PRODUCT TEST REPORT - CIE/IEC 62471:2006
Photobiological Safety of Lamps and Lamp Systems

APPLICANT'S INFORMATION:

Prepared for: Orb Optronix
1003 7th Ave
Kirkland, WA 98033

Test Report: IEC62471-02
Report Number: ORBX000
Release Date: 01/01/12

Manufacturer: Orb Optronix
Product Description: Sample Report

TESTING LABORATORY:

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SAMPLE

SAMPLE REPORT

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REPORT DESCRIPTION:

This test report provides a photobiological assessment of the specified product under the guidance of the double-logo standard CIE/IEC 62471: Photobiological safety of lamps and lamp systems. This International standard gives guidance for evaluating the photobiological safety of lamps and lamp systems including luminaries. Specifically it specifies the exposure limits, reference measurement technique and classification scheme for the evaluation and control of photobiological hazards from all electrically powered incoherent broadband sources of optical radiation, including LEDs but excluding lasers, in the wavelength range from 200 nm through 3000 nm.

This report is provided as a reference of the photobiological assessment for this package. This assessment is not applicable to end-user applications where multiple packages are used in close proximity, or the package optical distribution has been modified. Ultimately, it remains the end-users responsibility for providing the proper assessment and labeling for each unique application using this package.

TESTING SUMMARY

Testing performed to a single Sample Report package. Measurements are performed up to the characterization drive current for this package, as provided in the manufacturers specification sheet. Exposure limits and classification extending beyond the manufacturers characterization drive current for this product are not covered in this report. All measurements are performed where case temperature is activaly controlled to the test condition listed in the table below.

RESULTS SUMMARY

Testing has show this product is classified as Moderate Risk or RG-1 when used within the characterization drive current provided in the manufacturers data sheet. Mearsurements pertaining to the highest photobiological risk were recorded under the following device test conditions.

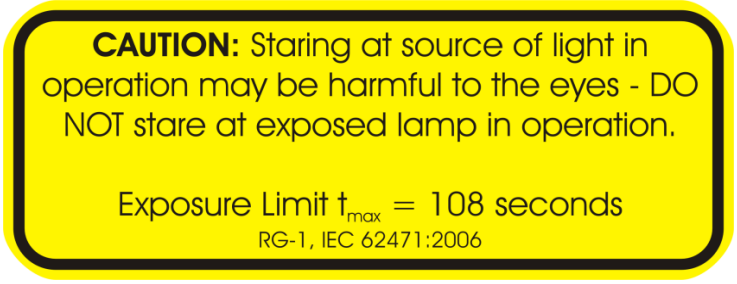
Test Conditions for Classification		
Drive Current	0.500	A
Forward Voltage	39.372	V
Case Temperature	25.0	°C
Angle to Source	On-Axis	Deg
Distance from Source	20.0	cm

Risk Group Classifications		
Actinic UV	E_S	Exempt
Near UV	E_{UVA}	Exempt
Blue light	L_B	Low Risk
Retinal thermal	L_R	Exempt
IR radiation, eye	E_{IR}	Exempt

The exposure limit for the Retinal blue light hazard, calculated in section 4.3.3 is: $t_{max} = 124$

SUGGESTED LABELING

Labeling is not required for products with an exempt or RG-1 Blue Light hazard classification. A sample label has been provided, and may be included on and with product materials at the users discretion.



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Section	Requirement/Test	Result or Remark	Verdict
4	EXPOSURE LIMITS		
4.1	General		
	The exposure limits represent conditions that nearly all individuals in the general population may be repeatedly exposed without adverse health effects. However, limits do not apply to individuals who are abnormally potosensitive or concomitantly exposed to photosensitizing agents.		
	The exposure limits in this standard apply to continuous sources where exposure duration is not less than 0.01 ms and not more than any 8-hour period, and should be used as guides in the control of exposure.		
	Detailed spectral data of a light source is generally required only if the maximum luminance of the source exceeds 10^4 cd·m^{-2}.	Max luminance for α_{eff} 2.28E+06 cd·m^{-2}	Required See Page 11
4.3	Hazard exposure limits		
4.3.1	Actinic UV hazard exposure limit for the skin and eye	200 nm - 400 nm	
	The exposure limit for effective radiant exposure is 30 J·m^{-2} within any 8-hour period. Continuous exposure exceeding 8 hours in any day need not be considered.	Measured 0.0052 J·m^{-2} Percent of Limit 0.02%	Exempt
	To protect against injury of the eye or skin from ultraviolet radiation exposure produced by a broadband source, the effective integrated spectral irradiance, E_S, of the light source shall not exceed the levels defined by:		
	$E_s \cdot t = \sum_{200}^{400}\sum_{t} E_\lambda(\lambda,t)\cdot S_{uv}(\lambda)\cdot\Delta t\cdot\Delta\lambda \le 30$ J·m^{-2}	Exempt Limit 0.001 / Measured 1.735E-07 Percent of Limit 0.02%	Exempt
	The permissible time for exposure to ultraviolet radiation incident upon the unprotected eye or skin shall be computed by:		
	$t_{max} = \frac{30}{E_S}$ s	E_s Exposure Limit t_{max} = NA, safe at 8 Hr	Exempt
4.3.2	Near-UV hazard exposure limit for the eye	315 nm - 400 nm	
	For the spectral region 315 nm to 400 nm (UV-A) the total radiant exposure to the eye shall not exceed 10000 J·m^{-2} for exposure times less than 1000 s. For exposure times greater than 1000 s (approximately 16 minutes) the UV-A irradiance for the unprotected eye, E_{UVA}, shall not exceed 10 W·m^{-2}. These specifications can be expressed as follows:		
	$E_{UVA}\cdot t = \sum_{315}^{400}\sum_{t} E_\lambda(\lambda,t)\cdot\Delta t\cdot\Delta\lambda \le 10000$ J·m^{-2} (t < 1000 s)	Exempt 10000 / Measured 129 Percent of Limit 1.29%	Exempt
	$E_{UVA} \le 10$ W·m^{-2} (t ≥ 1000 s)	Exempt Limit 10 / Measured 4.312E-03 Percent of Limit 0.04%	Exempt
	The permissible time for exposure to ultraviolet radiation incident upon the unprotected eye for time less than 1000 s, shall be computed by:		
	$t_{max} \le \frac{10000}{E_{UVA}}$ s	E_s Exposure Time Limit t_{max} = safe at 1000 s	Exempt

4.3.3	Retinal blue light hazard exposure limit	300 nm - 700 nm		
	To protect against retinal photochemical injury from chronic blue-light exposure, the integrated spectral radiance of the light source weighted against the blue-light hazard function, B(λ), i.e., the blue-light weighted radiance, L_B, shall not exceed the levels defined by:			
	$L_B \cdot t = \sum_{300}^{700} \sum_{t} L_\lambda(\lambda,t) \cdot B(\lambda) \cdot \Delta t \cdot \Delta\lambda \le 10^6$ J·m^{-2}·sr^{-1} (for t ≤ 10^4 s)	Limit 1.00E+06	Measured 8.04E+07	Non-Exempt
		Percent of Limit:	Limit Exceeded	
	$L_B = \sum_{300}^{700} L_\lambda \cdot B(\lambda) \cdot \Delta\lambda \le 100$ W·m^{-2}·sr^{-1} (for t > 10^4 s)	RG-1 Limit 10000	Measured 8041	Low Risk
		Percent of Limit	80.41%	
	For a weighted source radiance, L_B, exceeding 100 W·m^{-2}·sr^{-1}, the maximum permissible exposure duration, t_{max}, shall be computed:			
	$t_{max} = \frac{10^6}{L_B}$ s (for t ≤ 10^4 s)	L_B Exposure Time Limit t_{max} = 124.4		Time Limit Applicable
4.3.4	Retinal blue light hazard exposure limit - small source	300 nm - 700 nm		
	For a light source subtending an angle less than 0.011 radian, the limits of 4.3.3 lead to a simpler equation based on the spectral irradiance rather than the spectral radiance. Spectral irradiance at the eye E_λ, weighted against the blue-light hazard function B(λ) shall not exceed the levels defined by:	Angle subtended by the source 0.037 radian		Limit Not Applicable
	$E_B \cdot t = \sum_{300}^{700} \sum_{t} E_\lambda(\lambda,t) \cdot B(\lambda) \cdot \Delta t \cdot \Delta\lambda \le 100$ J·m^{-2} (for t ≤ 100 s)			Limit Not Applicable
	$E_B = \sum_{300}^{700} E_\lambda \cdot B(\lambda) \cdot \Delta\lambda \le 1$ W·m^{-2} (for t > 100 s)			Limit Not Applicable
	For a source where the blue light weighted irradiance, E_B, exceeds 0.01 W·m^{-2}, the maximum permissible exposure duration shall be computed:			
	$t_{max} = \frac{100}{E_B}$ s (for t ≤ 100 s)			Limit Not Applicable
4.3.5	Retinal thermal hazard exposure limit	380 nm - 1400 nm		
	To protect against retinal thermal injury, the integrated spectral radiance of the light source, L_λ, weighted by the burn hazard weighting function R(λ), i.e., the burn hazard weighted radiance, shall not exceed the levels defined by:			
	$L_R = \sum_{380}^{1400} L_\lambda \cdot R(\lambda) \cdot \Delta\lambda \le \frac{50000}{\alpha \cdot t^{0.25}}$ W·m^{-2}·sr^{-1} (10 us ≤ t ≤ 10 s)	Exempt 7.49E+05	Measured 3.16E+04	Exempt
		Percent of Limit	4.21%	

4.3.6	Retinal thermal hazard exposure limit - weak visual stimulus			
	For an infrared heat lamp or any near-infrared source where a weak visual stimulus is inadequate to activate the aversion response, the near infrared (780 nm to 1400 nm) radiance, L_{IR}, as viewed by the eye for exposure times greater than 10 s shall be limited to:			
	$L_{IR} = \sum_{780}^{1400} L_\lambda \cdot R(\lambda) \cdot \Delta\lambda \le \frac{6000}{\alpha}$ W·m^{-2}·sr^{-1} (t > 10 s)	Exempt 1.61E+05	Measured 1.50E+01	Exempt
		Percent of Limit	0.01%	
4.3.7	Infrared radiation hazard exposure limits for the eye	780 nm to 3000 nm		
	To avoid thermal injury of the cornea and possible delayed effects upon the lens of the eye (cataractogenesis), ocular exposure to infrared radiation, E_{IR}, over the wavelength range 780 nm to 3000 nm, for times less than 1000 s, shall not exceed:			
	$E_{IR} = \sum_{780}^{3000} E_\lambda \cdot \Delta\lambda \le 18000 \cdot t^{-0.75}$ W·m^{-2} (t ≤ 1000 s)	Limit 1.01E+02	Measured 3.445E-02	Exempt
		Percent of Limit	0.03%	
	For times greater than 1000 s the limit becomes:			
	$E_{IR} = \sum_{780}^{3000} E_\lambda \cdot \Delta\lambda \le 100$ W·m^{-2} (t > 1000 s)	Exempt Limit 100	Measured 3.445E-02	Exempt
		Percent of Limit	0.03%	
4.3.8	Thermal hazard exposure limit for the skin			
	Visible and infrared radiant exposure (380 nm to 3000 nm) of the skin shall be limited to:			
	$E_H \cdot t = \sum_{380}^{3000} \sum_t E_\lambda(\lambda, t) \cdot \Delta t \cdot \Delta\lambda \le 20000 \cdot t^{0.25}$ n^{-2} (t ≤ 10 s)	Limit 11247	Measured 42.148	Exempt
		Percent of Limit	0.37%	

SECTION	REQUIREMENT	REMARK	RATING
5	MEASUREMENT OF LAMPS AND LAMP SYSTEMS		
5.1	Measurement conditions		
	Measurement conditions reported as part of the evaluation against the exposure limits and the assignment of risk classification.		**PASS**
5.1.1	Lamp aging (seasoning)		
	Seasoning of lamps shall be done as stated in the appropriate IEC Lamp Standard.		**PASS**
5.1.2	Test environment		
	Specific test conditions referenced via the appropriate IEC lamp standard or in the absence of such standards, the appropriate national standards or manufacturer's recommendations.	Manufacturer specified.	**PASS**
5.1.3	Extraneous radiation		
	Careful checks made to ensure that extraneous sources of radiation and reflections do not add significantly to the measurement result.		**PASS**

5.1.4	Lamp operation		RATING
	Operation of the test lamp shall be provided in accordance with: - the appropriate IEC lamp standard, or - the manufacturer's recommendation	Measured per manufacturer's recommendations.	**PASS**
5.1.5	Lamp system operation		
	The power source for operation of the test lamp shall be provided in accordance with: - the appropriate IEC standard, or - the manufacturer's recommendation	Measured per manufacturer's recommendations.	**PASS**
5	Measurement procedure		
5.2.1	Irradiance measurements		
	- The minimum input aperture diameter shall be 7 mm. - The maximum input aperture diameter shall be 50 mm. - The measurement was made in that position of the beam giving the maximum reading. - The measurement of irradiance was calibrated to read in absolute incident radiant power per unit receiving area.	Aperture used is compliant Aperture used is compliant See Irradiance vs angle (pg 12) See Equipment (pg 13)	**PASS** **PASS** **PASS** **PASS**
5.2.2	Radiance measurements		
5.2.2.1	Standard method		
	The measurements were made with an optical system. The instrument shall be calibrated to read in absolute radiant power per unit receiving area and per unit solid angle to acceptance averaged over the field of view of the instrument.	Alternate method used (5.2.2.2) Requirement not applicable for this product	**NA**
5.2.2.2	Alternative method		
	Alternatively to an imaging radiance set-up, an irradiance measurement set-up with a circular field stop placed at the source can be used to perform radiance measurements.		**PASS**
5.2.3	Measurements of source size		
	The determination of α, the angle subtended by a source, was made by determining the 50% emission points of the source.		**PASS**
5.2.4	Pulse width measurements for pulsed sources		
	The determination of Δt, the minimal pulse duration of a source, was made by determining the time duration at which the emission is > 50% of its peak value.	Product measured with direct current. Requirement not applicable for this product.	**NA**
5.3	Analysis method		
5.3.1	Weighting curve interpolations		
	To standardize interpolated values, linear interpolation on the log of given values was used to obtain intermediate points at the wavelength intervals desired.	Spectrum measured at sub-nm interval, and interpolated to 1.0 nm interval.	**PASS**
5.3.2	Calculations		
	The calculation of source hazard values was performed by weighting the spectral scan by the appropriate function and calculating the total weighted energy.		**PASS**
5.3.3	Measurement uncertainty		
	The quality of all measurement results are quantified by an analysis of the uncertainty.		**PASS**

6	LAMP CLASSIFICATION		
	For the purposes of this standard, classification of this product shall be determined by one of the following criteria.		
	- Lamps intended for general lighting service (GLS), the hazard values shall be reported as either irradiance or radiance values at a distance which produces an Illuminance of 500 lux, but not at a distance less than 200 mm		**NA**
	- For all other light sources, including pulsed lamp sources, the hazard values shall be reported at a distance of 200 mm	Non GLS source, hazard values reported at 200 mm.	**PASS**
6.1	Continuous wave lamps		
6.1.1	Exempt Group		
	Classification is that the lamp does not pose any photobiological hazard for the end points in this standard. This requirement is met by any lamp that does not pose:		
	- an actinic ultraviolet hazard (E_S) within 8-hours exposure (30000 s), nor		**PASS**
	- a near-UV hazard (E_{UVA}) within 1000 s (about 16 min), nor		**PASS**
	- a retinal blue-light hazard (L_B) within 10000 s (about 2.8 h), nor		**FAIL**
	- a retinal thermal hazard (L_R) within 10 s, nor		**PASS**
	- an infrared radiation hazard for the eye (E_{IR}) within 1000 s.		**PASS**
	These lamps are in the Exempt Group		
	Also, lamps that emit infrared radiation without a strong visual stimulus (i.e., less than 10 $cd \cdot m^{-2}$) and do not pose a near-infrared retinal hazard (L_{IR}) within 1000 s are in the Exempt Group.		**PASS**
6.1.2	Risk Group 1 (Low-Risk)		
	The philosophical basis for this classification is that the lamp does not pose a hazard due to normal behavioral limitations on exposure. This requirement is met by any lamp that exceeds the limits for the Exempt Group but that does not pose:		
	- an actinic ultraviolet hazard (E_S) within 10000 s, nor		**PASS**
	- a near ultraviolet hazard (E_{UVA}) within 300 s, nor		**PASS**
	- a retinal blue-light hazard (L_B) within 100 s, nor		**PASS**
	- a retinal thermal hazard (L_R) within 10 s, nor		**PASS**
	- an infrared radiation hazard for the eye (E_{IR}) within 100 s.		**PASS**
	These lamps are in Risk Group 1 (Low-Risk)		
	Also, Lamps that emit infrared radiation without a strong visual stimulus (i.e., less than 10 $cd \cdot m^{-2}$) and do not pose a near-infrared retinal hazard (L_{IR}) within 100 s are in Risk Group 1 (Low-Risk).		**PASS**
6.1.3	Risk Group 2 (Moderate-Risk)		
	The Philosophical basis for the Risk Group 2 (Moderate-Risk) classification is that the lamp does not pose a hazard due to the aversion response to very bright light sources or due to thermal discomfort. This requirement is met by any lamp that exceeds the limits for Risk Group 1 (Low-Risk), but that dose not pose:		
	- an actinic ultraviolet hazard (E_S) within 1000 s exposure, nor		**PASS**
	- a near ultraviolet hazard (E_{UVA}) within 100 s, nor		**PASS**
	- a retinal blue-light hazard (L_B) within 0.25 s (aversion response) nor		**PASS**
	- an infrared radiation hazard for the eye (E_{IR}) within 10 s.		**PASS**

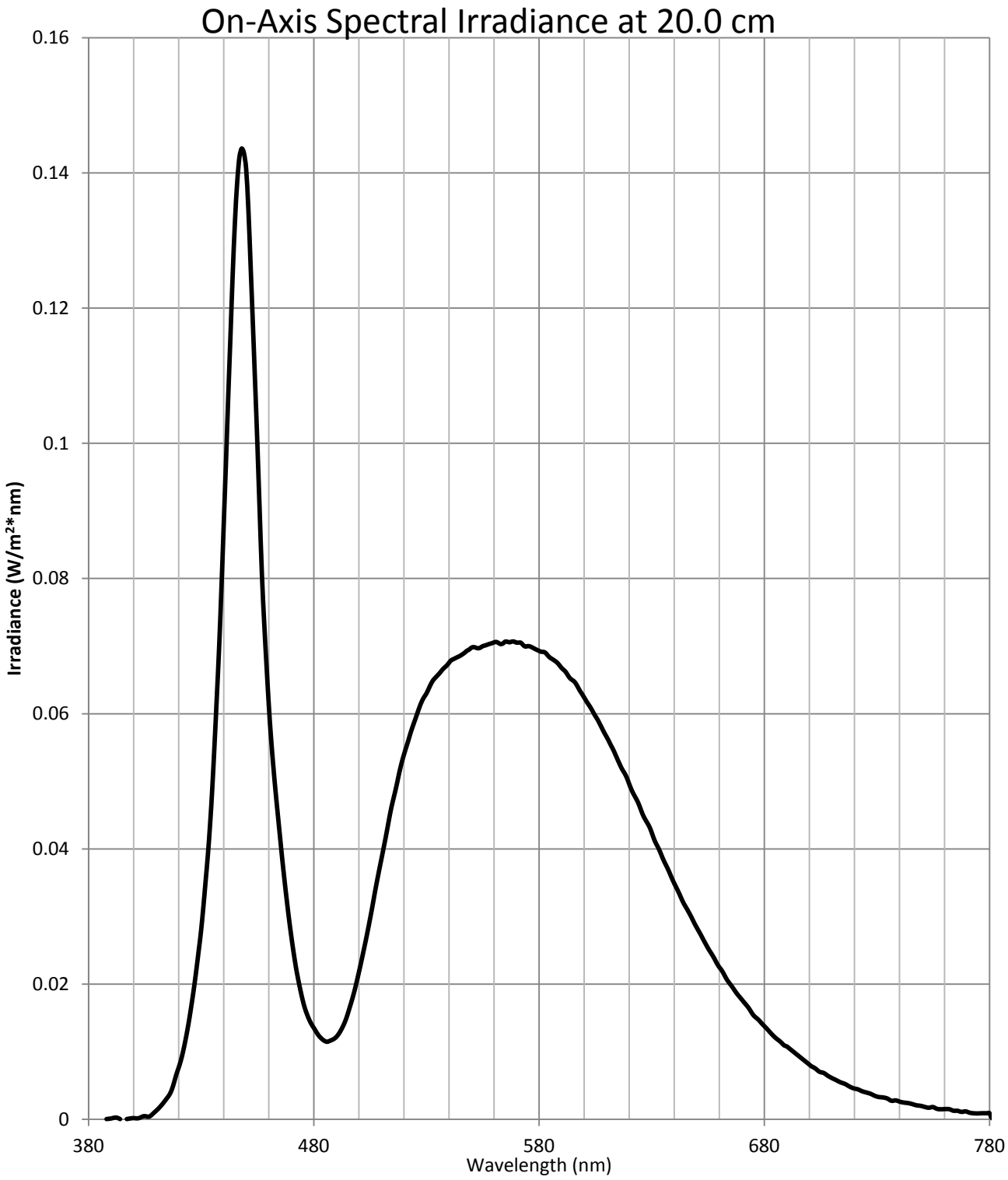
	- a retinal thermal hazard (L_R) within 0.25 s (aversion response), nor Such lamps are in Risk Group 2 (Moderate-Risk).		PASS
	Also, lamps that emit infrared radiation without a strong visual stimulus (i.e., less than 10 $cd \cdot m^{-2}$) and do not pose a near infrared retinal hazard (L_{IR}) within 10 s are in Risk Group 2 (Moderate-Risk).		PASS
6.1.4	Risk Group 3 (High-Risk)		
	The philosophical basis for this classification is that the lamp may pose a hazard even for momentary or brief exposure. Lamps which exceed the limits for Risk Group 2 (Moderate-Risk) are in Risk Group 3 (High-Risk).		PASS
6.2	Pulsed lamps		
	Pulsed lamp criteria shall apply to a single pulse and to any group of pulses within 0.25 second.		PASS
	A pulsed lamp shall be evaluated at the highest nominal energy loading as specified by the manufacturer.		PASS
	The relevant weighted radiant exposure, (H or E·t), or time-integrated weighted radiance dose, (L·t), for each pulse shall be obtained by integration of the weighted irradiance or radiance emitted from the source over the full pulse width, with the integration time limited to a maximum of 0.25 s. The weighted radiant exposure or weighted radiance dose calculated shall be compared to the exposure limits (ELs) given in section 4.3 for each of the photobiological hazards evaluated.		
	Note: The weighted radiance values obtained shall be averaged over a right circular cone field of view of 0.0017 radian included angle as discussed in section 4.2.2.		
	The risk group determination of the lamp being tested shall be made as follows:		
	- A lamp that exceeds the exposure limit shall be classified as belonging to Risk Group 3 (High-Risk). - For single pulsed lamps, a lamp whose weighted radiant exposure or weighted radiance dose is below the EL shall be classified as belonging to the Exempt Group. - For repetitively pulsed lamps, a lamp whose weighted radiant exposure or weighted radiance dose is below the EL, shall be evaluated using the continuous wave risk criteria discussed in section 6.1, using time averaged values of the pulsed emission.		PASS PASS PASS

Table 1 Emission Limits for risk groups of continuous wave lamps
α= 37.37 mrad

Risk	Action spectrum	Symbol	Units	Emission Measurement					
				Exempt		Low Risk		Mod Risk	
				Limit	Result	Limit	Result	Limit	Result
Actinic UV	$S_{UV}(\lambda)$	E_S	$W \cdot m^{-2}$	0.001	0.000	0.003		0.03	
Near UV		E_{UVA}	$W \cdot m^{-2}$	10	0.004	33		100	
Blue light	B(λ)	L_B	$W \cdot m^{-2} \cdot sr^{-1}$	100		10000	8041	4000000	
Blue light small source	B(λ)	E_B	$W \cdot m^{-2}$	1		1		400	
Retinal thermal	R(λ)	L_R	$W \cdot m^{-2} \cdot sr^{-1}$	28000/α	31561	28000/α		71000/α	
Retinal thermal weak visual stimulus**	R(λ)	L_{IR}	$W \cdot m^{-2} \cdot sr^{-1}$	6000/α	15.02	6000/α		6000/α	
IR radiation, eye		E_{IR}	$W \cdot m^{-2}$	100	0.03	570		3200	

Table 2 Exposure Limits continuous wave lamps

Risk	Action spectrum	Symbol	Units	Exposure Limit in Seconds					
				Exempt		Low Risk		Mod Risk	
				Limit	Result	Limit	Result	Limit	Result
Actinic UV	$S_{UV}(\lambda)$	E_S	$W \cdot m^{-2}$	30000	> Limit	10000		1000	
Near UV		E_{UVA}	$W \cdot m^{-2}$	1000	> Limit	300		100	
Blue light	B(λ)	L_B	$W \cdot m^{-2} \cdot sr^{-1}$	10000		100	124.4	0.25	
Retinal thermal	R(λ)	L_R	$W \cdot m^{-2} \cdot sr^{-1}$	10	> Limit	10		0.25	
IR radiation, eye		E_{IR}	$W \cdot m^{-2}$	1000	> Limit	100		10	



NOTE: Spectradiometer used to measure broadband spectrum. Calibrated radiometers used to check spectra beyond the limits of the spectraradiometer for assessment of each risk group.

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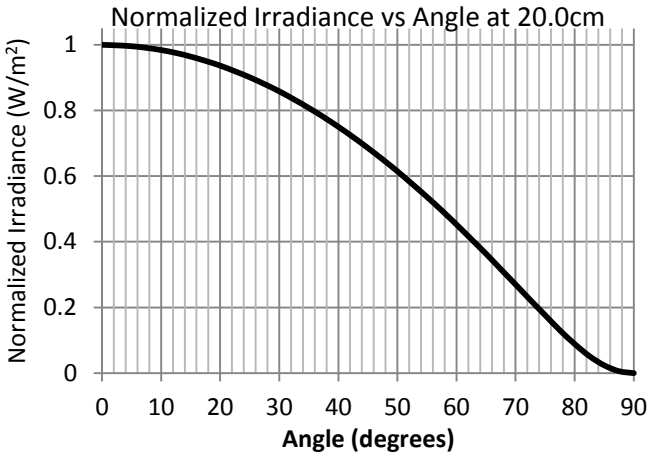
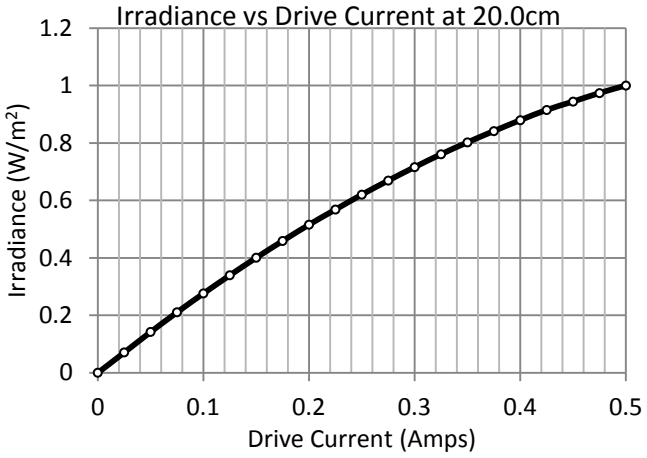
IRRADIANCE VS ANGLE



TEST DESCRIPTION
The product under evaluation is swept angular to locate the angle of peak Irradiance.

TEST RESULT
The location of peak Irradiance was found on-axis to the device under test.

IRRADIANCE VS DRIVE CURRENT

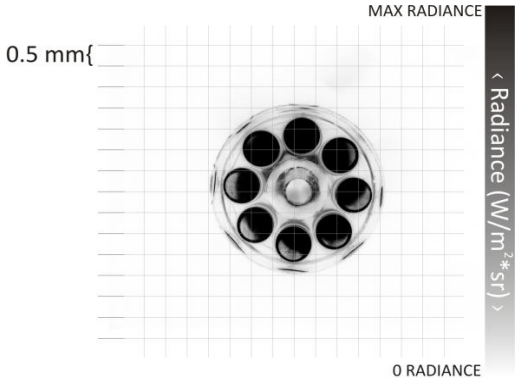


TEST DESCRIPTION
The product under evaluation is swept through a series of drive currents while actively holding case temperature to 25.0°C.

TEST RESULT
Test confirms that the manufacturers maximum rated current for the part provides maximum flux.

PEAK IRRADIANCE	48.45	W/m^2
DRIVE CURRENT	0.500	A

REFERENCE PHOTOGRAPH



Calibrated Image shown with scale reference

Sample Report package as tested

LIST OF TEST EQUIPMENT LIST

DESCRIPTION	MANUFACTURER	MAKE	SN	NEXT CAL DATE
Spectradiometer	Orb Optronix	SP-100	2908028	9/1/2012
Spectradiometer	Orb Optronix	SP-200	2009063	9/1/2012
Thermal controller	Ferrotec	FTC-100	090330-0009	Not Applicable
DC Power Supply	Keithley	2425	1186074	8/9/2013
Radiometer	International Light	ILT1700	IL17005244	3/15/2013
Radiometer Detector Head	International Light	SED033	8898	3/15/2013

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