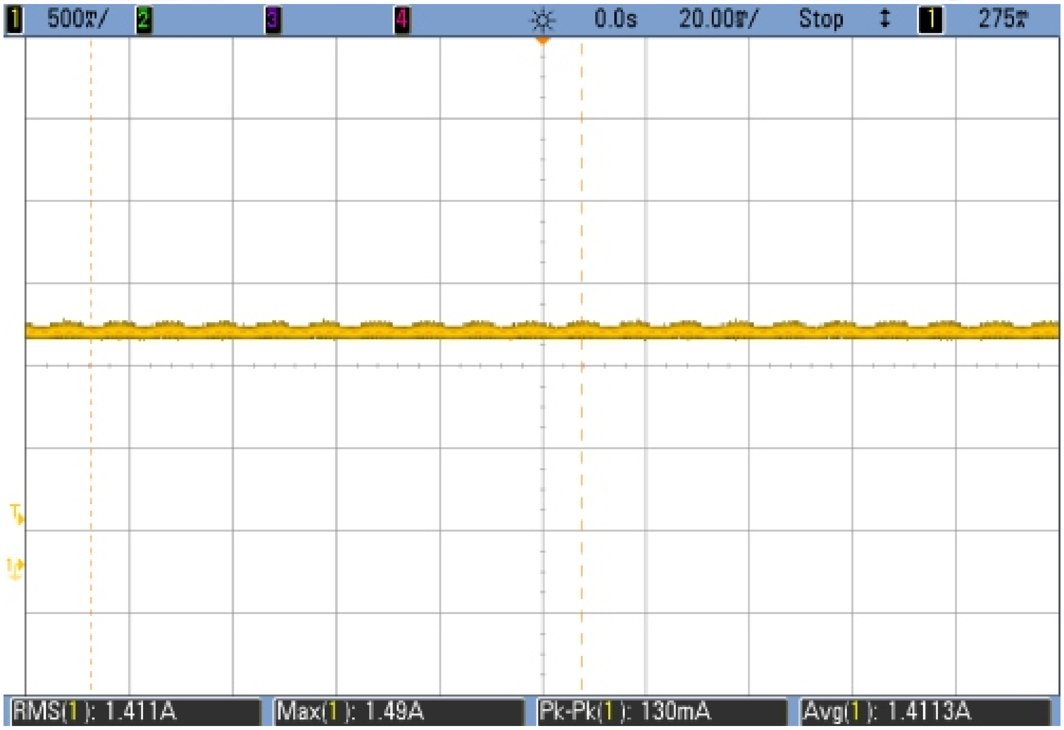

Figure 9: Driver Output Ripple Current

Source Start Time Test

The source start time test measures the delay between when power from the mains is applied and when the luminaire output reaches 98% of full output. In the figure below, the yellow trace is the AC input current and the purple trace is the output of a photodetector. A delay of approximately 740 milliseconds was observed prior to the LEDs reaching 98% of full output.

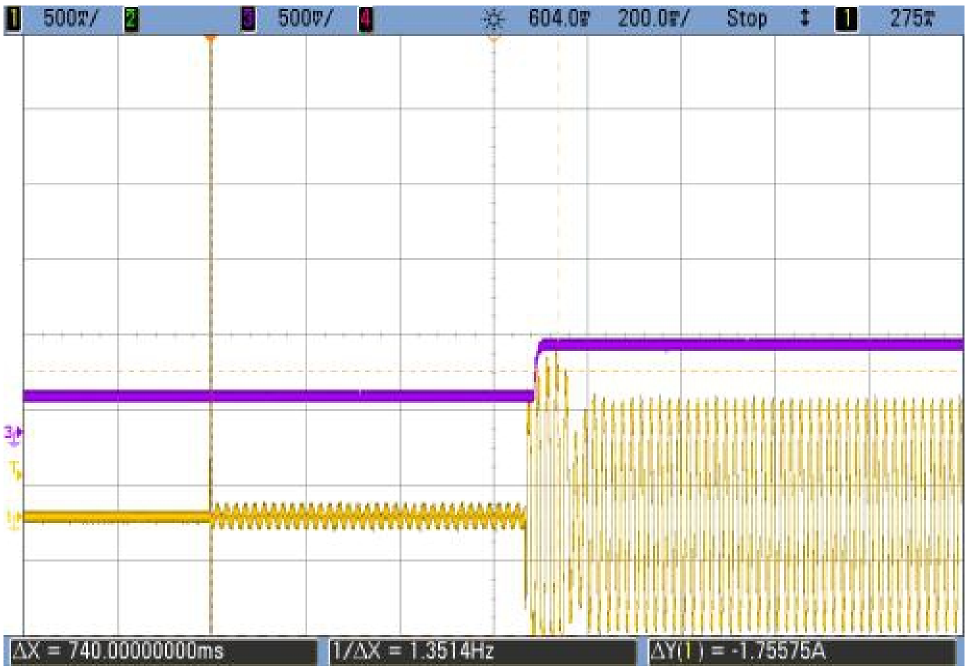

Figure 10: Turn-on Delay

Vf / Current Balance

Luminaires utilizing multiple emitters are often configured using parallel strings which are then driven by a single constant-current source. One drawback to this approach is that careful attention must be paid to minimize the difference in forward voltage between the individual strings; otherwise, the currents will not balance evenly.

Driver / String	Current (mA)	Vf	Total LED Wattage
1	1,411	76.5	107.9

Table 13: LED Load Current, Forward Voltage, and Power

Dielectric Breakdown Testing

Dielectric withstand testing or "hi-pot" testing is a safety test performed to ensure that the insulation of an electrical device is sufficient to protect humans from electrical shock. A voltage that is several times higher than the working voltage of the device is applied for a period of either one second or one minute. The test is used to verify the mechanical integrity of the insulation and grounding continuity. Typically the voltage applied is 1000V plus 2 times the working voltage.

The hi-pot tester was connected with the positive terminal to the neutral and line inputs and with the negative terminal to the chassis. Ground continuity between the various metal parts was verified. A voltage of1.480 kVDC was applied for 60 seconds. The result was the sample passed.

Figure 11: Dielectric Withstand Test Result

Dimmer Compatibility Test

The sample was not tested for dimmer compatibility because it is not intended to be dimmed.

Electrolytic Capacitor Test

Electrolytic capacitor testing was not able to be performed on this luminaire.

Thermal and Mechanical Testing

In-situ Temperature Measurement Test (ISTMT)

Measuring solder point (case) temperature of the LEDs used in a luminaire is useful for determining the junction temperature and thus predicting lifetime. For more information on measuring case temperature, refer to Cree's Application note on Soldering & Handling.

One thermocouple (TC1) was attached to the solder point of the LED. A second thermocouple (TC2) was attached to the heat sink. A third thermocouple (TC3) was attached to the case of the driver and fourth (TC4) was used to monitor the ambient room temperature, which averaged 22.5°C. Chart 10 shows the measured temperatures over a period of approximately 3 hours. The measured case temperature was 59.9°C.

Tc = 59.9°C

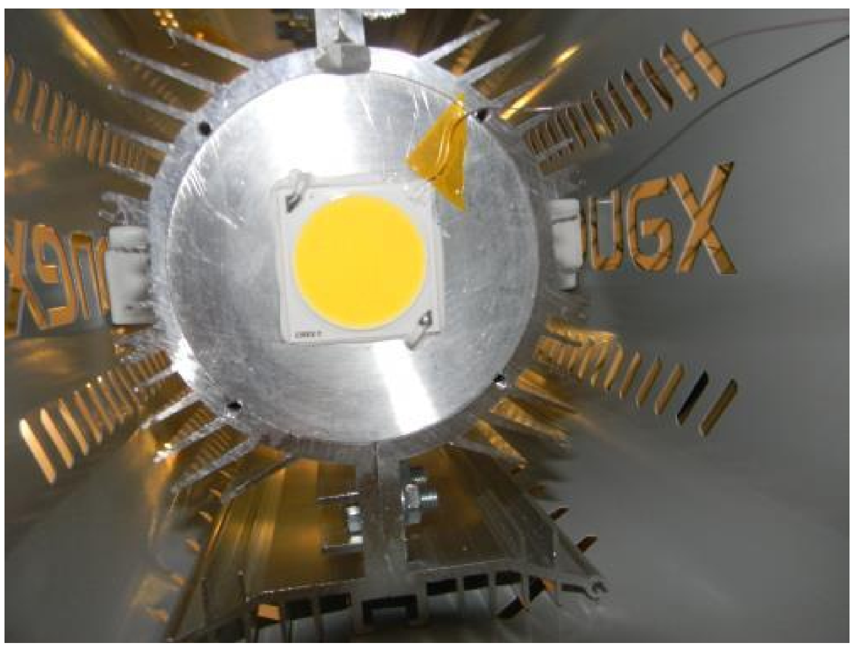

Figure 12: Thermal Testing Set-up

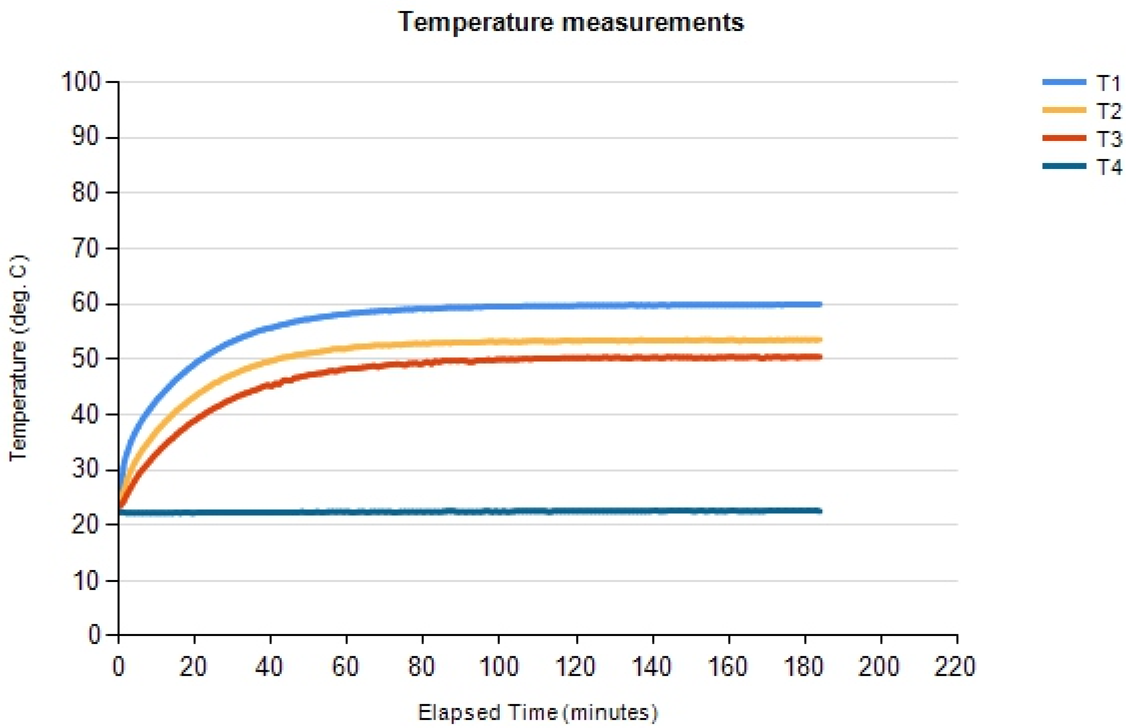

Chart 10: Measured Temperature Graphs

Recorded Tc (°C)	Recorded Ta (°C)	Tc Adjusted to 25° Ambient
59.9	22.5	62.4

Table 14: Normalized ISTMT result

Thermal Imaging Analysis

With the fixture at steady-state temperature, a series of infrared (IR) imaging photographs were taken using a FLIR T300 to evaluate thermal dissipation and areas of concern on the light engine, heat sink, and external housing. The FLIR camera, when used in this way, gives primarily qualitative information. Without precise per-material emissivity calibration, the analysis will not provide exact correspondence to other temperature measurements. The emissivity was set to the default value of 0.95.

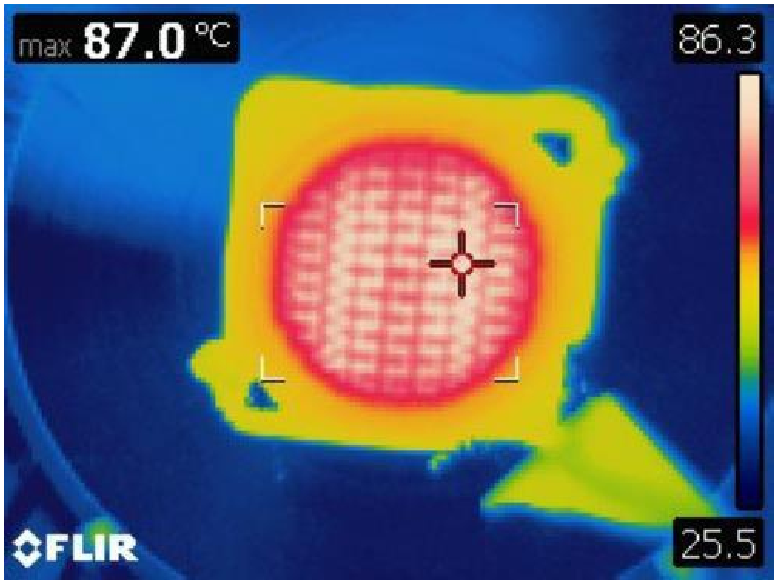

Figure 13: Thermal Image #1

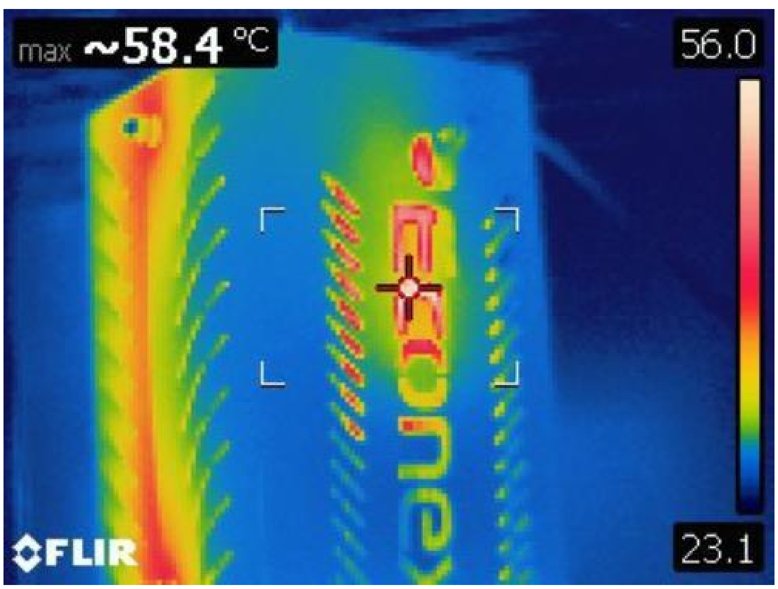

Figure 14: Thermal Image 2

Qualitative Mechanical Construction

The following figures show details of the mechanical construction of the luminaire. The luminaire consists of a single CXB3590 array mounted to an aluminum heat sink. An unknown thermal epoxy was used as the thermal interface material between the heat sink and CXB. A thick dome lens was used as the primary optic with a metal retaining ring and rubber gasket. Two drivers were connected in series and mounted to the heat sink to supply power to the CXB.

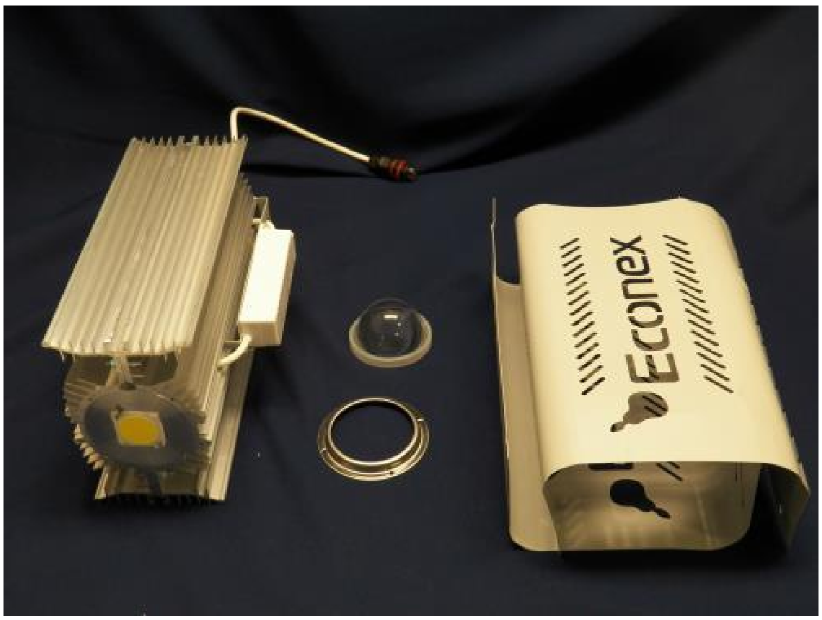

Figure 15: Luminaire Components

Chemical Compatibility Analysis

During operation of the luminaire, volatile organic compounds may outgas from materials used in the construction of the luminaire. Testing of these materials is recommended. For more information on chemical compatibility refer to Cree's Application note on Chemical Compatibility[4]

The sample contains Dow Corning SE4486 Conductive Epoxy used as the thermal interface material. No other chemicals of concern were observed.

[4] http://www.cree.com/~/media/Files/Cree/LED-Components-and-Modules/XLamp/XLamp-Application-Notes/XLamp_Chemical_Comp.pdf

LED Lumen Maintenance Estimate (per TM-21)

IESNA TM-21-11, "Projecting Long Term Lumen Maintenance of LED Light Sources" is a newly developed Technical Memorandum which provides recommendations for projecting long term lumen maintenance of LEDs using data obtained when testing the LEDs per IESNA LM-80-08, "IES Approved Method for Measuring Lumen Maintenance of LED Light Sources." The TM-21 standard is the industry-standard calculation method on which to base lumen maintenance of LEDs. Using TM-21, a projected "L**70**" value can be no greater than six times the actual test duration of the LM-80 data sets.

The TM-21 projections represent the anticipated lumen maintenance of the LEDs and does not account for reliability of all of the other components of the luminaire or of the luminaire as a system.

Cree currently has published 8,064 hours of LM-80 data[1] on the XLamp CXB3590 White (72V) where If = 1400mA and Tsp = 85°C. When using the TM-21 method to determine lumen maintenance of the CXB3590 based on a normalized Tsp of 62°C, the reported L70 is > 44,400 hours. This projection is limited by the 6X rule as defined in TM-21. This method also allows lumen maintenance for other L-values to be calculated. In this case, at 133,000 hours the calculated lumen maintenance will be 90%.

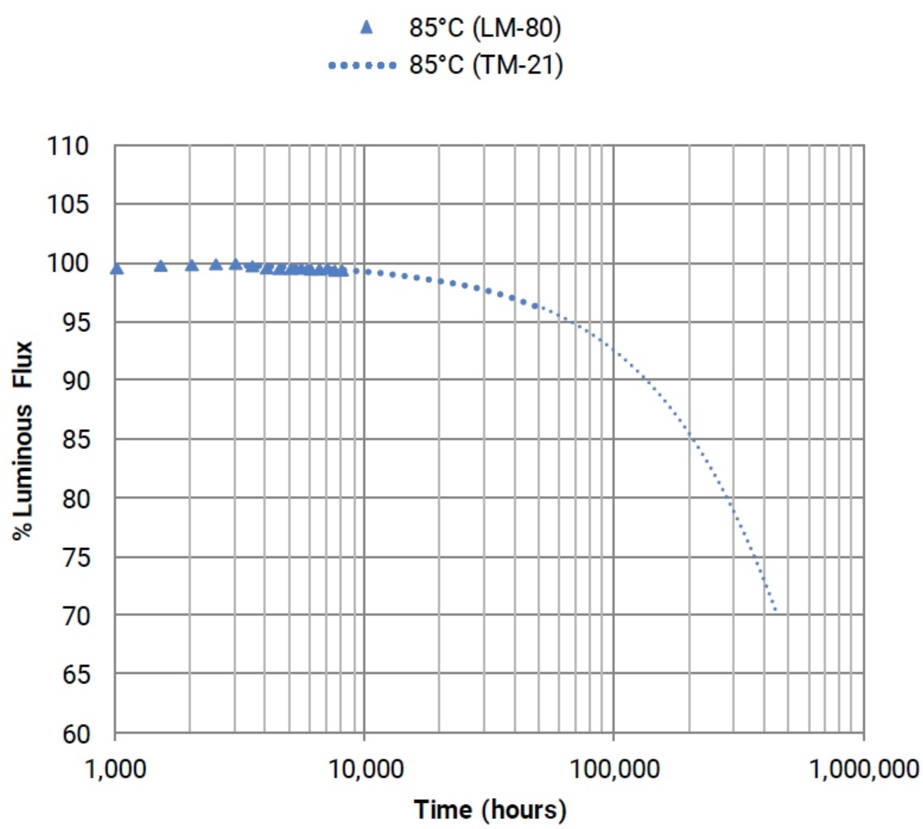

Chart 11: TM-21 projection chart

Current	**1400 mA**
Ta/Tsp	**85°C**
α	7.976E-07
β	1.001
Duration	8,064 hrs
Calculated L90	>133,000 hrs
Calculated L80	>133,000 hrs
Calculated L70	>133,000 hrs
Reported L90	**>44,400 hrs**
Reported L80	**>44,400 hrs**
Reported L70	**>44,400 hrs**

Table 15: TM-21 calculation summary table

[2]LM-80 data set(s) provided by Cree SSL Reliability Lab, accredited under NVLAP Lab Code: 500041-0.

Review Against Appropriate DLC Criteria

High-Bay Luminaires for Commercial and Industrial Buildings		
Criteria	**Requirement**	**Tempo Result**
Minimum Light Output	5000 - lm	Meets requirement, 13,449 lm
Zonal Lumen Density	>30%: 20-50º	Meets requirement
Minimum Luminaire Efficacy	105 lm/W	Meets requirement, 118 lm/W
Allowable CCTs	<5700k	Meets requirement, 4762k
Minimum CRI	70	Meets requirement, 74.7394
L70 Lumen Maintenance	50000 hours	=133,000
L90 hours	14000 hours	= 44,400 hours
Power Factor	>=0.9	Meets requirement, 0.988
aTHD	<20%	Meets requirement, 10.99%

Table 16: DLC Requirements Summary

The sample was reviewed against the requirements for the DesignLights™ Consortium for High Bay Luminaires for Commercial and Industrial Buildings. In addition to these technical specifications, products must have a minimum warranty of 5 years.

Data Summary

Results in this report are for the sample submitted and used in this evaluation only.

Criteria	Result
Total Luminous Flux	13,449
Power (W)	113.8
Tc(°C)[2]	62.4
Power Factor	0.988
Lumens per Watt (LPW)	118.2
Optical Efficiency (%)	93
Driver Efficiency (%)	90
CCT (K)	4762
CRI (Ra)	75
Chromaticity (x-coord)	0.3533
Chromaticity (y-coord)	0.3666
LED Lumen Maintenance	Reported L_{70}(6k) :> 44,400

Table 17: Summary of Test Results

[6]*Measured at ambient temperature of 22.5ºC and normalized to 25ºC*

Measurement Uncertainty

Measurement Parameter	2m Integrating Sphere (+/-)	Goniophotometer
CCx	0.0012	
CCy	0.0013	
Total Luminous Flux (lm)	3.9%	2%

Table 18: Measurement Uncertainty

Equipment List

Using calibrated, state-of-the-art equipment at Cree Technology Centers across the world, Cree Services reports provide measurements you can trust. Below is a list of manufacturers and equipment that allows Cree to evaluate important aspects of your LED system design and examine areas critical to certifications, as well as cover areas not currently tested by regulatory bodies but vital to quality LED system design. That's lighting-class.

Equipment Used	Manufacturer	Model	ID No. / Serial No.
Software	Lighting Analysts, Inc.	Photometric Toolbox Pro. Ed.	
Software	jSolutions, Inc.	Photometrics Pro Version 1.3.14	
Software	Agilent	Meas. Manager version 2.0	
Amplifier	UDT Instruments	Tramp	
Photosensor	UDT Instruments	211	
USB Oscilloscope	Agilent	U2702A	
Digital multimeter	Fluke	289	
Type C Goniophotometer	LSI / UL	6440T	TEMPO-0026 / SN: 6440TE0192T
Software	LSI / UL	Photometric Suite	
Power Meter	Yokogawa	WT210	
AC Power Supply	Adaptive Power Sys.	FC210	
Dielectric Breakdown Tester	GW Instek	GPT-9802	
Spectrometer (2m sphere)	Otsuka Electronics	MC-9801:3683	TEMPO-0034 / SN: 98010162
Two-meter integrating sphere	Labsphere	CSLMC-7660	TEMPO-0023 / SN: 128090799
Software	Labsphere	TOCS Version 3.41	
AC power source	Chroma	61503	TEMPO-0038 / SN:615030000243
AC power source	Chroma	61501	TEMPO-0016 / SN:615010000682
Power analyzer	Xitron	2801	
Infrared camera	FLIR	T300	
Thermocouple	Omega	Type T	
Thermometer	OMEGA	HH147U	TEMPO-0082 / SN: 150504129
Oscilloscope	Agilent Technologies	MS0-6034A	
Current probe	Agilent Technologies	1147A	

Table 19: List of Equipment Used in Testing

Regulatory Submittals

The Cree Durham Technology Center (DTC) (NVLAP lab code 500070-0) has been accredited by NVLAP to satisfy the requirements of ISO/IEC 17025:2005, IES LM-79-08, and LM 58-94.

The Cree DTC is recognized under the LED Lighting Facts® Approved Labs List.
http://www.lightingfacts.com/approvedlabs

The Cree DTC is recognized by Underwriters Laboratories (UL) in accordance with their Third Party Test Data Program (TPTDP) for in-situ temperature measurement testing (ISTMT), DA file DA1054.

The data in this report that conform with LM-79-08 may be used for submittal to the EPA Energy Star® Program, Design Lights Consortium (DLC) and DOE Lighting Facts® Label. However, Cree does not guarantee qualification to the requirements of these programs based solely on the results from this test report.

Additional tests beyond the scope of IES LM-79-08 with data sets from approved testing labs are required by these regulatory bodies. Note that for many of the criteria listed in the Energy Star Program requirements, a sample size of 10 units is required.

Links to the specific requirements for each program are listed below:

ENERGY STAR® Luminaires 1.1 (Final_Luminaires_Program_Requirements.pdf)

ENERGY STAR® Integral LED Lamps 1.4* (Integral_LED_Lamps_Program_Requirements.pdf)

DesignLights Consortium (http://www.designlights.org/Content/QPL/ProductSubmit)

U.S. DOE Lighting Facts http://www.lightingfacts.com/About/manufacturers

* These requirements will be superseded by Lamps Version 1.0 effective September 30, 2014.
(Lamps Version 1.0 Requirements)

Report Review

This report has been reviewed by:

Date: 8/23/2016

Tom Place
Manager, Cree Durham Technology Center

If there are any questions or concerns on the information or content of this report, please contact your Cree sales representative or your local Cree field application engineer. If you do not know these points of contacts or require additional assistance, please contact Cree Product Support.

For support of all Cree products, send an e-mail to productsupport@cree.com or call:

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Outside the US: +1-919-287-7888

Additionally, please provide us feedback on how we are doing by completing the survey at:
https://www.research.net/s/temposurvey