



# **UV CURING FOR FINGER NAILS**

**Robert M. Sayre, Ph. D.**

**RPTL Cordova, TN**

**Division of Dermatology, Dept of Medicine, UTHSC,**

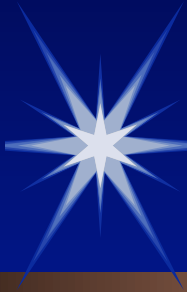
**Memphis, TN**

**Photobiological Safety Evaluation  
of Optical Emission from Finger  
Polish Curing Lamps**

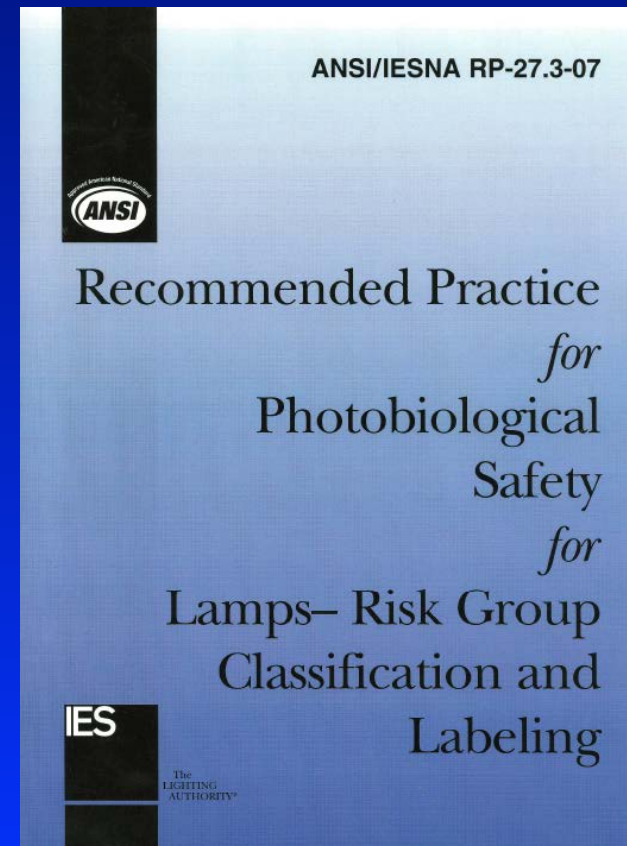
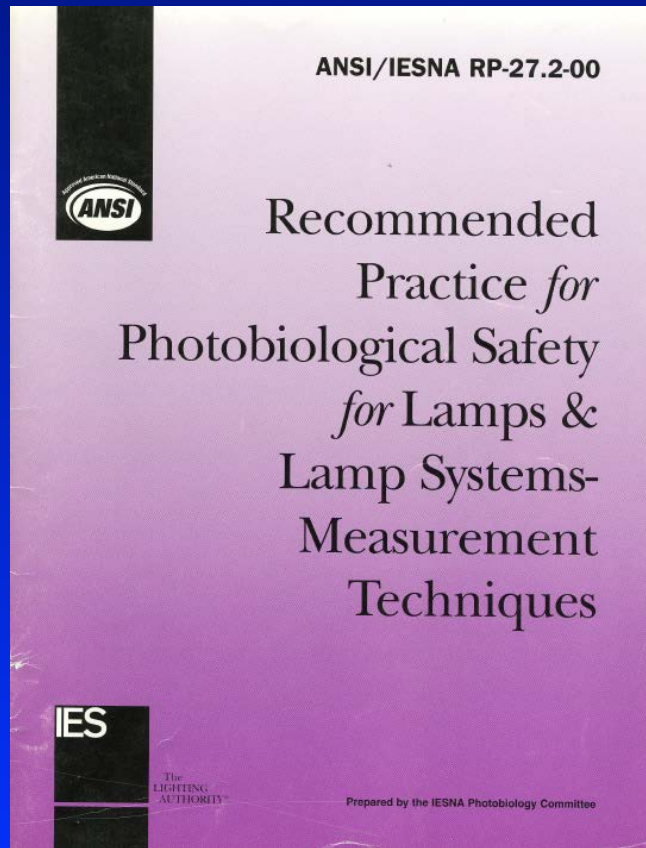


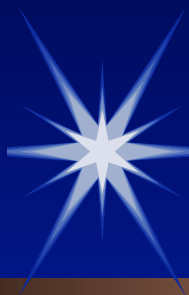
# OUTLINE

- I. **PHOTOBIOLOGICAL SAFETY OF LAMPS**
- II. **CND**
- III. **Light Elegance: EASY CURE**
- IV. **OPI – AXXIUM**
- V. **OPI – LED**
- VI. **Conclusions**



# ANSI/IESNA RP-27.2





# CIE and IEC/CIE



COMMISSION INTERNATIONALE DE L'ÉCLAIRAGE  
INTERNATIONAL COMMISSION ON ILLUMINATION  
INTERNATIONALE BELEUCHTUNGSKOMMISSION

CIE S 009/E:2002

Standard

## Photobiological Safety of Lamps and Lamp Systems

Sécurité photobiologique des lampes et des appareils utilisant les lampes  
Photobiologische Sicherheit von Lampen und Lampensystemen

CIE Standards are copyrighted and shall not be reproduced in any form, entirely or partly, without the explicit agreement of the CIE.

CIE Central Bureau, Vienna  
Keplergasse 27, A-1030 Vienna, Austria

S 009/E:2002

UDC: 612.014.481 Descriptor: Optical radiation effects on human

NORME  
INTERNATIONALE  
INTERNATIONAL  
STANDARD

CEI  
IEC  
62471  
CIE S 009:2002

Première édition  
First edition  
2006-07

Sécurité photobiologique des lampes  
et des appareils utilisant des lampes

Photobiological safety of lamps  
and lamp systems

© IEC 2006 Droits de reproduction réservés — Copyright - all rights reserved

Aucun partie de cette publication ne peut être reproduite ni  
utilisée sous quelque forme que ce soit et par aucun procédé,  
électronique ou mécanique, y compris la photocopie et les  
microfilms, sans l'accord écrit de l'éditeur.

No part of this publication may be reproduced or utilized in any  
form or by any means, electronic or mechanical, including  
photocopying and microfilm, without permission in writing from  
the publisher.

International Electrotechnical Commission, 3, rue de Varembé, PO Box 131, CH-1211 Geneva 20, Switzerland  
Telephone: +41 22 919 02 11 Telex: +41 22 919 02 00 E-mail: [enr@iec.ch](mailto:enr@iec.ch) Web: [www.iec.ch](http://www.iec.ch)



CODE PRIX  
PRICE CODE X

Plus prix, voir catalogue en espère  
For price, see current catalogue



# Photobiological Lamp Safety

**The evaluation and examination focuses on the skin and eyes of not only the user but someone in the vicinity of the device.**



# Photobiological Lamp Safety

**The evaluation and examination focuses on the skin and eyes of not only the user but someone in the vicinity of the device.**

**The device might use general lighting bulbs but because they are used in a differently from normal general lighting, evaluation of the safety of that use requires additional review.**



# Seven risk evaluations are required for a device photosafety analysis

**Table 3: Emission Limits for Risk Groups of Continuous Wave (Non-Pulsed) Lamps**

Risk	Metric	Formula in Section:	Notes	Risk Group			Units
				Exempt	RG-1 (Low-Risk)	RG-2 (Moderate-Risk)	
Actinic UV, $S(\lambda)$	$E_S$	5.4.1		0.1	0.3	3.0	$\mu\text{W}/\text{cm}^2$
Near UV, 320-400 nm	$E_{UV}$	5.4.2		1.0	3.3	10.	$\text{mW}/\text{cm}^2$
Retinal Thermal, $R(\lambda)$	$L_R$	5.4.3		$2.8/\alpha$	$2.8/\alpha$	$7.1/\alpha$	$\text{W}/(\text{cm}^2\text{sr})$
Blue Light, $B(\lambda)$	$L_B$	5.4.4		0.01	1.0	400	$\text{W}/(\text{cm}^2\text{sr})$
Blue Light, $B(\lambda)$	$E_B$	5.4.5	Small Source Alternative	100*	100	900*	$\mu\text{W}/\text{cm}^2$
Cornea/Lens, IR	$E_{IR}$	5.4.6		10.	57.	320.	$\text{mW}/\text{cm}^2$
Low Luminance, Retinal IR	$L_{IR}$	5.4.7	Non GLS Only	$0.6/\alpha$	$0.6/\alpha$	$0.6/\lambda$	$\text{W}/(\text{cm}^2\text{sr})$



# Photobiological Lamp Safety

**Involves generally three types of measurements:**

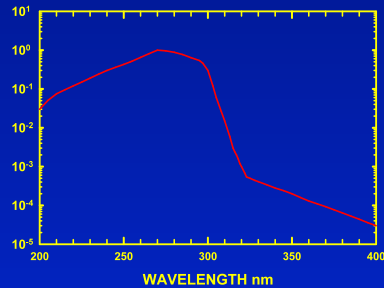
**The first requires determining how close to a source someone's skin or eyes might be when using it and evaluating it at that distance – use distance.**

**The second is evaluating it at the either the GLS (500 LUX) or non-GLS distance of 20 cm.**

**The other distance is how close you can be without risk – minimum hazard distance.**



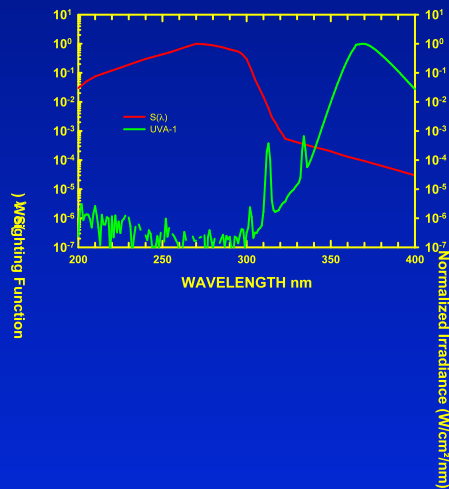
# $S(\lambda)$ UV Hazard Weighting Function



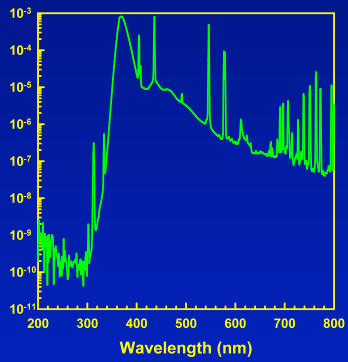
**$S(\lambda)$  extends ~4.5 decades.**

The spectroradiometer used to measure a source to be evaluated using  $S(\lambda)$  must be able to measure 5 or more decades of power. This applies to other functions which must also be evaluated

# $S(\lambda)$ and Normalized UVA-1 Source

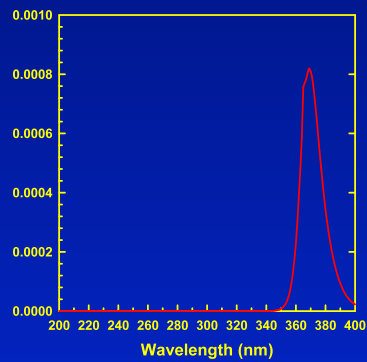


Note: the OL-756 used for this measurement measures at least 6 decades of power. Background noise can be clearly see between the 6 and 7 decade establishing the baseline of the measurements.



**CND UV Lamp, model 08200,  
with UVB9W-365nm/2G7 bulbs  
1 cm from bulb**





**UVB9W-365nm/2G7 bulbs**  
This bulb primarily emits UVA-1 radiation. On this linear plot, you cannot see any emission shorter than the 340 nm UVA-1 spectral region.



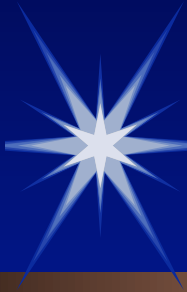


Risk	Metric	+1cm lower shelf	Classification	Units	Wavelength Range (nm)
Actinic UV, S( $\lambda$ )	E <sub>S</sub>	<b>1.387</b>	>0.3 <b>RG-2</b> (Moderate)	$\mu$ W/cm <sup>2</sup>	200-400

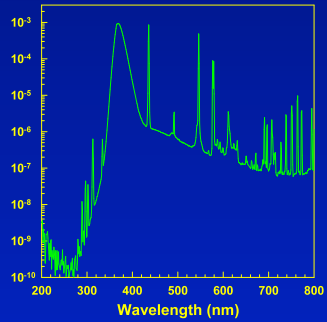
		Source Exposure Limit (sec)	Minimum Group Exposure Limit (sec)			
Risk	Metric	+1cm lower shelf	Exempt	RG-1	RG-2	RG-3
Actinic UV, S( )	E <sub>S</sub>	<b>2162</b>	8 hr	10,000	1,000	<1000

		Source Exposure Limit (sec)			Minimum Group Exposure Limit (sec)			
Risk	Metric	20 cm upper shelf	20 cm upper shelf	20 cm lower shelf	Exempt	RG-1	RG-2	RG-3
Actinic UV, S( $\lambda$ )	E <sub>S</sub>	110044	103760	86410	8 hr	10,000	1,000	<1000
Near UV 320-400 nm	E <sub>UV</sub>	3491	3205	2655	1,000	300	100	<100
Blue Light, B( $\lambda$ )	L <sub>B</sub>	185758	--	--	10,000	100	0.25	<0.25
Aphakic Blue, A( $\lambda$ )	L <sub>B</sub>	13460	--	--	10,000	100	0.25	<0.25





# Light Elegance: EASY CURE



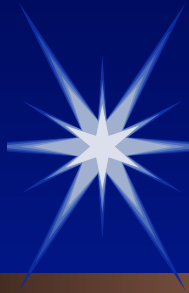
# Light Elegance: EASY CURE

Risk	Metric	+1cm lower surface	Classification	Units	Wavelength Range (nm)
Actinic UV, $S(\lambda)$	$E_s$	<b>1.676</b>	>0.3 <b>RG-2</b> (Moderate)	$\mu\text{W}/\text{cm}^2$	200-400

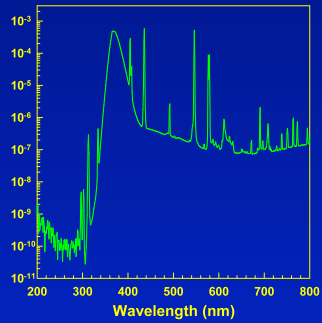
		Source Exposure Limit (sec)	Minimum Group Exposure Limit (sec)			
Risk	Metric	+1cm lower surface	Exempt	RG-1	RG-2	RG-3
Actinic UV, $S(\lambda)$	$E_s$	<b>1789</b>	8 hr	10,000	1,000	<1000

Risk	Metric	20 cm Centered	20 cm 45°	Classification	Units	Wavelength Range (nm)
Actinic UV, $S(\lambda)$	$E_s$	0.078	0.052	<0.1 Exempt	$\mu\text{W}/\text{cm}^2$	200-400
Near UV 320-400 nm	$E_{UV}$	0.354	0.483	<1.0 Exempt	$\text{mW}/\text{cm}^2$	320-400
Retinal Thermal, $R(\lambda)$	$L_R$	0.0000018	0.0000015	<2.8/ $\alpha$ * Exempt	$\text{W}/(\text{cm}^2\text{sr})$	400-1400
Blue Light, $B(\lambda)$	$L_B$	0.0003	0.0004	<0.01 Exempt	$\text{W}/(\text{cm}^2\text{sr})$	400-700
Aphakic Blue, $A(\lambda)$	$L_B$	<b>0.00999</b>	<b>0.014</b>	<b>&gt;0.01, &lt;1.0 RG-1</b>	$\text{W}/(\text{cm}^2\text{sr})$	400-700
Cornea/Lens, IR	$E_{IR}$	0.12	0.048	<10 Exempt	$\text{mW}/\text{cm}^2$	770-3000
Low Luminance, Retinal IR	$L_{IR}$	0.00085	0.00035	<0.6/ $\alpha$ * Exempt	$\text{W}/(\text{cm}^2\text{sr})$	770-1400

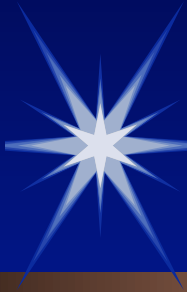




# OPI -- AXIUM







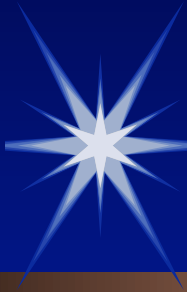
# OPI -- AXXIUM

Risk	Metric	Shelf level centered	+1cm above shelf	Classification	Units	Wavelength Range (nm)
Actinic UV, S( $\lambda$ )	$E_s$	<b>0.875</b>	<b>1.023</b>	>0.3 <b>RG-2</b> (Moderate)	$\mu\text{W}/\text{cm}^2$	200-400

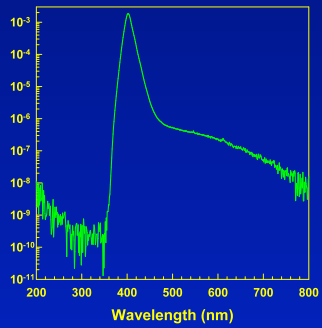
Risk	Metric	Source Exposure Limit (sec)		Minimum Group Exposure Limit (sec)			
		Shelf level centered	+1cm above shelf	Exempt	RG-1	RG-2	RG-3
Actinic UV, S( )	$E_s$	<b>3427</b>	<b>2932</b>	8 hr	10,000	<b>1,000</b>	<1000

Risk	Metric	20 cm Centered	20 cm 45°	Classification	Units	Wavelength Range (nm)
Actinic UV, S( $\lambda$ )	$E_s$	0.010	0.009	<0.1 Exempt	$\mu\text{W}/\text{cm}^2$	200-400
Near UV 320-400 nm	$E_{UV}$	0.105	0.091	<1.0 Exempt	$\text{mW}/\text{cm}^2$	320-400
Retinal Thermal, R( $\lambda$ )	$L_R$	0.0013	0.00073	<2.8/ $\alpha$ * Exempt	$\text{W}/(\text{cm}^2\text{sr})$	400-1400
Blue Light, B( $\lambda$ )	$L_B$	0.000053	0.000050	<0.01 Exempt	$\text{W}/(\text{cm}^2\text{sr})$	400-700
Aphakic Blue, A( $\lambda$ )	$L_B$	0.0018	0.0016	<0.01 Exempt	$\text{W}/(\text{cm}^2\text{sr})$	400-700
Cornea/Lens, IR	$E_{IR}$	0.27	0.014	<10 Exempt	$\text{mW}/\text{cm}^2$	770-3000
Low Luminance, Retinal IR	$L_{IR}$	0.0012	0.00018	<0.6/ $\alpha$ * Exempt	$\text{W}/(\text{cm}^2\text{sr})$	770-1400





# OPI -- Blue Light UV LED



# OPI -- Blue Light UV LED

Risk	Metric	+1cm above table	Classification	Units	Wavelength Range (nm)
Actinic UV, S( )	E <sub>S</sub>	<b>0.387</b>	>0.3 <b>RG-2</b> (Moderate)	μW/cm <sup>2</sup>	200-400

Risk	Metric	+1cm lower shelf	Source Exposure Limit (sec)		Minimum Group Exposure Limit (sec)		
			Exempt	RG-1	RG-2	RG-3	
Actinic UV, S( )	E <sub>S</sub>	<b>7759</b>	8 hr	10,000	1,000	<1000	



Risk	Metric	20 cm Centered	20 cm 45°	Classification	Units	Wavelength Range (nm)
Actinic UV, S(λ)	E <sub>S</sub>	0.014	0.016	<0.1 Exempt	μW/cm <sup>2</sup>	200-400
Near UV 320-400 nm	E <sub>UV</sub>	0.340	0.324	<1.0 Exempt	mW/cm <sup>2</sup>	320-400
Retinal Thermal, R(λ)	L <sub>R</sub>	0.0134	0.0129	<2.8/α * Exempt	W/(cm <sup>2</sup> sr)	400-1400
Blue Light, B(λ)	L <sub>B</sub>	0.00134	0.00093	<0.01 Exempt	W/(cm <sup>2</sup> sr)	400-700
Aphakic Blue, A(λ)	L <sub>B</sub>	0.0068	0.0064	<0.01 Exempt	W/(cm <sup>2</sup> sr)	400-700
Cornea/Lens, IR	E <sub>IR</sub>	0.000036	0.000057	<10 Exempt	mW/cm <sup>2</sup>	770-3000
Low Luminance, Retinal IR	L <sub>IR</sub>	0.01	--	<0.6/α * Exempt	W/(cm <sup>2</sup> sr)	770-1400



# CONCLUSIONS

- 1. Three of the four units used the same lamp phosphor primarily producing UVA-1 radiation 340 nm and longer. Two different lamp bases were employed.**
- 2. The other unit was a blue light LED system. All the UV was from 360 nm and longer.**
- 3. None of the sources evaluated exceeded risk group 2.**
- 4. Total exposure following programmed exposure times and steps (less than ~10 min total) amount to a small fraction of the permissible daily exposure under ANSI/IESNA RP-27.**
- 5. Any risk is further reduced in realistic use scenarios since it is unlikely to be a daily occurrence.**



# MEDs vary on Different Body Areas

Olson, R. L., R. M. Sayre and M. A. Everett (1966) Effect of anatomic location and time on ultraviolet erythema. *Arch Dermatol* **93**, 211-5.

		Average SEDs/MED	SED Range
Trunk	Abdomen	2	1.3 - 3
	Chest	2	1 - 4
	Back	2.3	0.8 - 5
Head	Forehead	2	1 - 5
	Cheek	2	1.5 - 3
	Neck	2.1	1 - 4
Extremities	Ventral Arm	3.4	2 - 6
	Dorsal Arm	3.5	1 - 5
	Ventral Forearm	4	2 - 6
	Dorsal Forearm	4.8	2 - 8
	Lower Leg	7.5	4 - 10
	Dorsum Hand	8	6 - 10

The UV dose required to sunburn varies greatly with anatomical location.

The UV acclimatized back of the hand is least sensitive area.

**Note the Standard Erythemal Dose (SED) is ~1/2 the typical sunburn or minimal erythemal dose (MED) on the trunk.**