國立中央大學

CIE Taiwan 台灣照明委員會

光與照明國際最新標準與技術發展現況研討會

CIE / IEC 62471 光生物安全 最新修訂現況

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Guidance/Regulations

- ANSI/IES RP27:
  Recommended Practice for Photobiological Safety for Lamps and Lamp Systems
- CIE S009/IEC 62471
  Photobiological safety of lamps and lamp system
- CNS 15592 光源及光源系統之光生物安全性
  Photobiological safety of lamps and lamp system
- IEC TR 62778
  Application of IEC 62471 for the assessment of blue light hazard to light sources and luminaries

IEC 62471-2002

IEC 62471-1-2016

Not Finalized Yet
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Optical Radiation Hazards

Hazard Distance

- distance from a lamp or lamp system within which the radiance or irradiance for a given exposure duration equals the applicable exposure limit. It is recommended that the hazard distance be evaluated for each hazard for which an RG3 classification results, using the respective time bases for lower risk groups (such as RG2) as the assumed exposure durations for the determination of the hazard distance, and noting that the AEL defined for the risk groups are numerically equivalent to the exposure limits (Annex B).

Measurement Distance

- distance from the closest point of human access at which the measurement is performed. If the measurement distance deviates from the specified classification distance, the measurement values need to be scaled to the appropriate levels that would have been obtained at the classification distance.

Pulse Duration

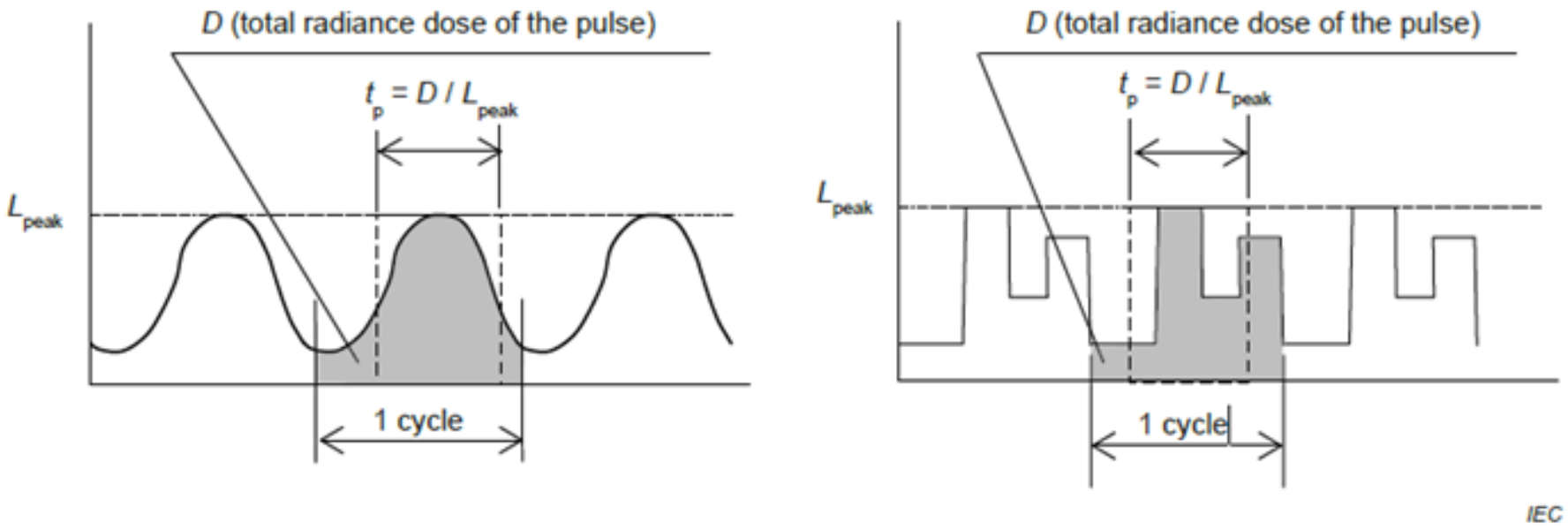

Figure 2 – Examples of the application of the definition of pulse duration

Optical Radiation Hazards

Target Tissue	Hazard	Action Spectrum	Wavelength range, nm	Assessed Quantity	Symbol for emission level	Units
Skin and anterior tissues of the eye	UV	$S_{UV}(\lambda)$	200 – 400	Irradiance	E_s	$W \cdot m^{-2}$
Lens	UV-A,	N/A	315 – 400	Irradiance	E_{UVA}	$W \cdot m^{-2}$
Retina	Blue light	$B(\lambda)$	300 – 700	Spatially-averaged radiance	L_B	$W \cdot m^{-2} \cdot sr^{-1}$
Retina	Blue light, small source	$B(\lambda)$	300 – 700	Irradiance	E_B	$W \cdot m^{-2}$
Retina	Retinal thermal	$R(\lambda)$	380 – 1400	Spatially-averaged radiance	L_R	$W \cdot m^{-2} \cdot sr^{-1}$
Retina	Retinal thermal, weak visual stimulus	$R(\lambda)$	780 – 1400	Spatially-averaged radiance	L_{IR}	$W \cdot m^{-2} \cdot sr^{-1}$
Anterior tissues of the eye	Infrared	N/A	780 – 3000	Irradiance	E_{IR}	$W \cdot m^{-2}$

Evaluation of UV hazard

UV effective irradiance

Spectral irradiance

光譜取樣頻寬
單位: nm

$$E_S = \sum_{200}^{400} E_\lambda S_{UV}(\lambda)\Delta\lambda \text{ , W m}^{-2}$$

UV hazard Action Spectrum

Other Optical Hazards

$$E_{UVA} = \sum_{315}^{400} E_\lambda \Delta\lambda, W\,m^{-2}$$

$$L_B = \sum_{300}^{700} L_\lambda(t)\, B(\lambda)\, \Delta\lambda, W\,m^{-2}sr^{-1}$$

$$E_B = \sum_{300}^{700} E_\lambda\, B(\lambda)\Delta\lambda,\ W\ \mathrm{m}^{-2}$$

$$L_R = \sum_{380}^{1400} L_\lambda\, R(\lambda)\Delta\lambda, \mathrm{W\,m^{-2}\ sr^{-1}}$$

$$L_{IR} = \sum_{780}^{1400} L_\lambda\, R(\lambda)\Delta\lambda, \mathrm{W\,m^{-2}\ sr^{-1}}$$

$$E_{IR} = \sum_{780}^{1000} 0,3\, E_\lambda\, \Delta\lambda + \sum_{1000}^{3000} E_\lambda\, \Delta\lambda, \mathrm{W\,m^{-2}}$$

For pulsed emission, the radiance dose

$$D_R = \int L_R(t)\,\mathrm{dt}$$

Time Base Criteria For Classification

Not Finalized Yet
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Hazard Name	Wavelength range, nm	Time (sec)		
		Exempt Group	Risk Group 1	Risk Group 2
UV	200 – 400	30 000	10 000	1000
UV-A	315 – 400	30 000	300	100
Blue light	300 – 700	10 000	100	0,25
Blue light small source	300 – 700	10 000	100	0,25
Retinal thermal	380 – 1400	0,25	N/A[a]	N/A[a]
Retinal thermal, weak visual stimulus	780 – 1400	100	10	N/A[b]
Corneal/lens IR	780 – 3000	1000	100	10

Angle of acceptance, CW

Hazard Name	Wavelength range, nm	Angle of acceptance γ, rad		
		Exempt Group	Risk Group 1	Risk Group 2
UV	200 – 400	1,4	1,4	1,4
UV-A	315 – 400	1,4	1,4	1,4
Blue-light	300 – 700	0,11	0,011	0,011
Blue-light small source[a]	300 – 700	N/A	N/A	N/A
Retinal Thermal	380-1400	0,011[b]	N/A	N/A
Retinal Thermal weak visual stimulus	780-1400	0,011	0,011	N/A
Corneal/Lens IR	780 – 3000	1,4	1,4	1,4

Emission Limits, CW

Hazard	Wavelength range, nm	Symbol	Emission limits			Units
			Exempt Group	Risk Group 1	Risk Group 2	
UV	200 – 400	E_s	0,001	0,003	0,03	$W \cdot m^{-2}$
UVA	315 – 400	E_{UVA}	0,33	33	100	$W \cdot m^{-2}$
Blue light	300 – 700	L_B	100	10 000	4 000 000	$W \cdot m^{-2} \cdot sr^{-1}$
Blue light, small source	300 – 700	E_B	1,0	N/A	400,0	$W \cdot m^{-2}$
Retinal thermal	380 – 1400	L_R	28 000/α	N/A	N/A[c]	$W \cdot m^{-2} \cdot sr^{-1}$
Retinal thermal, weak visual stimulus	780 – 1400	L_{IR}	6300/α	11 000/α	N/A	$W \cdot m^{-2} \cdot sr^{-1}$
Corneal/Lens IR	780 – 3000	E_{IR}	100	570	3200	$W \cdot m^{-2}$

Hazard related RG Labeling

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Not for Circulation

Hazard	RG1	RG2	RG3
Actinic UV	NOTICE UV emitted from this product.	CAUTION. UV emitted from this product.	WARNING. UV emitted from this product.
UV-A	NOTICE UV emitted from this product.	CAUTION. UV emitted from this product.	WARNING. UV emitted from this product.
Blue Light	-	CAUTION. Possibly hazardous optical radiation emitted from this product.	WARNING. Possibly hazardous optical radiation emitted from this product.
Retinal Thermal	-	CAUTION. Possibly hazardous optical radiation emitted from this product.	WARNING. Possibly hazardous optical radiation emitted from this product.
Retinal Thermal, weak visual stimulus	NOTICE IR emitted from this product.	CAUTION. IR emitted from this product.	WARNING IR emitted from this product.
Corneal/ lens IR	WARNING IR emitted from this product.	WARNING IR emitted from this product.	WARNING IR emitted from this product.

On Protective Measures

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Hazard	Exempt	RG1	RG2	RG3
Actinic UV	-	Minimise exposure to eyes or skin. Use appropriate shielding.	Eye or skin irritation may result from exposure. Use appropriate shielding.	Avoid eye and skin exposure to unshielded product.
UV-A	-	Minimise exposure to eyes or skin. Use appropriate shielding.	Eye or skin irritation may result from exposure. Use appropriate shielding.	Avoid eye and skin exposure to unshielded product.
Blue Light	-	-	Do not stare at operating lamp. May be harmful to the eye	Do not look at operating lamp. Eye injury may result.
Retinal Thermal	-	-	Do not stare at operating lamp. May be harmful to the eye	Do not look at operating lamp. Eye injury may result.
Retinal Thermal, weak visual stimulus	-	Use appropriate shielding or eye protection.	Do not stare at operating lamp.	Avoid eye exposure. Use appropriate shielding or eye protection.
Corneal/ lens IR	-	Do not stare at operating lamp	Do not stare at operating lamp	Do not look at operating lamp

Symbols

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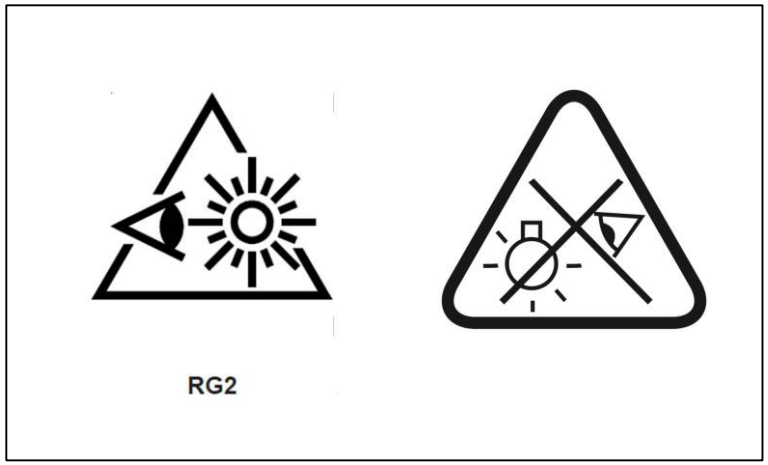
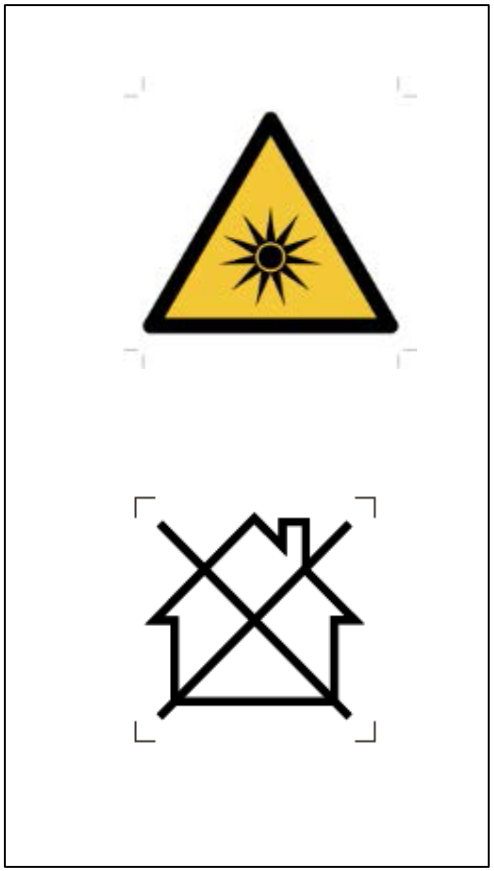
Not for Circulation

RG1

IEC



RG3



Summary

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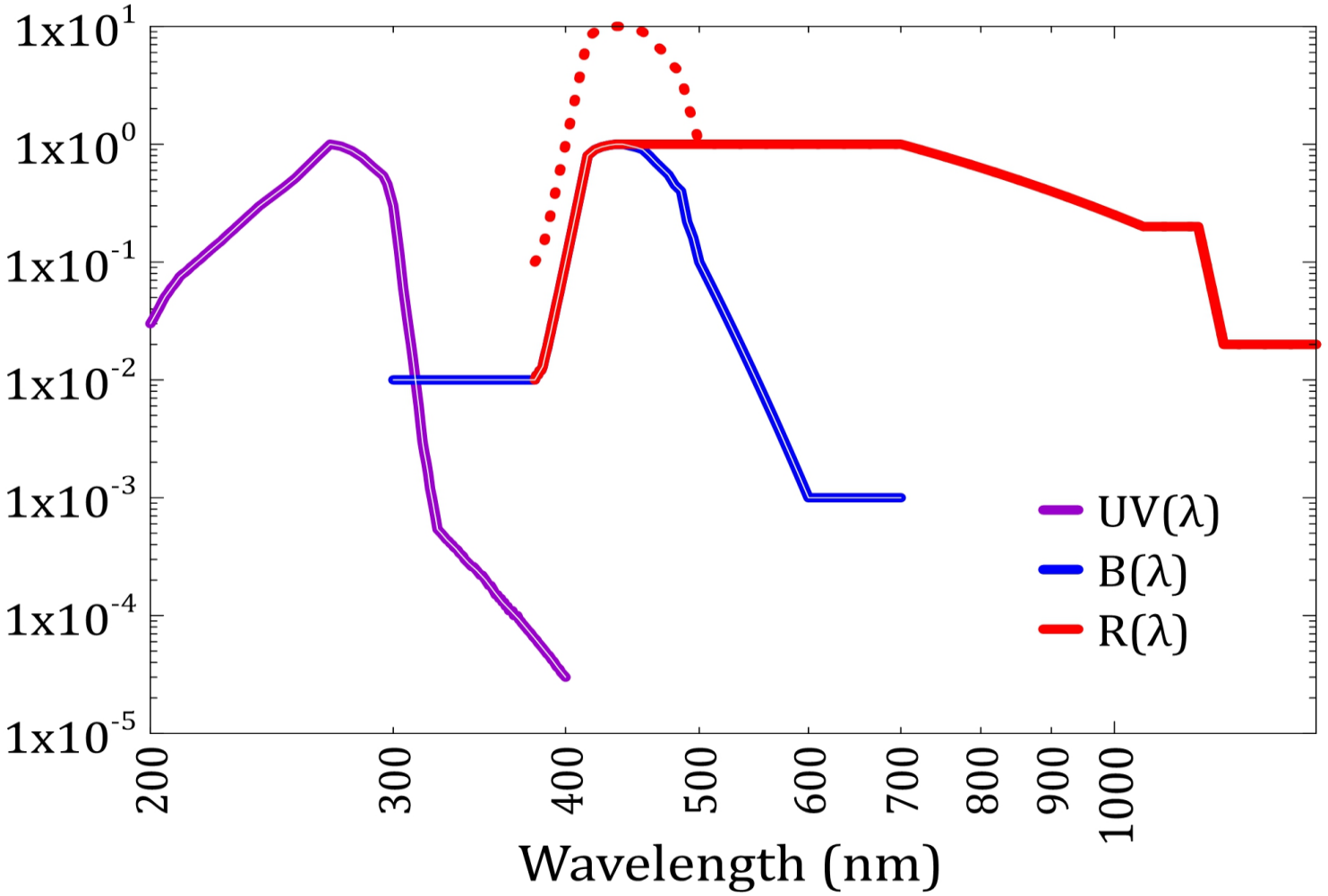
Hazard Name	Wavelength range, nm	Metric	Exposure duration (s)	Exposure Limit Value	Units
UV	200 – 400[a]	H_{eff}^{EL}	t ≤ 30 000	30	$J \cdot m^{-2}$
UVA	315 – 400	H_{UVA}^{EL}	t ≤1000	10 000	$J \cdot m^{-2}$
			1000< t ≤ 30000	10	$W \cdot m^{-2}$
Blue light	300 – 700[b]	D_B^{EL}	0.25 ≤ t ≤ 10000	10^6	$J \cdot m^{-2} \cdot sr^{-1}$
		L_B^{EL}	10000< t ≤ 30000	100	$W \cdot m^{-2} \cdot sr^{-1}$
Blue light, small source	300 – 700[b]	H_B^{EL}	0.25 ≤ t <100	100	$J \cdot m^{-2}$
		E_B^{EL}	100 ≤ t ≤ 30000	1	$W \cdot m^{-2}$
Retinal thermal	380 – 1400[c]	L_R^{EL}	$t < 10^{-6}$	$0.63\ \alpha^{-1}$	$W \cdot m^{-2} \cdot sr^{-1}$
		D_R^{EL}	$10^{-6} \le t < 0.25$	$20\,000\ \alpha^{-1}\ t^{0,75}$	$J \cdot m^{-2} \cdot sr^{-1}$
		L_R^{EL}	$t \ge 0.25$	$28\,000\ \alpha^{-1}$	$W \cdot m^{-2} \cdot sr^{-1}$
Retinal thermal, weak visual stimulus	780 – 1400[c]	L_{WVS}^{EL}	0,25 < t < 100	$20\,000\ \alpha^{-1}\ t^{-0,25}$	$W \cdot m^{-2} \cdot sr^{-1}$
		L_{WVS}^{EL}	t ≥ 100	$6300 \cdot \alpha^{-1}$	$W \cdot m^{-2} \cdot sr^{-1}$
Corneal/lens IR	780 –3000	E_{IR}^{EL}	t < 1000	$18\,000 \cdot t^{-0,75}$	$W \cdot m^{-2}$
			t ≥ 1000	100	$W \cdot m^{-2}$
Skin thermal	380 – 3000	H_{skin}^{EL}	t ≤ 10	$20\,000 \cdot t^{0,25}$	$J \cdot m^{-2}$

Action Spectra



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Thanks for your attention

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