Test Report issued under the responsibility of:

KEMA Quality
a DEKRA company

TEST REPORT
IEC 62471
Photobiological safety of lamps and lamp systems

Report Reference No. ..... :	2138821-QUA/PHO 10-164-02A
Date of issue ..... :	October 26, 2010
Total number of pages ..... :	15
CB Testing Laboratory ..... :	KEMA Quality B.V.
Address ..... :	Utrechtseweg 310, 6812AR Arnhem, the Netherlands
Applicant's name ..... :	Philips Lumileds Lighting Company B.V.
Address ..... :	Gebouw HBR, Hurksestraat 2C, 5652 AJ EINDHOVEN
Test specification:	
Standard ..... :	IEC 62471:2006 (First Edition)
Test procedure ..... :	Type test
Non-standard test method..... :	N/A
Test Report Form No. ..... :	IEC62471A
TRF Originator ..... :	VDE Testing and Certification Institute
Master TRF ..... :	Dated 2009-05

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.

Test item description ..... :	LED
Trade Mark ..... :	LUXEON®
Manufacturer ..... :	Philips Lumileds Lighting Co L L C 370 W Trimble Rd San Jose CA 95131, USA
Model/Type reference ..... :	"LXML-PWC2" (Bin: TWNB)
Ratings ..... :	I_F = 1500 mA

Testing procedure and testing location:

☒ **CB Testing Laboratory**:

Testing location/ address.....: KEMA Quality B.V.
Utrechtseweg 310, 6812 AR, Arnhem, the Netherlands

☐ **Associated CB Laboratory:**

Testing location/ address.....:

Tested by (name + signature) .....: Hanson

Approved by (+ signature) .....: K. Meun

☐ ~~Testing procedure: TMP~~

~~Tested by (name + signature) .....:~~

~~Approved by (+ signature) .....:~~

~~Testing location/ address.....:~~

☐ ~~Testing procedure: WMT~~

~~Tested by (name + signature) .....:~~

~~Witnessed by (+ signature).....:~~

~~Approved by (+ signature) .....:~~

~~Testing location/ address.....:~~

☐ ~~Testing procedure: SMT~~

~~Tested by (name + signature) .....:~~

~~Approved by (+ signature) .....:~~

~~Supervised by (+ signature) .....:~~

~~Testing location/ address..... :~~

☐ ~~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):	**Testing location:**
These tests Fulfil the requirements of standard ISO/IEC 17025. When determining the test conclusion, the Measurement Uncertainty of test has been considered. The tested sample of LED list as below "LXML-PWC2" (Bin: TWNB) has been tested according to the IEC 62471(first edition, 2006-07) and been classified as **Group 2**. LXML-PWC2 belongs to an product range, and is considered to be the worst case in this product range. This classification is also valid for LXML-PW31, LXML-PW21, LXML-PW11 and LXML-PWC1-yyyy (with yyyy = 0120 or less).	KEMA Quality B.V. Utrechtseweg 310, 6812AR, Arnhem The Netherlands

Summary of compliance with National Differences:

Pass

Copy of marking plate:

N/A

Test item particulars	:
Tested lamp	: ☒ continuous wave lamps ☐ pulsed lamps
Tested lamp system	: Not applicable
Lamp classification group	: ☐ exempt ☐ risk 1 ☒ risk 2 ☐ risk 3
Lamp cap	: N/A
Bulb	: 1 x LED
Rated of the lamp	: I_F = 1500 mA
Furthermore marking on the lamp	: N/A
Seasoning of lamps according IEC standard	: N/A
Used measurement instrument	: Spectroradiometer
Temperature by measurement	: 25 ℃
Information for safety use	: --

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 ..... : Sep 20, 2010

Date (s) of performance of tests ..... : Oct 18, 2010-Oct 20, 2010

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.

The product complied with the following standards:

IEC 62471:2006

IEC/TR 62471-2:2009

EN 62471:2008

This report should be read in conjunction with the attached pages concerned with the European group differences and national differences of the standards EN 62471:2008 with the reference number of 2138821-QUA/PHO 10-164-02B. (2 pages)

Factory Location:

Philips Lumileds Malaysia Sdn Bhd

Lebuh Kampung Jawa,

Bayan Lepas FIZ, Phase 3

11900 Penang, Malaysia

General product information:

The forward current of the LED was 1500 mA.

The LED was soldered on a PCB, which was attached o a heat sink during the testing.

The LED was considered as Non-GLS therefore the testing has been performed at a distance of 200 mm. LXML-PWC2 belongs to an product range, and is considered to be the worst case in this product range. This classification is also valid for LXML-PW31, LXML-PW21, LXML-PW11 and LXML-PWC1-yyyy (with yyyy = 0120 or less).

IEC 62471			
Clause	Requirement + Test	Result – Remark	Verdict
4	**EXPOSURE LIMITS**		P
4.1	General		P
	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 cd·m^{-2}	see clause 4.3	P
4.3	Hazard exposure limits		P
4.3.1	Actinic UV hazard exposure limit for the skin and eye		P
	The exposure limit for effective radiant exposure is 30 J·m^{-2} within any 8-hour period		P
	To protect against injury of the eye or skin from ultraviolet radiation exposure produced by a broad-band source, the effective integrated spectral irradiance , E_S, of the light source shall not exceed the levels defined by:		P
	$E_s \cdot t = \sum_{200}^{400} \sum_{t} E_\lambda(\lambda,t) \cdot S_{UV}(\lambda) \cdot \Delta t \cdot \Delta\lambda \le 30$ J·m^{-2}		P
	The permissible time for exposure to ultraviolet radiation incident upon the unprotected eye or skin shall be computed by:		P
	$t_{max} = \frac{30}{E_s}$ s		P
4.3.2	Near-UV hazard exposure limit for eye		P
	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}.		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
	$t_{max} \le \frac{10\,000}{E_{UVA}}$ s		P
4.3.3	Retinal blue light hazard exposure limit		N/A
	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:		N/A

IEC 62471			
Clause	Requirement + Test	Result – Remark	Verdict
	$L_B \cdot t = \sum_{300}^{700} \sum_{t} L_\lambda(\lambda,t) \cdot B(\lambda) \cdot \Delta t \cdot \Delta\lambda \le 10^6$ $J \cdot m^{-2} \cdot sr^{-1}$	for $t \le 10^4$ s $t_{max} = \frac{10^6}{L_B}$	N/A
	$L_B = \sum_{300}^{700} L_\lambda \cdot B(\lambda) \cdot \Delta\lambda \le 100$ $W \cdot m^{-2} \cdot sr^{-1}$	for $t > 10^4$ s	N/A
4.3.4	Retinal blue light hazard exposure limit - small source		F
	Thus the spectral irradiance at the eye E_λ, weighted against the blue-light hazard function B(λ) shall not exceed the levels defined by:	see table 4.2	F
	$E_B \cdot t = \sum_{300}^{700} \sum_{t} E_\lambda(\lambda,t) \cdot B(\lambda) \cdot \Delta t \cdot \Delta\lambda \le 100$ $J \cdot m^{-2}$	for $t \le 100$ s	F
	$E_B = \sum_{300}^{700} E_\lambda \cdot B(\lambda) \cdot \Delta\lambda \le 1$ $W \cdot m^{-2}$	for $t > 100$ s	F
4.3.5	Retinal thermal hazard exposure limit		P
	To protect against retinal thermal injury, the integrated spectral radiance of the light source, L_λ, 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
	$L_R = \sum_{380}^{1400} L_\lambda \cdot R(\lambda) \cdot \Delta\lambda \le \frac{50\,000}{\alpha \cdot t^{0,25}}$ $W \cdot m^{-2} \cdot sr^{-1}$	(10 µs ≤ t ≤ 10 s)	P
4.3.6	Retinal thermal hazard exposure limit – weak visual stimulus		N/A
	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:		N/A
	$L_{IR} = \sum_{780}^{1400} L_\lambda \cdot R(\lambda) \cdot \Delta\lambda \le \frac{6\,000}{\alpha}$ $W \cdot m^{-2} \cdot sr^{-1}$	t > 10 s	N/A
4.3.7	Infrared radiation hazard exposure limits for the eye		P
	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
	$E_{IR} = \sum_{780}^{3\,000} E_\lambda \cdot \Delta\lambda \le 18\,000 \cdot t^{-0,75}$ $W \cdot m^{-2}$	t ≤ 1000 s	P
	For times greater than 1000 s the limit becomes:		P

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Clause	Requirement + Test	Result – Remark	Verdict
	$E_{IR} = \sum_{780}^{3\,000} E_\lambda \cdot \Delta\lambda \le 100 \qquad W \cdot m^{-2}$	t > 1000 s	P
4.3.8	Thermal hazard exposure limit for the skin		P
	Visible and infrared radiant exposure (380 nm to 3000 nm) of the skin shall be limited to:		P
	$E_H \cdot t = \sum_{380}^{3\,000} \sum_{t} E_\lambda(\lambda,t) \cdot \Delta t \cdot \Delta\lambda \le 20\,000 \cdot t^{0,25} \qquad J \cdot m^{-2}$		P
5	**MEASUREMENT OF LAMPS AND LAMP SYSTEMS**		P
5.1	Measurement conditions		P
	Measurement conditions shall be reported as part of the evaluation against the exposure limits and the assignment of risk classification.		P
5.1.1	Lamp ageing (seasoning)		N/A
	Seasoning of lamps shall be done as stated in the appropriate IEC lamp standard.		N/A
5.1.2	Test environment		P
	For specific test conditions, see the appropriate IEC lamp standard or in absence of such standards, the appropriate national standards or manufacturer's recommendations.		P
5.1.3	Extraneous radiation		P
	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		P
	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		N/A
	The power source for operation of the test lamp shall be provided in accordance with:		N/A
	– the appropriate IEC standard, or		N/A
	– the manufacturer' s recommendation		N/A
5.2	Measurement procedure		P
5.2.1	Irradiance measurements		P
	Minimum aperture diameter 7mm.		P
	Maximum aperture diameter 50 mm.		P

IEC 62471			
Clause	Requirement + Test	Result – Remark	Verdict
	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		P
5.2.2.1	Standard method		P
	The measurements made with an optical system.		P
	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.		P
5.2.2.2	Alternative method		P
	Alternatively to an imaging radiance set-up, an ir-radiance 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		P
	The determination of α, the angle subtended by a source, requires the determination of the 50% emis-sion points of the source.		P
5.2.4	Pulse width measurement for pulsed sources		N/A
	The determination of Δt, 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		P
5.3.1	Weighting curve interpolations		P
	To standardize interpolated values, use linear in-terpolation on the log of given values to obtain in-termediate points at the wavelength intervals de-sired.	see table 4.1	P
5.3.2	Calculations		P
	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		P
	The quality of all measurement results must be quantified by an analysis of the uncertainty.	see Annex C in the norm	P
6	**LAMP CLASSIFICATION**		P
	For the purposes of this standard it was decided that the values shall be reported as follows:	see table 6.1	P

IEC 62471			
Clause	Requirement + Test	Result – Remark	Verdict
	– 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		N/A
	– for all other light sources, including pulsed lamp sources, the hazard values shall be reported at a distance of 200 mm		P
6.1	Continuous wave lamps		P
6.1.1	Exempt Group		F
	In the exempt group are lamps, which does not pose any photobiological hazard. The requirement is met by any lamp that does not pose:		P
	– an actinic ultraviolet hazard (E_S) within 8-hours exposure (30000 s), nor		P
	– a near-UV hazard (E_{UVA}) within 1000 s, (about 16 min), nor		P
	– a retinal blue-light hazard (L_B) within 10000 s (about 2,8 h), nor	Exceed the limit	F
	– a retinal thermal hazard (L_R) within 10 s, nor		P
	– an infrared radiation hazard for the eye (E_{IR}) within 1000 s		P
6.1.2	Risk Group 1 (Low-Risk)		F
	In this group are lamps, which exceeds the limits for the except group but that does not pose:		P
	– an actinic ultraviolet hazard (E_S) within 10000 s, nor		P
	– a near ultraviolet hazard (E_{UVA}) within 300 s, nor		P
	– a retinal blue-light hazard (L_B) within 100 s, nor	Exceed the limit	F
	– a retinal thermal hazard (L_R) within 10 s, nor		P
	– an infrared radiation hazard for the eye (E_{IR}) within 100 s		P
	Lamps that emit infrared radiation without a strong visual stimulus and do not pose a near-infrared retinal hazard (L_{IR}), within 100 s are in Risk Group 1.		P
6.1.3	Risk Group 2 (Moderate-Risk)		P
	This requirement is met by any lamp that exceeds the limits for Risk Group 1, but that does not pose:		P
	– an actinic ultraviolet hazard (E_S) within 1000 s exposure, nor		P
	– a near ultraviolet hazard (E_{UVA}) within 100 s, nor		P
	– a retinal blue-light hazard (L_B) within 0,25 s (aversion response), nor	Group 2	P

IEC 62471			
Clause	Requirement + Test	Result – Remark	Verdict
	– a retinal thermal hazard (L_R) within 0,25 s (aversion response), nor		P
	– an infrared radiation hazard for the eye (E_{IR}) within 10 s		P
	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.		P
6.1.4	Risk Group 3 (High-Risk)		NA
	Lamps which exceed the limits for Risk Group 2 are in Group 3.	Group 2	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.	Continuous wave	N/A
	A pulsed lamp shall be evaluated at the highest nominal energy loading as specified by the manufacturer.	Continuous wave	N/A
	The risk group determination of the lamp being tested shall be made as follows:	Continuous wave	N/A
	– a lamp that exceeds the exposure limit shall be classified as belonging to Risk Group 3 (High-Risk)	Continuous wave	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	Continuous wave	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	Continuous wave	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[1] λ, nm	**UV hazard function $S_{UV}(\lambda)$**	**Wavelength λ, 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

[1] Wavelengths chosen are representative: other values should be obtained by logarithmic interpolation at intermediate wavelengths.
* Emission lines of a mercury discharge spectrum.

IEC 62471			
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 (λ)	Burn hazard function R (λ)
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	≤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	≤100 >100	< 0,011	100/t 1,0
Eye IR	$E_{IR} = \sum E_\lambda \cdot \Delta\lambda$	780 –3000	≤1000 >1000	1,4 (80)	$18000/t^{0,75}$ 100
Skin thermal	$E_H = \sum E_\lambda \cdot \Delta\lambda$	380 – 3000	< 10	2π sr	$20000/t^{0,75}$

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 ≥ 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

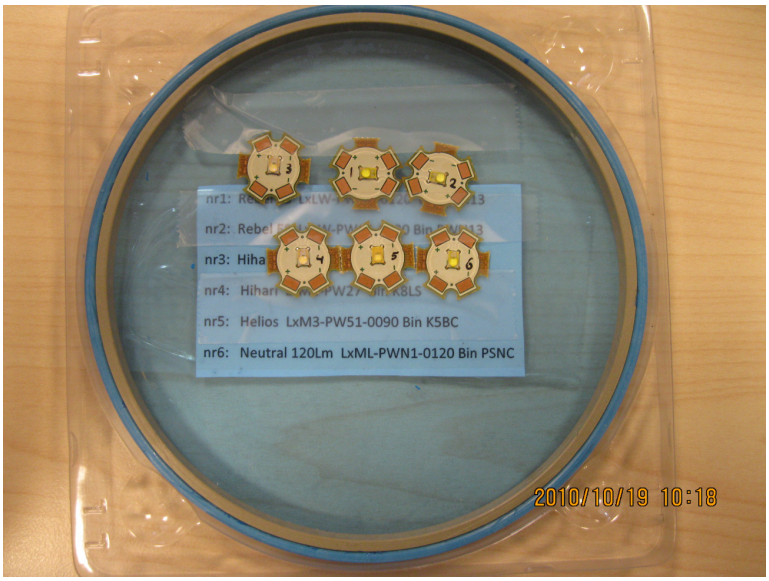
IEC 62471			
Clause	Requirement + Test	Result – Remark	Verdict
Table 6.1	Emission limits for risk groups of continuous wave lamps ("LXML-PWC2" (Bin: TWNB) , **α=1,7 mrad**)		

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	0,00005	0,003		0,03	
Near UV		E_{UVA}	$W \cdot m^{-2}$	10	0,00031	33		100	
Blue light	B(λ)	L_B	$W \cdot m^{-2} \cdot sr^{-1}$	100	--	10000		4000000	
Blue light, small source	B(λ)	E_B	$W \cdot m^{-2}$	1,0*	2,26	1,0	2,26	400	2,26
Retinal thermal	R(λ)	L_R	$W \cdot m^{-2} \cdot sr^{-1}$	28000/α	282418	28000/α		71000/α	
Retinal thermal, weak visual stimulus**	R(λ)	L_{IR}	$W \cdot m^{-2} \cdot sr^{-1}$	6000/α	--	6000/α		6000/α	
IR radiation, eye		E_{IR}	$W \cdot m^{-2}$	100	0,03	570		3200	

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

Furthermore remarks:

Appendix 1: Photo documentation



"LXML-PWC2" (Bin: TWNB)

(2# sample marked on the photo)