



<b>TEST REPORT</b> <b>IEC 62471</b> <b>Photobiological safety of lamps and lamp systems</b>	
<b>Report Reference No.</b> .....	Dialight Optics Lab Request #16119
Date of issue .....	9/22/2016
Total number of pages .....	15 pages plus one attachment
<b>CB Testing Laboratory</b> .....	Dialight Optics Lab
Address.....	1501 Route 34 South Farmingdale, NJ 07727 USA
<b>Applicant's name</b> .....	Dialight
Address.....	1501 Route 34 South Farmingdale, NJ 07727 USA
<b>Test specification:</b>	
Standard .....	IEC 62471:2006 (First Edition)
Test procedure .....	N/A
Non-standard test method.....	Dialight Internal Test 62471:2008
<b>Test Report Form No.</b> .....	IEC62471A
TRF Originator.....	VDE Testing and Certification Institute
Master TRF .....	Dated 2009-05
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<b>This report is not valid as a CB Test Report unless signed by an approved CB Testing Laboratory and appended to a CB Test Certificate issued by an NCB in accordance with IECEE 02.</b>	
<b>Test item description</b> .....	Stainless 4ft linear LED light with battery backup
Trade Mark.....	Dialight
Manufacturer .....	Dialight
Model/Type reference .....	ELEA-2C4R-SSCB
Ratings.....	100-277VAC, 70Watt

Testing procedure and testing location:	
<input type="checkbox"/> <b>CB Testing Laboratory:</b>	Dialight Optics lab
Testing location/ address .....	1501 Route 34 South Farmingdale, NJ 07727 USA
<input type="checkbox"/> <b>Associated CB Laboratory:</b>	
Testing location/ address .....	
Tested by (name + signature) .....	Yinan Zhang <i>Yinan Zhang</i>
Approved by (+ signature) .....	Vishnu Shastry <i>Chakrabarti Sa</i>
<input type="checkbox"/> Testing procedure: TMP	
Tested by (name + signature) .....	
Approved by (+ signature) .....	
Testing location/ address .....	
<input type="checkbox"/> Testing procedure: WMT	
Tested by (name + signature) .....	
Witnessed by (+ signature) .....	
Approved by (+ signature) .....	
Testing location/ address .....	
<input type="checkbox"/> Testing procedure: SMT	
Tested by (name + signature) .....	
Approved by (+ signature) .....	
Supervised by (+ signature) .....	
Testing location/ address .....	
<input type="checkbox"/> Testing procedure: RMT	
Tested by (name + signature) .....	
Approved by (+ signature) .....	
Supervised by (+ signature) .....	
Testing location/ address .....	

**Summary of testing:****Tests performed (name of test and test clause):**

Measurement of irradiance, spectrum, and radiance as prescribed by BS:EN 62471:2008.

4.2.2 Angular subtense of source and measurement field-of-view

5.2.2. Radiance Measurements

5.2.2.2 Alternative method

5.3 Analysis Method

6.1 Continuous Wave lamps- Lamp classification

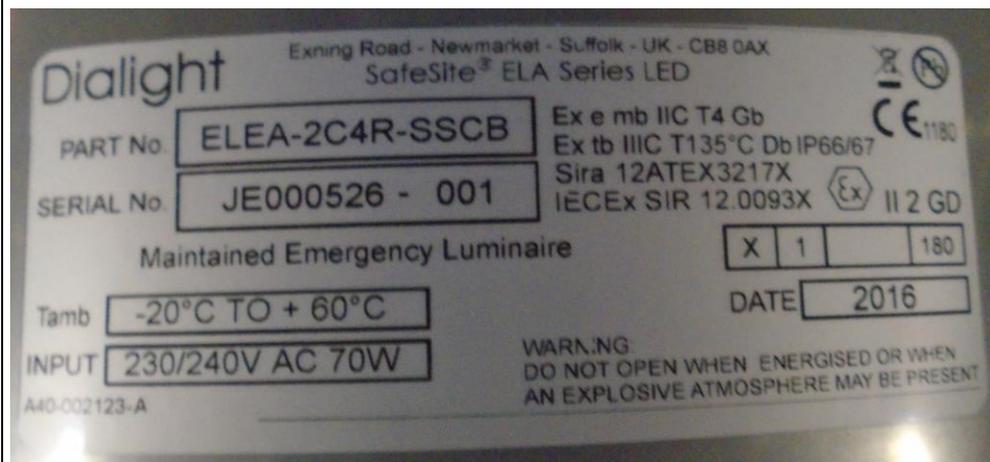
Table 6.1

**Testing location:**

Dialight Optics Lab  
1501 Route 34 South  
Farmingdale, NJ 07727 USA

**Summary of compliance with National Differences:**

N/A

**Copy of marking plate:**

**Test item particulars**..... :

Tested lamp ..... :  continuous wave lamps       pulsed lamps

Tested lamp system..... :

Lamp classification group ..... :  exempt       risk 1       risk 2       risk 3

Lamp cap ..... :

Bulb ..... :

Rated of the lamp ..... : 70 W, 100-277 VAC

Furthermore marking on the lamp..... : See Photos

Seasoning of lamps according IEC standard ..... : N/A

Used measurement instrument ..... : Ocean Optics USB 2000 Spectrometer  
FOIS-1 Fiber Optics Integrating Sphere  
Hoffman Type B goniometer  
Steel Rule

Temperature by measurement ..... : 25±1 °C

Information for safety use ..... : N/A

**Possible test case verdicts:**

- test case does not apply to the test object ..... : N/A
- test object does meet the requirement ..... : P (Pass)
- test object does not meet the requirement ..... : F (Fail)

**Testing:**

Date of receipt of test item..... : 8/24/2016

Date (s) of performance of tests ..... : 9/23/2016

**General remarks:**

The test results presented in this report relate only to the object tested.  
 This report shall not be reproduced, except in full, without the written approval of the Issuing testing laboratory.  
 "(See Enclosure #)" refers to additional information appended to the report.  
 "(See appended table)" refers to a table appended to the report.  
 Throughout this report a comma (point) is used as the decimal separator.  
 List of test equipment must be kept on file and available for review.

**General product information:**

This area light is a general LED light source. The light is rated for 100-277V, 50-60 Hz. The tests were performed at 120V.



IEC 62471			
Clause	Requirement + Test	Result – Remark	Verdict
<b>4</b>	<b>EXPOSURE LIMITS</b>		
4.1	General		
	The exposure limits in this standard 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		P
	Detailed spectral data of a light source are generally required only if the luminance of the source exceeds $10^4 \text{ cd}\cdot\text{m}^{-2}$	see clause 4.3	P
4.3	Hazard exposure limits		
4.3.1	Actinic UV hazard exposure limit for the skin and eye		
	The exposure limit for effective radiant exposure is $30 \text{ J}\cdot\text{m}^{-2}$ within any 8-hour period		P
	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:		P
	$E_s \cdot t = \sum_{200}^{400} \sum_t E_\lambda(\lambda, t) \cdot S_{UV}(\lambda) \cdot \Delta t \cdot \Delta \lambda \leq 30 \quad \text{J}\cdot\text{m}^{-2}$		P
	The permissible time for exposure to ultraviolet radiation incident upon the unprotected eye or skin shall be computed by:		P
	$t_{\max} = \frac{30}{E_s} \quad \text{s}$		P
4.3.2	Near-UV hazard exposure limit for eye		
	For the spectral region 315 nm to 400 nm (UV-A) the total radiant exposure to the eye shall not exceed $10000 \text{ J}\cdot\text{m}^{-2}$ 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 $10 \text{ W}\cdot\text{m}^{-2}$ .		P
	The permissible time for exposure to ultraviolet radiation incident upon the unprotected eye for time less than 1000 s, shall be computed by:		P
	$t_{\max} \leq \frac{10\,000}{E_{UVA}} \quad \text{s}$		P
4.3.3	Retinal blue light hazard exposure limit		
	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, $B(\lambda)$ , i.e., the blue-light weighted radiance, $L_B$ , shall not exceed the levels defined by:		P
	$L_B \cdot t = \sum_{300}^{700} \sum_t L_\lambda(\lambda, t) \cdot B(\lambda) \cdot \Delta t \cdot \Delta \lambda \leq 10^6 \quad \text{J} \cdot \text{m}^{-2} \cdot \text{sr}^{-1}$	for $t \leq 10^4 \text{ s}$ $t_{\max} = \frac{10^6}{L_B}$	P

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Clause	Requirement + Test	Result – Remark	Verdict
	$L_B = \sum_{300}^{700} L_\lambda \cdot B(\lambda) \cdot \Delta\lambda \leq 100 \quad W \cdot m^{-2} \cdot sr^{-1}$	for $t > 10^4$ s	P
4.3.4	Retinal blue light hazard exposure limit - small source		
	Thus the spectral irradiance at the eye $E_\lambda$ , weighted against the blue-light hazard function $B(\lambda)$ shall not exceed the levels defined by:	see table 4.2	N/A
	$E_B \cdot t = \sum_{300}^{700} \sum_t E_\lambda(\lambda, t) \cdot B(\lambda) \cdot \Delta\lambda \leq 100 \quad J \cdot m^{-2}$	for $t \leq 100$ s	N/A
	$E_B = \sum_{300}^{700} E_\lambda \cdot B(\lambda) \cdot \Delta\lambda \leq 1 \quad W \cdot m^{-2}$	for $t > 100$ s	N/A
4.3.5	Retinal thermal hazard exposure limit		
	To protect against retinal thermal injury, the integrated spectral radiance of the light source, $L_\lambda$ , weighted by the burn hazard weighting function $R(\lambda)$ (from Figure 4.2 and Table 4.2), i.e., the burn hazard weighted radiance, shall not exceed the levels defined by:		P
	$L_R = \sum_{380}^{1400} L_\lambda \cdot R(\lambda) \cdot \Delta\lambda \leq \frac{50\,000}{\alpha \cdot t^{0,25}} \quad W \cdot m^{-2} \cdot sr^{-1}$	( $10 \mu s \leq t \leq 10$ s)	P
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:		P
	$L_{IR} = \sum_{780}^{1400} L_\lambda \cdot R(\lambda) \cdot \Delta\lambda \leq \frac{6\,000}{\alpha} \quad W \cdot m^{-2} \cdot sr^{-1}$	$t > 10$ s	P
4.3.7	Infrared radiation hazard exposure limits for the eye		
	The 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:		P
	$E_{IR} = \sum_{780}^{3000} E_\lambda \cdot \Delta\lambda \leq 18\,000 \cdot t^{-0,75} \quad W \cdot m^{-2}$	$t \leq 1000$ s	P
	For times greater than 1000 s the limit becomes:		N/A
	$E_{IR} = \sum_{780}^{3000} E_\lambda \cdot \Delta\lambda \leq 100 \quad W \cdot m^{-2}$	$t > 1000$ s	N/A
4.3.8	Thermal hazard exposure limit for the skin		

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Clause	Requirement + Test	Result – Remark	Verdict
	Visible and infrared radiant exposure (380 nm to 3000 nm) of the skin shall be limited to:		P
	$E_{H \cdot t} = \sum_{380}^{3000} \sum_t E_{\lambda}(\lambda, t) \cdot \Delta t \cdot \Delta \lambda \leq 20\,000 \cdot t^{0,25} \quad \text{J} \cdot \text{m}^{-2}$		P
<b>5</b>	<b>MEASUREMENT OF LAMPS AND LAMP SYSTEMS</b>		
5.1	Measurement conditions		
	Measurement conditions shall be reported as part of the evaluation against the exposure limits and the assignment of risk classification.		N/A
5.1.1	Lamp ageing (seasoning)		
	Seasoning of lamps shall be done as stated in the appropriate IEC lamp standard.		N/A
5.1.2	Test environment		
	For specific test conditions, see the appropriate IEC lamp standard or in absence of such standards, the appropriate national standards or manufacturer's recommendations.		N/A
5.1.3	Extraneous radiation		
	Careful checks should be made to ensure that extraneous sources of radiation and reflections do not add significantly to the measurement results.		P
5.1.4	Lamp operation		
	Operation of the test lamp shall be provided in accordance with:		P
	– the appropriate IEC lamp standard, or		N/A
	– the manufacturer's recommendation		P
5.1.5	Lamp system operation		
	The power source for operation of the test lamp shall be provided in accordance with:		P
	– the appropriate IEC standard, or		N/A
	– the manufacturer's recommendation		P
5.2	Measurement procedure		
5.2.1	Irradiance measurements		
	Minimum aperture diameter 7mm.		P
	Maximum aperture diameter 50 mm.		P
	The measurement shall be made in that position of the beam giving the maximum reading.		P
	The measurement instrument is adequate calibrated.		P
5.2.2	Radiance measurements	Radiance measurements were derived from the irradiance	P

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Clause	Requirement + Test	Result – Remark	Verdict
5.2.2.1	Standard method		N/A
	The measurements made with an optical system.		N/A
	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.		N/A
5.2.2.2	Alternative method		P
	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.		P
5.2.3	Measurement of source size		
	The determination of $\alpha$ , the angle subtended by a source, requires the determination of the 50% emission points of the source.	The source size and distance were measured with the steel rule.	P
5.2.4	Pulse width measurement for pulsed sources		
	The determination of $\Delta t$ , the nominal pulse duration of a source, requires the determination of the time during which the emission is > 50% of its peak value.		N/A
5.3	Analysis methods		
5.3.1	Weighting curve interpolations		
	To standardize interpolated values, use linear interpolation on the log of given values to obtain intermediate points at the wavelength intervals desired.	see table 4.1	P
5.3.2	Calculations		
	The calculation of source hazard values shall be performed by weighting the spectral scan by the appropriate function and calculating the total weighted energy.		P
5.3.3	Measurement uncertainty		
	The quality of all measurement results must be quantified by an analysis of the uncertainty.	see Annex C in the norm	P
<b>6</b>	<b>LAMP CLASSIFICATION</b>		
	For the purposes of this standard it was decided that the values shall be reported as follows:	see table 6.1	
	– for lamps intended for general lighting service, 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	500 lux is at 3.502m	N/A
	– for all other light sources, including pulsed lamp sources, the hazard values shall be reported at a distance of 200 mm	Device is a GLS	P

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Clause	Requirement + Test	Result – Remark	Verdict
6.1	Continuous wave lamps		
6.1.1	Exempt Group		N/A
	In the except group are lamps, which does not pose any photobiological hazard. The requirement is met by any lamp that does not pose:		
	– an actinic ultraviolet hazard ( $E_S$ ) within 8-hours exposure (30000 s), nor		N/A
	– a near-UV hazard ( $E_{UVA}$ ) within 1000 s, (about 16 min), nor		N/A
	– a retinal blue-light hazard ( $L_B$ ) within 10000 s (about 2,8 h), nor	Permissible Exposure Time <10000 seconds. See Table 6.1	P
	– a retinal thermal hazard ( $L_R$ ) within 10 s, nor	Permissible Exposure Time > 10 seconds. See Table 6.1	P
	– an infrared radiation hazard for the eye ( $E_R$ ) within 1000 s		N/A
6.1.2	Risk Group 1 (Low-Risk)		
	In this group are lamps, which exceeds the limits for the except group but that does not pose:		
	– an actinic ultraviolet hazard ( $E_S$ ) within 10000 s, nor	Exempt group	N/A
	– a near ultraviolet hazard ( $E_{UVA}$ ) within 300 s, nor	Exempt group	N/A
	– a retinal blue-light hazard ( $L_B$ ) within 100 s, nor	10000 seconds >Permissible Exposure Time >100 seconds. See Table 6.1	P
	– a retinal thermal hazard ( $L_R$ ) within 10 s, nor	Exempt group	N/A
	– an infrared radiation hazard for the eye ( $E_R$ ) within 100 s	Exempt group	N/A
	Lamps that emit infrared radiation without a strong visual stimulus and do not pose a near-infrared retinal hazard ( $L_R$ ), within 100 s are in Risk Group 1.		N/A
6.1.3	Risk Group 2 (Moderate-Risk)		
	This requirement is met by any lamp that exceeds the limits for Risk Group 1, but that does not pose:		N/A
	– an actinic ultraviolet hazard ( $E_S$ ) within 1000 s exposure, nor		N/A
	– a near ultraviolet hazard ( $E_{UVA}$ ) within 100 s, nor		N/A
	– a retinal blue-light hazard ( $L_B$ ) within 0,25 s (aversion response), nor		N/A
	– a retinal thermal hazard ( $L_R$ ) within 0,25 s (aversion response), nor		N/A
	– an infrared radiation hazard for the eye ( $E_R$ ) within 10 s		N/A

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Clause	Requirement + Test	Result – Remark	Verdict
	Lamps that emit infrared radiation without a strong visual stimulus and do not pose a near-infrared retinal hazard ( $L_{IR}$ ), within 10 s are in Risk Group 2.		N/A
6.1.4	Risk Group 3 (High-Risk)		
	Lamps which exceed the limits for Risk Group 2 are in Group 3.		N/A
6.2	Pulsed lamps		
	Pulse lamp criteria shall apply to a single pulse and to any group of pulses within 0,25 s.		N/A
	A pulsed lamp shall be evaluated at the highest nominal energy loading as specified by the manufacturer.		N/A
	The risk group determination of the lamp being tested shall be made as follows:		N/A
	– a lamp that exceeds the exposure limit shall be classified as belonging to Risk Group 3 (High-Risk)		N/A
	– for single pulsed lamps, a lamp whose weighted radiant exposure or weighted radiance does is below the EL shall be classified as belonging to the Exempt Group		N/A
	– 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 clause 6.1, using time averaged values of the pulsed emission		N/A

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Clause	Requirement + Test	Result – Remark	Verdict

Table 4.1		Spectral weighting function for assessing ultraviolet hazards for skin and eye	
Wavelength <sup>1</sup> $\lambda$ , nm	UV hazard function $S_{uv}(\lambda)$	Wavelength $\lambda$ , nm	UV hazard function $S_{uv}(\lambda)$
200	0,030	313*	0,006
205	0,051	315	0,003
210	0,075	316	0,0024
215	0,095	317	0,0020
220	0,120	318	0,0016
225	0,150	319	0,0012
230	0,190	320	0,0010
235	0,240	322	0,00067
240	0,300	323	0,00054
245	0,360	325	0,00050
250	0,430	328	0,00044
254*	0,500	330	0,00041
255	0,520	333*	0,00037
260	0,650	335	0,00034
265	0,810	340	0,00028
270	1,000	345	0,00024
275	0,960	350	0,00020
280*	0,880	355	0,00016
285	0,770	360	0,00013
290	0,640	365*	0,00011
295	0,540	370	0,000093
297*	0,460	375	0,000077
300	0,300	380	0,000064
303*	0,120	385	0,000053
305	0,060	390	0,000044
308	0,026	395	0,000036
310	0,015	400	0,000030

<sup>1</sup> Wavelengths chosen are representative: other values should be obtained by logarithmic interpolation at intermediate wavelengths.

\* Emission lines of a mercury discharge spectrum.

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Clause	Requirement + Test	Result – Remark	Verdict

Table 4.2		Spectral weighting functions for assessing retinal hazards from broadband optical sources	
Wavelength nm	Blue-light hazard function B ( $\lambda$ )	Burn hazard function R ( $\lambda$ )	
300	0,01		
305	0,01		
310	0,01		
315	0,01		
320	0,01		
325	0,01		
330	0,01		
335	0,01		
340	0,01		
345	0,01		
350	0,01		
355	0,01		
360	0,01		
365	0,01		
370	0,01		
375	0,01		
380	0,01		0,1
385	0,013		0,13
390	0,025		0,25
395	0,05		0,5
400	0,10		1,0
405	0,20		2,0
410	0,40		4,0
415	0,80		8,0
420	0,90		9,0
425	0,95		9,5
430	0,98		9,8
435	1,00		10,0
440	1,00		10,0
445	0,97		9,7
450	0,94		9,4
455	0,90		9,0
460	0,80		8,0
465	0,70		7,0
470	0,62		6,2
475	0,55		5,5
480	0,45		4,5
485	0,40		4,0
490	0,22		2,2
495	0,16		1,6
500-600	$10^{[(450-\lambda)/50]}$		1,0
600-700	0,001		1,0
700-1050			$10^{[(700-\lambda)/500]}$
1050-1150			0,2
1150-1200			$0,2 \cdot 10^{0,02(1150-\lambda)}$
1200-1400			0,02

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Clause	Requirement + Test	Result – Remark	Verdict

Table 5.4 Summary of the ELs for the surface of the skin or cornea (irradiance based values)					
Hazard Name	Relevant equation	Wavelength range nm	Exposure duration sec	Limiting aperture rad (deg)	EL in terms of constant irradiance $W \cdot m^{-2}$
Actinic UV skin & eye	$E_S = \sum E_\lambda \cdot S(\lambda) \cdot \Delta\lambda$	200 – 400	< 30000	1,4 (80)	30/t
Eye UV-A	$E_{UVA} = \sum E_\lambda \cdot \Delta\lambda$	315 – 400	$\leq 1000$ $> 1000$	1,4 (80)	10000/t 10
Blue-light small source	$E_B = \sum E_\lambda \cdot B(\lambda) \cdot \Delta\lambda$	300 – 700	$\leq 100$ $> 100$	< 0,011	100/t 1,0
Eye IR	$E_{IR} = \sum E_\lambda \cdot \Delta\lambda$	780 – 3000	$\leq 1000$ $> 1000$	1,4 (80)	18000/t <sup>0,75</sup> 100
Skin thermal	$E_H = \sum E_\lambda \cdot \Delta\lambda$	380 – 3000	< 10	2π sr	20000/t <sup>0,75</sup>

Table 5.5 Summary of the ELs for the retina (radiance based values)					
Hazard Name	Relevant equation	Wavelength range nm	Exposure duration sec	Field of view radians	EL in terms of constant radiance $W \cdot m^{-2} \cdot sr^{-1}$
Blue light	$L_B = \sum L_\lambda \cdot B(\lambda) \cdot \Delta\lambda$	300 – 700	0,25 – 10 10-100 100-10000 $\geq 10000$	$0,011 \cdot \sqrt{(t/10)}$ 0,011 $0,0011 \cdot \sqrt{t}$ 0,1	$10^6/t$ $10^6/t$ $10^6/t$ 100
Retinal thermal	$L_R = \sum L_\lambda \cdot R(\lambda) \cdot \Delta\lambda$	380 – 1400	< 0,25 0,25 – 10	0,0017 $0,011 \cdot \sqrt{(t/10)}$	$50000/(\alpha \cdot t^{0,25})$ $50000/(\alpha \cdot t^{0,25})$
Retinal thermal (weak visual stimulus)	$L_{IR} = \sum L_\lambda \cdot R(\lambda) \cdot \Delta\lambda$	780 – 1400	> 10	0,011	6000/α

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Clause	Requirement + Test	Result – Remark	Verdict

Table 6.1		Emission limits for risk groups of continuous wave lamps							
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	N/A	0,003	N/A	0,03	N/A
Near UV		$E_{UVA}$	$W \cdot m^{-2}$	10	N/A	33	N/A	100	N/A
Blue light	$B(\lambda)$	$L_B$	$W \cdot m^{-2} \cdot sr^{-1}$	100	<b>6</b>	10000	N/A	4000000	N/A
Blue light, small source	$B(\lambda)$	$E_B$	$W \cdot m^{-2}$	1,0*	N/A	1,0	N/A	400	N/A
Retinal thermal	$R(\lambda)$	$L_R$	$W \cdot m^{-2} \cdot sr^{-1}$	$28000/\alpha$	<b>1912</b> <b><math>\alpha = 0.062</math></b>	$28000/\alpha$	N/A	$71000/\alpha$	N/A
Retinal thermal, weak visual stimulus**	$R(\lambda)$	$L_{IR}$	$W \cdot m^{-2} \cdot sr^{-1}$	$6000/\alpha$	N/A	$6000/\alpha$	N/A	$6000/\alpha$	N/A
IR radiation, eye		$E_{IR}$	$W \cdot m^{-2}$	100	N/A	570	N/A	3200	N/A

\* Small source defined as one with  $\alpha < 0,011$  radian. Averaging field of view at 10000 s is 0,1 radian.  
\*\* Involves evaluation of non-GLS source

**Furthermore remarks:**

See attached document: PHOTOBIOLOGICAL SAFETY EVALUATION OF LED PRODUCTS for Nichia LED NVSL219B.