




TEST REPORT IEC 62471 Photobiological safety of lamps and lamp systems	
Report Reference Number :	SVL-Sample
Date of issue:	6/24/2013
Total Number of Pages:	14
Testing Laboratory:	Smart Vision Lights
Address:	5113 Robert Hunter Dr. Norton Shores, MI 49441
Applicant's Name:	Smart Vision Lights
Address:	5113 Robert Hunter Dr. Norton Shores, MI 49441
Test Specification:	Standard: IEC 62471:2006 (First Edition) IEC/TR 62471-2:2009 Test Procedure: cETLus
Test Report Form Number:	IEC62471A
Master TRF:	Dated 2009-05
Test item:	Sample
Test item description:	Sample Light
Manufacturer:	Smart Vision Lights, Inc.

Summary of testing:	
Tests performed (name of test and test clause): 4.2.2 Angular subtense of source and measurement field-of-view 4.3.1 Actinic UV hazard exposure limit for the skin and eye 4.3.2 Near-UV hazard exposure limit for the eye 4.3.3 Retina blue light hazard exposure limit 4.3.4 Retina blue light hazard exposure limit – small source 4.3.5 Retina thermal hazard exposure limit 4.3.6 Retina thermal hazard exposure limit – weak visual stimulus 4.3.7 Infrared radiation hazard exposure limit for the eye 4.3.8 Thermal hazard exposure limit for the skin 5.2.1 Irradiance measurements 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: Smart Vision Lights 5113 Robert Hunter Dr. Norton Shores, MI 49441
Picture of Test Sample: 	

SAMPLE

Test Item Particulars:

Tested Lamp: Continuous Wave Lamps Pulsed Lamps

Tested Lamp System:

Lamp classification group: exempt risk 1 risk 2 risk 3

Lamp/Illumination Source: LED

Rating of the lamp: N/A

Furthermore marking on the lamp: N/A

Seasoning of lamps according IEC standard: N/A

Temperature by measurement: 21.1° C

Information for safety use: No labeling required

Possible test case verdicts:

Test Case Does Not Apply to the Test Object N/A

Test Case Does Meet the Requirement P (Pass)

Test Case Does Not Meet the Requirement F (Fail)

Testing:

Performance Test Date: 6/7/2013

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 Smart Vision Lights.

Throughout this report a period (point) is used as the decimal separator.

List of test equipment must be kept on file and available for review.

General Product Information:

12 High Current LED's

Emits red light

M12 Quick Disconnect

Driver built in – No External wiring to a driver

PNP and NPN Strobe input

Continuous operation or Strobe mode

Dimmable via built in potentiometer

Analog intensity via 0-10VDC signal

Option of connecting lights together

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Clause	Requirement & Test	Result / Remark		Verdict
4	EXPOSURE LIMITS			
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.			
	Detailed spectral data of a light source are generally required only if the luminance of the source exceeds 104 cd/m ²			See clause 4.3
4.3	Hazard Exposure Limits			
4.3.1	Actinic UV hazard exposure limit for the skin and eye	200nm-400nm		
	The exposure limit for effective radiant exposure is 30 J.m ⁻² within any 8-hour period	Measured .40		Exempt
		Percent of Limit 1.45%		
	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:			
	$E_s \cdot t = \sum_{200}^{400} \sum_t E_\lambda(\lambda, t) \cdot S_{UV}(\lambda) \cdot \Delta t \cdot \Delta \lambda \leq 30 \text{ J/m}^2$	Exempt Limit 0.001	Measured 1.45%	Exempt
	Percent of Limit 1.4E-05%			
	The permissible time for exposure to ultraviolet radiation			
	$t_{max} = \frac{30}{E_s} \text{ sec}$	t _{max} =(NA), safe at 8 Hr		Exempt
4.3.2	Near-UV hazard exposure limit for eye	315nm-400nm		
	For the spectral region 315nm to 400nm (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:			See table 6.1
	$E_{UVA} \cdot t = \sum_{315}^{400} \sum_t E_\lambda(\lambda, t) \cdot \Delta t \cdot \Delta \lambda \leq 10000 \text{ J/m}^2 (t < 1000 \text{ s})$	Exempt Limit 10000	Measured .0047	Exempt
		Percent of Limit 4.5E-05%		
	$E_{UVA} \leq 10 \text{ W/m}^2 (t \geq 1000 \text{ s})$	Exempt Limit 10	Measured .0000047	Exempt
	Percent of Limit 4.5E-05%			
	The permissible time for exposure to ultraviolet radiation incident upon the unprotected eye for time less than 1000 s, shall be computed by:			
	$t_{max} \leq \frac{10000}{E_{UVA}} \text{ sec}$	t _{max} =safe at 620395 hours		Exempt

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Clause	Requirement & Test	Result / Remark		Verdict
4.3.3	Retinal blue light hazard exposure limit	300nm-700nm		
	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:			See table 6.1
	$L_B \cdot t = \sum_{300}^{700} \sum_t L_\lambda(\lambda, t) \cdot B(\lambda) \cdot \Delta\lambda \cdot \Delta t \leq 10^6 \text{ J}/(\text{m}^2\text{sr}^{-1}) \text{ (for } t \leq 10^4\text{s)}$	Exempt Limit 1.00E+06	Measured 3440	Exempt
		Percent of Limit 3.44%		
	$L_B = \sum_{300}^{700} L_\lambda \cdot B(\lambda) \cdot \Delta\lambda \leq 100 \text{ J}/(\text{m}^2\text{sr}^{-1}) \text{ (for } t > 10^4\text{s)}$	Exempt Limit 100	Measured 3.44	Exempt
	Percent of Limit 3.44%			
	For a weighted source radiance, L_B , exceeding $100 \text{ W}/(\text{m}^2\text{sr}^{-1})$, the maximum permissible exposure duration, t_{\max} , shall be computed:			
	$t_{\max} = \frac{10^6}{L_B} \text{ sec} \text{ (for } t \leq 10^4\text{s)}$	$t_{\max} = 80.7 \text{ hours}$	Exempt	
4.3.4	Retinal blue light hazard exposure limit (small source)	300nm-700nm		
	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			Limit Not Applicable
	$E_B \cdot t = \sum_{300}^{700} \sum_t E_\lambda(\lambda, t) \cdot B(\lambda) \cdot \Delta\lambda \cdot \Delta t \leq 100 \text{ J}/\text{m}^2 \text{ (for } t \leq 100\text{s)}$			Limit Not Applicable
	$E_B = \sum_{300}^{700} E_\lambda \cdot B(\lambda) \cdot \Delta\lambda \leq 1 \text{ W}/\text{m}^2 \text{ (for } t > 100\text{s)}$			Limit Not Applicable
	For a source where the blue light weighted irradiance, E_B , exceeds $0.01 \text{ W}/\text{m}^2$, the maximum permissible exposure duration shall be computed:			
	$t_{\max} = \frac{100}{E_B} \text{ sec} \text{ (for } t \leq 100\text{s)}$			Limit Not Applicable
4.3.5	Retinal thermal hazard exposure limit	380nm-1400nm		
	To protect against retinal thermal injury, the integrated spectral radiance of the light source, L_λ , weighted by the			
	$L_R = \sum_{380}^{1400} L_\lambda \cdot R(\lambda) \cdot \Delta\lambda \leq \frac{50000}{\alpha \cdot t^{0.25}} \text{ W}/(\text{m}^2\text{sr}^{-1}) \text{ (} 10\mu\text{s} \leq t \leq 10\text{s)}$	Exempt 2.8E+05	Measured 3142	Exempt
	Percent of Limit 1.12%			

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Clause	Requirement & Test	Result / Remark		Verdict
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:			
	$L_{IR} = \sum_{780}^{1400} L_{\lambda} \cdot R(\lambda) \cdot \Delta\lambda \leq \frac{6000}{\alpha} \text{ W}/(\text{m}^2\text{sr}^{-1}) \quad (t > 10\text{s})$	Exempt 6E+04	Measured .142	Exempt
	Percent of Limit 2.3E-04%			
4.3.7	Infrared radiation hazard exposure limits for the eye	780nm to 3000nm		
	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:			
	$E_{IR} = \sum_{780}^{3000} E_{\lambda} \cdot \Delta\lambda \leq 18000 \cdot t^{-0.75} \text{ W}/\text{m}^2 \quad (t \leq 1000\text{s})$	Exempt Limit 1.01E+02	Measured .005	Exempt
		Percent Limit .005%		
	For times greater than 1000 s the limit becomes:			
$E_{IR} = \sum_{780}^{3000} E_{\lambda} \cdot \Delta\lambda \leq 100 \text{ W}/\text{m}^2 \quad (t > 1000\text{s})$	Exempt Limit 100	Measured .005	Exempt	
	Percent Limit .005%			
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:			
	$E_H \cdot t = \sum_{380}^{3000} \sum_t E_{\lambda}(\lambda, t) \cdot \Delta t \cdot \Delta\lambda \leq 20000 \cdot t^{0.25} \text{ }^2 \quad (t \leq 10\text{s})$	Exempt Limit 3556	Measured 73.5	Exempt
	Percent Limit 2.07%			
5	MEASUREMENT OF LAMPS AND LAMP SYSTEMS			
5.1	Measurement conditions			
	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)			
	Seasoning of lamps shall be done as stated in the appropriate IEC lamp standard.			P

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Clause	Requirement & Test	Result / Remark	Verdict
5.1.2	Test environment	Testing was conducted under ambient conditions in accordance with IEC 61010-1	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.		
5.1.3	Extraneous radiation	Test devices were baffled to eliminate extraneous sources of radiation and reflections	P
	Careful checks should be made to ensure that extraneous sources of radiation and reflections do not add significantly to the measurement results.		
5.1.4	Lamp operation	Devices were operated per the mfg's recommendations	P
	Operation of the test lamp shall be provided in accordance with:		
	– the appropriate IEC lamp standard, or – the manufacturer's recommendation		
5.1.5	Lamp system operation	Devices were operated per the mfg's recommendations	P
	The power source for operation of the test lamp shall be provided in accordance with:		
	– the appropriate IEC lamp standard, or – the manufacturer's recommendation		
5.2	Measurement Procedure		
5.2.1	Irradiance measurements	Actual aperture: 31.75 mm	P
	Minimum aperture diameter 7mm. Maximum aperture diameter 50 mm.		
	The measurement shall be made in that position of the beam giving the maximum reading.	Prior to test, the beam was scanned for maximum reading	P
	The measurement instrument is adequate calibrated.	All equipments was in calibration prior to testing	P
5.2.2	Radiance measurements	Radiance measurements were derived from the irradiance	
5.2.2.1	Standard method	Alternate method used (5.2.2.2). Requirement not applicable.	N/A
	The measurements 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.		

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Clause	Requirement & Test	Result / Remark	Verdict
5.2.2.2	Alternative method	Irradiance measurements were made with the aperture	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.		
5.2.3	Measurement of source size	The source size and distance were measured with the steel rule and digital micrometer	P
	The determination of α , the angle subtended by a source, requires the determination of the 50% emission points of the source.		
5.2.4	Pulse width measurement for pulsed sources	Product measured with direct current. Requirement not applicable for this product.	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.		
5.3	Analysis methods		
5.3.1	Weighting curve interpolations	see table 4.1	P
	To standardize interpolated values, use linear interpolation on the log of given values to obtain intermediate points at the wavelength intervals desired.		
5.3.2	Calculations	The spectral measurements were weighted by the appropriate weighting functions to determine the total weighted energy for each hazard function	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.		
5.3.3	Measurement uncertainty	see Annex C in the norm	P
	The quality of all measurement results must be quantified by an analysis of the uncertainty.		
6	LAMP CLASSIFICATION		
	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		P
	– for all other light sources, including pulsed lamp sources, the hazard values shall be reported at a distance of 200 mm		N/A

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Clause	Requirement & Test	Result / Remark	Verdict
6.1	Continuous Wave Lamps		
6.1.1	Exempt Group	The device met the Exempt	
	In the exempt 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)		P
	– a near-UV hazard (E_{UVA}) within 1000 s, (about 16 min)		P
	– a retinal blue-light hazard (L_B) within 10000 s (about 2.8 h)		P
	– a retinal thermal hazard (L_R) within 10 s, nor		P
	– an infrared radiation hazard for the eye (E_{IR}) within 1000 s		P
	Lamps that emit infrared radiation without a strong visual stimulus and do not pose a near-infrared retinal hazard (L_{IR}) within 1000 s are in the Exempt group.		P
6.1.2	Risk Group 1 (Low-Risk)	The device met the Group 1 requirements for all hazard types.	
	In this group are lamps, which exceeds the limits for the exempt group but that does not pose:		
	– an actinic ultraviolet hazard (E_s) within 10000 s		P
	– a near ultraviolet hazard (E_{UVA}) within 300 s		P
	– a retinal blue-light hazard (L_B) within 100 s		P
	– a retinal thermal hazard (L_R) within 10 s		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

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Clause	Requirement & Test	Result / Remark	Verdict
6.1.3	Risk Group 2 (Moderate-Risk)	The device met the Group 2 requirements for all hazard types.	
	This requirement is met by any lamp that exceeds the limits for Risk Group 1, but that does not pose:		
	– an actinic ultraviolet hazard (E_s) within 1000 s		P
	– a near ultraviolet hazard (E_{UVA}) within 100 s		P
	– a retinal blue-light hazard (L_B) within 0.25 s		P
	– a retinal thermal hazard (L_R) within 0.25s		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)		
	Lamps which exceed the limits for Risk Group 2 are in Group 3.		P
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:		
	– 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 dose is below the E_L 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 E_L , 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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Table 4.1 Spectral weighting function for assessing ultraviolet hazards for skin and eye

Wavelength ¹	S _{UV} (nm)	Wavelength ¹	S _{UV} (nm)
200	0.030	313*	0.006000
205	0.051	315	0.003000
210	0.075	316	0.002400
215	0.095	317	0.002000
220	0.120	318	0.001600
225	0.150	319	0.001200
230	0.190	320	0.001000
235	0.240	322	0.000670
240	0.300	323	0.000540
245	0.360	325	0.000500
250	0.430	328	0.000440
254*	0.500	330	0.000410
255	0.520	333*	0.000370
260	0.650	335	0.000340
265	0.810	340	0.000028
270	1.000	345	0.000240
275	0.960	350	0.000200
280*	0.880	355	0.000160
285	0.770	360	0.000130
290	0.640	365*	0.000110
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.

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Table 4.2 Spectral weighting functions for assessing retinal hazards from broadband optical sources

Wavelength (nm)	Blue-light hazard function B(nm)	Burn hazard function R(nm)
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	0.10
385	0.013	0.13
390	0.025	0.25
395	0.05	0.50
400	0.1	1.00
405	0.2	2.00
410	0.4	4.00
415	0.8	8.00
420	0.9	9.00
425	0.95	9.50
430	0.98	9.80
435	1	10.00
440	1	10.00
445	0.97	9.70
450	0.94	9.40
455	0.9	9.00
460	0.8	8.00
465	0.7	7.00
470	0.62	6.20
475	0.55	5.50
480	0.45	4.50
485	0.4	4.00
490	0.22	2.20
495	0.16	1.60
500-600	$10^{[(450-\lambda)/50]}$	1.00
600-700	0.001	1.00
700-1050		$10^{[(700-\lambda)/300]}$
1050-1150		0.2
1150-1200		$0.2 \cdot 10^{0.02(1150-\lambda)}$
1200-1400		0.02

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Table 5.4 Exposure Limits for continuous wave lamps								
Hazard Name	Relevant Equation	Exposure Limit in Seconds						
		Exempt		Low Risk		Mod Risk		High Risk
		Limit	Result	Limit	Result	Limit	Result	Res
Actinic UV skin & eye	$E_s = \sum E_\lambda \cdot S(\lambda) \cdot \Delta\lambda$	30000	> Limit	10000		1000		-
Eye UV-A	$E_{UVA} = \sum E_\lambda \cdot \Delta\lambda$	1000	> Limit	300		100		-
Blue-light	$L_B = \sum L_\lambda \cdot B(\lambda) \cdot \Delta\lambda$	10000	> Limit	100		0.25		-
Retinal thermal	$L_R = \sum L_\lambda \cdot R(\lambda) \cdot \Delta\lambda$	10	> Limit	10		0.25		-
Eye IR	$E_{IR} = \sum E_\lambda \cdot \Delta\lambda$	1000	> Limit	100		10		-

Table 6.1 Emission limits for risk groups of continuous wave lamps -										
Risk	Action Spectrum	Symbol	Units	Emission Measurement						
				Exempt		Low Risk		Mod Risk		High Risk
				Limit	Result	Limit	Result	Limit	Result	Res
Actinic UV	$S_{UV}(\lambda)$	E_s	$W \cdot m^{-2}$	0.001	1.4E-05	0.003		0.03		-
Near UV		E_{UVA}	$W \cdot m^{-2}$	10	4.5E-06	33		100		-
Blue light	$B(\lambda)$	L_B	$W \cdot m^{-2} \cdot sr^{-1}$	100	3.44	10000		4000000		-
Blue light, small source	$B(\lambda)$	E_B	$W \cdot m^{-2}$	1	N/A	1		400		-
Retinal thermal	$R(\lambda)$	L_R	$W \cdot m^{-2} \cdot sr^{-1}$	2.8E+05	3142	2.8E+05		710000		-
Retinal thermal, weak visual stimulus*	$R(\lambda)$	L_{IR}	$W \cdot m^{-2} \cdot sr^{-1}$	60000	0.14	60000		60000		-
IR radiation, eye		E_{IR}	$W \cdot m^{-2}$	100	0.005	570		3200		-
Skin Thermal		E_H	$W \cdot m^{-2}$	3557	73.5	3557		3557		-

* Involves evaluation of non-GLS source

** The maximum Permissible Exposure Time is 80 hours

Note: At 20 cm the source is not considered a small source therefore the blue light small source hazard function is not applicable.

Futhermore Remarks	
	Model:
Subtended angle used in the calculations to determine risk levels:	0.1 radians
Solid Angle used in calculations to determine optical hazard function summations:	0.00785 steradians

Labeling Requirements:

The model meet the Exempt criteria for all the optical hazard types except. Therefore the model should be classified as an Exempt.

TEST EQUIPMENT				
#	Serial #	Description	Mfgr / Model	Calibration Due
1	13329405	Spectroradiometer Controller	OL 750-C	2/28/2014
2	13515178	Double Monochromator	OL 750-M-D	2/28/2014
3	13101259	Spectroradiometer Silicon Detector	OL 750-HSD-300	2/28/2014
4	13100466	6" Diameter Integrating Sphere	OL IS-670	2/28/2014
5	13000008	Field-of-View Attachment	ISA-670-FVA	2/28/2014
6	N/A	24 VDC Power Source	N/A	
7	N/A	Steel Rule	N/A	

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