

## Photobiological safety of lamps and lamp systems

Corral Oben

ENTER (PENGGUAN) CO., LTD.

TESTING

## Report No.: ED180402022L Ver.1.0

Master TRF ..... : Dated 2009-05

**Copyright © 2009 IEC System for Conformity Testing and Certification of Electrical Equipment (IECEE), Geneva, Switzerland. All rights reserved.**

This publication may be reproduced in whole or in part for non-commercial purposes as long as the IECEE is acknowledged as copyright owner and source of the material. IECEE takes no responsibility for and will not assume liability for damages resulting from the reader's interpretation of the reproduced material due to its placement and context.

Test item description ..... : telescope LED Torches

Trade Mark ... : N/A

Model and/or type reference..... : AT3541

Rating(s) ..... : DC 6V

#### Summary of testing:

After testing, the RG level of this product is risk 1.

**Tests performed (name of test and test clause):**  
All clauses.

#### Testing location:

No.281, Guantai Road, Nancheng District,  
Dongguan, Guangdong, China

#### Summary of compliance with National Differences:

European group deviation.

**Copy of marking plate:** N/A

<b>Test item particulars</b> .....	Photobiological safety
Tested lamp .....	<input checked="" type="checkbox"/> continuous wave lamps <input type="checkbox"/> pulsed lamps
Tested lamp system .....	N/A
Lamp classification group .....	<input type="checkbox"/> exempt <input checked="" type="checkbox"/> risk 1 <input type="checkbox"/> risk 2 <input type="checkbox"/> risk 3
Lamp cap .....	N/A
Bulb .....	LED
Rated of the lamp .....	See page 1
Furthermore marking on the lamp .....	N/A
Seasoning of lamps according IEC standard .....	N/A
Used measurement instrument .....	EVERFINE OST-300 system
Temperature by measurement .....	25 °C
Information for safety use .....	N/A
<b>Possible test case verdicts:</b>	
– 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)
<b>Testing:</b>	
Date of receipt of test item .....	April 03, 2017
Date (s) of performance of tests .....	April 08, 2017
<b>General remarks:</b>	
<p>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. For European group deviation, see attachment.</p>	
<b>General product information:</b>	
Only one model is covered in this test report.	

IEC62471			
Clause	Requirement + Test	Result - Remark	Verdict
4	<b>EXPOSURE LIMITS</b>		
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 $10^4 \text{ cd.m}^{-2}$		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 $30 \text{ J.m}^{-2}$ within any 8-hour period		P
	To protect against injury of the eye or skin from ultraviolet radiation exposure produced by a broadband source, the effective integrated spectral irradiance, $E_s$ , of the light source shall not exceed the levels defined by:		P
	$E_s \cdot t = \sum_{200}^{400} \sum_t E_\lambda(\lambda, t) \cdot S_{UV}(\lambda) \cdot \Delta t \cdot \Delta \lambda \leq 30 \quad \text{J.m}^{-2}$		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		P
	For the spectral region 315 nm to 400 nm (UV-A) the total radiant exposure to the eye shall not exceed $10000 \text{ J.m}^{-2}$ for exposure times less than 1000s. For exposure times greater than 1000s (approximately 16 minutes) the UV-A irradiance for the unprotected eye, $E_{UVA}$ , shall not exceed $10 \text{ W.m}^{-2}$ .		P
	The permissible time for exposure to ultraviolet radiation incident upon the unprotected eye for time less than 1000s, 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		P
	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
	$L_B \cdot t = \sum_{300}^{700} L_\lambda(\lambda, t) \cdot B(\lambda) \cdot \Delta t \cdot \Delta \lambda \leq 10^6 \quad \text{J} \cdot \text{m}^{-2} \cdot \text{sr}^{-1}$	for $t \leq 10^4 \text{ s}$	$t_{\max} = \frac{10^6}{L_B}$ P
	$L_B = \sum_{300}^{700} L_\lambda \cdot B(\lambda) \cdot \Delta \lambda \leq 100 \quad \text{W} \cdot \text{m}^{-2} \cdot \text{sr}^{-1}$	for $t > 10^4 \text{ s}$	N/A
4.3.4	Retinal blue light hazard exposure limit - small source		N/A

IEC62471			
Clause	Requirement + Test	Result - Remark	Verdict
	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:		N/A
	$E_B \cdot t = \sum_{300}^{700} \sum_t E_{\lambda}(\lambda, t) \cdot B(\lambda) \cdot \Delta\lambda \cdot \Delta t \leq 100 \quad \text{J} \cdot \text{m}^{-2}$		N/A
	$E_B = \sum_{300}^{700} E_{\lambda} \cdot B(\lambda) \cdot \Delta\lambda \leq 1 \quad \text{W} \cdot \text{m}^{-2}$		N/A
4.3.5	Retinal thermal hazard exposure limit		P
	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
	$L_R = \sum_{380}^{1400} L_{\lambda} \cdot R(\lambda) \cdot \Delta\lambda \leq \frac{50\,000}{\alpha \cdot t^{0,25}} \quad \text{W} \cdot \text{m}^{-2} \cdot \text{sr}^{-1}$	$(10 \mu\text{s} \leq t \leq 10 \text{ s})$	P
4.3.6	Retinal thermal hazard exposure limit – weak visual stimulus		P
	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 (780nm to 1400 nm) radiance, $L_{IR}$ , as viewed by the eye for exposure times greater than 10 s shall be limited to:		P
	$L_{IR} = \sum_{780}^{1400} L_{\lambda} \cdot R(\lambda) \cdot \Delta\lambda \leq \frac{6\,000}{\alpha} \quad \text{W} \cdot \text{m}^{-2} \cdot \text{sr}^{-1}$	$t > 10 \text{ s}$	P
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:		N/A
	$E_{IR} = \sum_{780}^{3000} E_{\lambda} \cdot \Delta\lambda \leq 18\,000 \cdot t^{-0,75} \quad \text{W} \cdot \text{m}^{-2}$	$t \leq 1000 \text{ s}$	N/A
	For times greater than 1000 s the limit becomes:		P
	$E_{IR} = \sum_{780}^{3000} E_{\lambda} \cdot \Delta\lambda \leq 100 \quad \text{W} \cdot \text{m}^{-2}$	$t > 1000 \text{ s}$	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
	$E_H \cdot t = \sum_{380}^{3000} \sum_t E_{\lambda}(\lambda, t) \cdot \Delta\lambda \cdot \Delta t \leq 20\,000 \cdot t^{0,25} \quad \text{J} \cdot \text{m}^{-2}$		P
5	<b>MEASUREMENT OF LAMPS AND LAMP SYSTEMS</b>		P
5.1	Measurement conditions		P

IEC62471			
Clause	Requirement + Test	Result - Remark	Verdict
	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		N/A
	Operation of the test lamp shall be provided in accordance with:		N/A
	– the appropriate IEC lamp standard, or		N/A
	– the manufacturer' s recommendation		N/A
5.1.5	Lamp system operation		P
	The power source for 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
5.2	Measurement procedure		P
5.2.1	Irradiance measurements		P
	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		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		N/A
	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.		N/A

IEC62471			
Clause	Requirement + Test	Result - Remark	Verdict
5.2.3	Measurement of source size		P
	The determination of $\alpha$ , the angle subtended by a source, requires the determination of the 50% emission points of the source.	$\alpha = 0.0239$ rad	P
5.2.4	Pulse width measurement for pulsed sources	Continuous wave lamps	N/A
	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		P
5.3.1	Weighting curve interpolations		P
	To standardize interpolated values, use linear interpolation on the log of given values to obtain intermediate points at the wavelength intervals desired.		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	Wavelength accuracy: 1 nm	P
	The quality of all measurement results must be quantified by an analysis of the uncertainty.		P
6	<b>LAMP CLASSIFICATION</b>		P
	For the purposes of this standard it was decided that the values shall be reported as follows:	see table 6.1	P
	– 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	At 401.0 mm	P
	– for all other light sources, including pulsed lamp sources, the hazard values shall be reported at a distance of 200 mm		N/A
6.1	Continuous wave lamps		P
6.1.1	Exempt Group		N/A
	In the exempt group are lamps, which does not pose any photobiological hazard. The requirement is met by any lamp that does not pose:		N/A
	– an actinic ultraviolet hazard (Es) within 8-hours exposure (30000 s), nor.		N/A
	– a near-UV hazard (EUVA) within 1000 s, (about 16min), nor		N/A
	– a retinal blue-light hazard (LB) within 10000 s (about 2,8 h), nor		N/A
	– a retinal thermal hazard (LR) within 10 s, nor		N/A
	– an infrared radiation hazard for the eye (EIR) within 1000 s		N/A
6.1.2	Risk Group 1 (Low-Risk)		P

IEC62471			
Clause	Requirement + Test	Result - Remark	Verdict
	In this group are lamps, which exceeds the limits for the exempt group but that does not pose:		P
	– an actinic ultraviolet hazard (Es) within 10000 s, nor		P
	– a near ultraviolet hazard (EUVA) within 300 s, nor		P
	– a retinal blue-light hazard (LB) within 100 s, nor		P
	– a retinal thermal hazard(LR) within 10 s, nor		P
	– an infrared radiation hazard for the eye (EIR) within 100 s		P
	Lamps that emit infrared radiation without a strong visual stimulus and do not pose a near-infrared retinal hazard (LIR) within 100 s are in Risk Group 1.		P
6.1.3	Risk Group 2 (Moderate-Risk)		N/A
	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 (Es) within 1000 s exposure, nor		N/A
	– a near ultraviolet hazard (EUVA) within 100 s, nor		N/A
	– a retinal blue-light hazard (LB) within 0,25 s (aversion response), nor		N/A
	– a retinal thermal hazard (LR) within 0,25 s (aversion response), nor		N/A
	– an infrared radiation hazard for the eye (EIR) within 10 s		N/A
	Lamps that emit infrared radiation without a strong visual stimulus and do not pose a near-infrared retinal hazard (LIR), within 10 s are in Risk Group 2.		N/A
6.1.4	Risk Group 3 (High-Risk)		N/A
	Lamps which exceed the limits for Risk Group 2 are in Group 3.		N/A
6.2	Pulsed lamps		N/A
	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



## IEC62471

Clause	Requirement + Test	Result - Remark	Verdict
--------	--------------------	-----------------	---------

Table 4.1	Spectral weighting function for assessing ultraviolet hazards for skin and eye			--
Wavelength $\lambda$ , 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	
Wavelengths chosen are representative: other values should be obtained by logarithmic interpolation at intermediate wavelengths.				
* Emission lines of a mercury discharge spectrum.				

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		
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		

## IEC62471

Clause	Requirement + Test	Result - Remark	Verdict
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-		$10^{[(450-\lambda)/50]}$	
1050-1150		0.2	
1150-1200			
1200-1400		0.02	

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 & ey	$ES = \sum E_{\lambda} \cdot S(\lambda) \cdot \Delta\lambda$	200 - 400	< 30000	1,4 (80)	30/t	
Eye UV-A	$EUVA = \sum E_{\lambda} \cdot \Delta\lambda$	315 - 400	$\leq 1000$ $> 1000$	1,4 (80)	10000/t 10	
Blue-light small source	$EB = \sum E_{\lambda} \cdot B(\lambda) \cdot \Delta\lambda$	300 - 700	$\leq 100$ $> 100$	< 0,011	100/t 1.0	
Eye IR	$EIR = \sum E_{\lambda} \cdot \Delta\lambda$	780 - 3000	$\leq 1000$ $> 1000$	1,4 (80)	18000/t <sup>0,75</sup> 100	
Skin thermal	$EH = \sum E_{\lambda} \cdot \Delta\lambda$	380 - 3000	< 10	$2\pi$ sr	20000/t <sup>0,75</sup>	

## IEC62471

Clause	Requirement + Test	Result - Remark	Verdict
--------	--------------------	-----------------	---------

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/ $\alpha$	

Table 6.1	Emission limits for risk groups of continuous wave lamps(Base on IEC62471:2006)								N/A
Risk	Action spectrum	Symbol	Units	Emission Measurement					
				Exempt		Low risk		Mod risk	
				Limit	Result	Limit	Result	Limit	Result
ActinicUV	$S_{UV}(\lambda)$	$E_s$	$W \cdot m^{-2}$	0.001	--	0.003	--	0.03	--
Near UV		$E_{uva}$	$W \cdot m^{-2}$	10	--	33	--	100	--
Blue light	$B(\lambda)$	$L_B$	$W \cdot m^{-2} \cdot sr^{-1}$	100	--	10000	--	40000	--
Blue light, small source	$B(\lambda)$	$E_B$	$W \cdot m^{-2}$	1.0*	--	1.0	--	400	--
Retinal thermal	$R(\lambda)$	$L_R$	$W \cdot m^{-2} \cdot sr^{-1}$	28000/ $\alpha$	--	28000/ $\alpha$	--	71000/ $\alpha$	--
Retinal Thermal (weak visual stimulus)	$R(\lambda)$	$L_{IR}$	$W \cdot m^{-2} \cdot sr^{-1}$	6000/ $\alpha$	--	6000/ $\alpha$	--	6000/ $\alpha$	--
IR radiation, eye		$E_{IR}$	$W \cdot m^{-2}$	100	--	570	--	3200	--
Remark: * 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									

**ATTACHMENT TO TEST REPORT IEC 62471**  
**EUROPEAN GROUP DIFFERENCES AND NATIONAL DIFFERENCES**  
Photobiological safety of lamps and lamps systems

Differences according to .....	EN 62471:2008
Attachment Form No.....	EU_GD_IEC62471A
Attachment Originator .....	IMQ S.p.A.
Master Attachment .....	2009-0
Copyright © 2009 IEC System for Conformity Testing and Certification of Electrical Equipment (IECEE), Geneva, Switzerland. All rights reserved.	

	CENELEC COMMON MODIFICATIONS (EN)	P
4	EXPOSURE LIMITS	P
	Contents of the whole Clause 4 of IEC 62471:2006 moved into a new informative Annex ZB	--
	Clause 4 replaced by the following:	P
	Limits of the Artificial Optical Radiation Directive(2006/25/EC) have been applied instead of those fixed in IEC 62471:2006	See appended table 6.1 P
4.1	General	P
	First paragraph deleted	--

Table 6.1	Emission limits for risk groups of continuous wave lamps (Artificial Optical Radiation Directive 2006/25/EC)								P
Risk	Action spectrum	Symbol	Units	Emission Measurement					
				Exempt		Low risk		Mod risk	
				Limit	Result	Limit	Result	Limit	Result
Actinic UV	SUV( $\lambda$ )	Es	W•m-2	0,001	--	0,003	9.7e-007	--	--
Near UV		Euva	W•m-2	0,33	--	33	2.0e-003	--	--
Blue light	B( $\lambda$ )	LB	W•m-2•sr-1	100	--	10000	8.31e+002	--	--
Blue light, small source	B( $\lambda$ )	EB	W•m-2	0,01*	--	1,0	--	--	--
Retinal thermal	R( $\lambda$ )	LR	W•m-2•sr-1	28000/ $\alpha$	--	28000/ $\alpha$	9.3e+003	--	--
Retinal thermal, weak visual stimulus**	R( $\lambda$ )	LIR	W•m-2•sr-1	545000 0,0017 $\leq \alpha \leq$ 0,011	--	3.7e+000			
				6000/ $\alpha$ 0,011 $\leq \alpha \leq$ 0,1					
IR radiation, eye		EIR	W•m-2	100	--	570	5.1e-003	3200	--
Remark: * 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									

Picture



Fig 1 - Front overview



Fig 2 - LED view