YouVeeShield
think health beauty

Summary of ANSI/IESNA RP-27.3-07
Recommended Practice for Photobiological Safety for Lamps – Risk Group Classification and Labeling

Why is this important?
The nail lamps have been examined and placed into "Risk Group" Classifications. This allows the user (the customer) to know under which Risk Group the nail lamps fall under and what warnings are recommended for you to know, either on the nail lamp itself or the manufacturer's instructions.

I will post photos of the various lamps here at www.youveeshield.com on this document page. You will see no such warnings can be found on the lamps.

Most likely, you will not have access to the manufacturer's instructions unless you purchase the nail lamp yourself. Most people do not do this.

The lamps used to cure the gel polishes in the salons today all fall into the Risk Group 2 Category of Lighting Systems. See page 11 for the applicable warnings recommended.

The nail lamp manufacturers are not obligated to post these warnings where the customer is likely to see them. They don't.

RISK TWO LAMPS (ALSO KNOWN AS MODERATE RISK & RG-2, RISK 2) ARE THE HIGHEST RISK GROUP OF LAMPS ALLOWED TO BE USED BY THE GENERAL PUBLIC IN UNSUPERVISED CONDITIONS.

ANSI/IESNA RP-27.3-07

Approved American National Standard

ANSI

Recommended Practice *for* Photobiological Safety *for* Lamps– Risk Group Classification and Labeling

IES

The LIGHTING AUTHORITY®

Contents

Photobiological Safety for Lamps-Risk Group Classification and Labeling

1.0 INTRODUCTION

This standard is the third in a series of standards relating to the photobiological safety of lamps and lamp systems and is devoted to lamp safety. Lamps were developed and produced in large quantities and became commonplace in an era when industry-wide safety standards were not common. The evaluation and control of lamp hazards is a far more complicated subject than similar tasks for a single-wavelength laser system. The required radiometric measurements are quite involved, for they do not deal with the simple optics of a point source, but rather with an extended source which may or may not be altered by diffusers or projection optics. Also, the wavelength distribution of the lamp may be altered by ancillary elements, diffusers, lenses, and the like, as well as by variations in operating voltage.

To evaluate a broad-band optical source, such as an arc lamp, an incandescent lamp, a fluorescent lamp, or an array of lamps, it is necessary to determine the spectral distribution of optical radiation emitted from the source at the point or points of nearest human access. This accessible emission spectral distribution of interest for a lamp system may differ from that actually being emitted by the lamp alone due to the filtration by any optical elements (e.g., projection optics) in the light path. Secondly, the size, or projected size, of the source must be characterized in the retinal hazard spectral region. Thirdly, it may be necessary to determine the variation of irradiance and projected radiance (see **glossary**) with distance. The performance of the necessary measurements is normally not an easy task without sophisticated instruments. Users must normally rely on the expertise of the manufacturers for information on lamps and lamp systems. General safety requirements and reference measurement techniques for lamp and specific lamp systems are provided in other standards of this series.

Finally, there are well known optical radiation hazards associated with some lamps and lamp systems. The purpose of the RP-27 series of standards is to inform the public and original equipment manufacturers (OEM) about potential radiation hazards that may be associated with various lamps and lamp systems. It is also the purpose of these standards to provide guidance, advice, and standard methods for evaluating and informing the user, both the public and the OEM, about the potential optical radiation hazards that may be associated with these products.

The purpose of this standard (RP-27.3) is to provide guidance for the proper categorization, classification, and informational requirements of lamps so that such sources may be properly applied in the design of lamp systems, recognizing that lamps commonly are used in a system or device of some type.

2.0 SCOPE

This standard covers the classification, labeling and informational requirements for lamps that emit optical radiation in the wavelength range from 200 nm to 3000 nm except for light emitting diodes used in optical fiber communication systems and for lasers which are covered in a separate series of ANSI standards (Series Z136). Federal mandatory requirements for lamps subject to specific Federal Regulations take precedence over requirements included in this consensus standard.

Note 1: Units of wavelength in this document are exclusively in nanometers (nm).

Note 2: Subtended angles are denoted by the full included angle, not the half angle.

3.0 DEFINITIONS

For standard nomenclature and definitions, radiometric and photometric quantities, and illuminating engineering terminology, refer to ANSI/IESNA RP-16-2005, *Nomenclature and Definitions for Illuminating Engineering*. Certain frequently used terms are defined in the **glossary**.

3.1 Blue Light Hazard

Potential for a photochemically induced retinal injury resulting from radiation exposure at wavelengths primarily between 400 nm and 500 nm. This damage mechanism dominates over thermal for times exceeding 10 s.

3.2 Continuous Wave (CW) Lamp

A lamp that is operated with a continuous output for a 0.25 s period of time or greater, i.e., a non pulsed lamp (see **Section 3.15**). In this standard, General Lighting Source (GLS) lamps (see **Section 3.7**) are defined to be Continuous Wave Lamps.

3.3 Emission Limit

A limit defined for each Risk Group, based upon reasonably foreseeable conditions of exposure. It

incorporates both the concept of exposure duration and exposure distance and is derived from exposure limits.

3.4 Exempt Group
See **Section 4.3**.

3.5 Exposure Limit
A value of exposure to the eye or skin that is not expected to result in adverse biological effects.

3.6 Exposure Distance
Nearest points of human exposure consistent with the application of the lamp.

3.7 General Lighting Source (GLS)
A general term for lamps, nominally of white color, intended for lighting spaces that are typically occupied or viewed by people. Examples would be lamps for lighting offices, schools, homes, factories, roadways, or automobiles. It does not include lamps for such uses as film projection, reprographic processes,

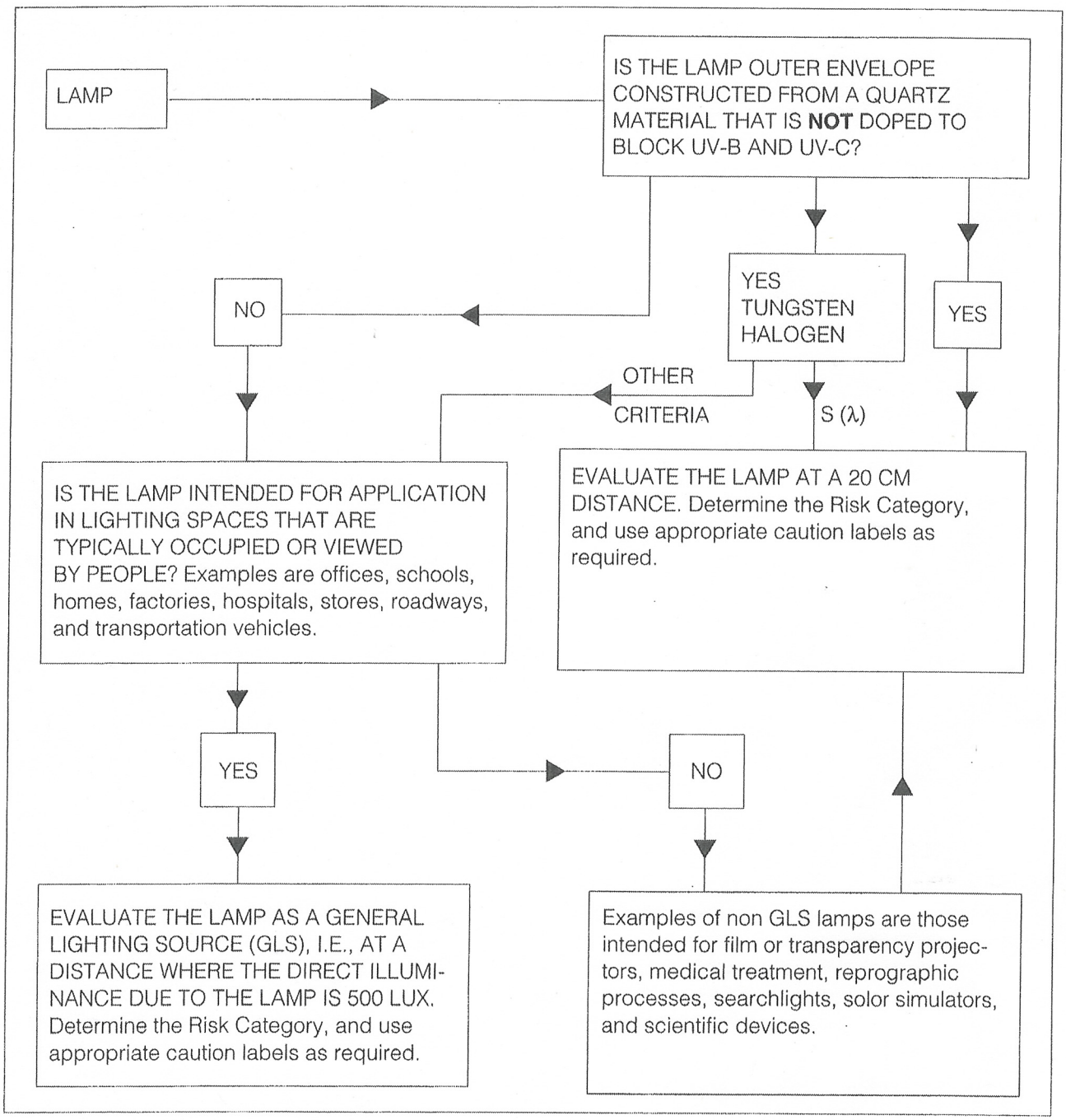

Figure 1. Process for identifying lamps in the General Lighting Source (GLS) lamp category.

"suntanning," industrial processes, medical treatment, and searchlight applications. It also does not include lamps with outer envelopes constructed from quartz material that is not doped to block UV-B and UV-C (see **Section 3.20**). Although lamps with undoped quartz outer envelopes may be used in locations typically occupied by people, their potential to emit UV power requires that they be more carefully evaluated. **Figure 1** defines the process for identifying lamps in the GLS lamp category for the purposes of this document.

3.8 Hazard Distance
See Skin Hazard Distance or Ocular Hazard Distance

3.9 Infrared Radiation
For practical purposes any radiant energy within the wavelength range 770 nm to 10^6 nm. The infrared spectrum is divided into three spectral bands for safety purposes: IR-A (770 nm to 1400 nm), IR-B (1400 nm to 3000 nm), and IR-C (3000 nm to 10^6 nm).

Note: Infrared radiation is generally evaluated in terms of its irradiance, i.e., the spectral total radiation incident per unit of the irradiated surface. Examples of application of infrared radiation are industrial heating, drying, baking, and photo reproduction. Some applications, such as infrared viewing systems, involve detectors sensitive to a restricted range of wavelengths; in these cases, the spectral characteristics of the source and detector are of importance.

3.10 Lamp
A generic term for a man-made source of light. As used in this standard, the term means an electrically powered source, other than a light emitting diode (LED) when used in a fiber-optic communication system or a laser. By extension, the term is also used to denote sources that radiate in regions of the spectrum adjacent to the visible region, i.e., in the ultraviolet and infrared spectral ranges. Devices that generate light and have integral components for optical control, such as lenses or reflectors, also are considered lamps. Some examples are a lens-end lamp and a PAR lamp with reflector or lens cover.

Note: A device consisting of a lamp with shade, reflector, enclosing globe, housing, or other accessories is often called a "lamp." However, in this standard, a lamp with such other components is termed a "lamp system" to distinguish between the assembled unit and the light source within it.

3.11 Lamp System
Any manufactured product or assemblage of components which incorporates, or is intended to incorporate a lamp.

3.12 Lamp Packaging
Any lamp carton, outer wrapping, or other means of containment that is intended for the storage, shipment, or display of a lamp(s) or that is intended to identify the contents or to recommend its use.

3.13 Ocular Hazard Distance
The distance from a source within which the projected radiance (see glossary) or irradiance exceeds the applicable exposure limit for momentary (0.25 s to 0.5 s) viewing.

3.14 Photokeratoconjunctivitis
An inflammatory response of the cornea and conjunctiva following exposure to ultraviolet (UV) radiation. Wavelengths shorter than 320 nm are most effective in causing photokeratoconjunctivitis. The peak of the action spectrum is approximately at 270 nm.

3.15 Pulsed Lamp
A lamp that delivers its energy in the form of a single pulse or a train of pulses where each pulse shall have a time duration of less that 0.25 s.

Note 1: The duration of a lamp pulse is the time interval between the half-power points on the leading and the trailing edges of the pulse.

Note 2: In this standard, General Lighting Source lamps are defined to be continuous Wave Lamps (see **Section 3.2**). Examples of pulsed lamps include photoflash lamps, flashlamps in photocopy machines, and strobe lights.

3.16 Retinal Burn
A photochemical or thermal retinal lesion.

3.17 Retinal Hazard Region
The spectral region from 400 nm to 1400 nm (visible plus IR-A) within which the normal ocular media transmit optical radiation to the retina.

3.18 Risk Group (RG)
See **Section 4.3.**

3.19 Skin Hazard Distance
The distance at which the irradiance exceeds the applicable exposure limit for 8 hours exposure.

3.20 Ultraviolet Radiation
For practical purposes, any radiation within the wavelength range from 100 nm to 400 nm. The UV-C extends from 100 nm to 280 nm, UV-B from 280 nm to 315 nm, and UV-A from 315 nm to 400 nm as defined by the Commission Internationale de l'Eclairage (CIE). Frequently in photobiology, the wavelength bands are taken as UV-C from 200 nm to 290 nm, UV-B from 290 nm to 320 nm, and UV-A from 320 nm to 400 nm. Ultraviolet radiation at wavelengths less than 180 nm is considered vacuum ultraviolet radiation.

3.21 Visible Radiation
Radiation within the wavelength range from 380 nm to 770 nm. (See "light" in the glossary.)

3.22 Visual Angle
The angle subtended by an object or detail at the point of observation. It usually is measured in radians, milliradians, degrees or minutes of arc.

4.0 LAMP SAFETY GROUPS

4.1 General
Lamps are categorized according to the degree of the hazard associated with them in either an Exempt Group or one of three Risk Groups. Risk Group 1 includes Low-Risk Sources, Risk Group 2 includes Moderate-Risk Sources, and Risk Group 3 includes High-Risk Sources (as defined in **Section 5.5**). The Exempt Group consists of those lamps for which no risks have been identified under realistic use conditions. Control measures and safety performance engineering requirements become more important and more stringent with increasing risk category (e.g., Risk Group 3).

4.2 Types of Lamps and Light Sources
The following types of lamps are covered in this standard: incandescent filament lamps including tungsten halogen types and incandescent heating sources, low pressure discharge lamps, high intensity discharge (HID) lamps, short arc lamps, carbon arcs, electroluminescent lamps, and light-emitting diodes, except as used with optical fibers.

Note: Some light sources such as radioactive-phosphor combinations, radioactive phosphorescent panels, and gas lamps are never sufficiently bright to be of concern from an optical hazard standpoint.

4.3 Lamp Classifications
Since lamps may be hazardous from several aspects, a classification scheme is helpful. The Risk Group scheme applies only to lamps. The class indicates only the potential risk. Depending upon use factors, time of exposure, and fixturing, these potential hazards may or may not actually become real hazards. Other standards in this series are intended to deal with specific applications, e.g., a fixture, copying machine, or scientific instrument.

4.3.1 *Exempt Group.* The philosophical basis for the Exempt Group classification is that the lamp does not pose any photobiological hazard for the end points in this standard. This requirement is met by any lamp that does not pose an actinic ultraviolet hazard (E_S) within 8-hours exposure, nor a near-ultraviolet hazard (E_{UV}) nor an infrared cornea/lens hazard (E_{IR}) within 1,000 s, nor retinal thermal hazard (L_R) within 10 s, nor a blue-light hazard (L_B) within 10,000 s (about 2.8 hours), and these lamps are in the Exempt Group. Also, lamps that emit infrared radiation without a strong visual stimulus (i.e., less than 10 cd • m^{-2}) and do not pose a near-infrared retinal hazard (L_{IR}) within 100 s are in the Exempt Group.

4.3.2 *Risk Group 1 (Low-Risk).* The philosophical basis for this classification is that the lamp does not pose a hazard due to normal behavioral limitations on exposure. This requirement is met by any lamp that exceeds the limits for the Exempt Group but that does not pose an actinic ultraviolet hazard (E_S) within 10,000 s (i.e., about 2.8 hrs.), nor a near ultraviolet hazard (E_{UV}) within 300 s, nor a blue-light hazard (L_B), nor an infrared cornea/lens hazard (E_{IR}) within 100 s, nor a retinal thermal hazard (L_R) within 10 s, and these lamps are in Risk Group 1, (Low-Risk). Also, lamps that emit infrared radiation without a strong visual stimulus (i.e., less than 10 cd • m^{-2}) and do not pose a near-infrared retinal hazard (L_{IR}), within 100 s are in Risk Group 1 (Low-Risk).

4.3.3 *Risk Group 2 (Moderate-Risk).* The philosophical basis for the Risk Group 2 (Moderate Risk) classification is that the lamp does not pose a hazard due to the aversion response to very bright light sources or due to thermal discomfort. This requirement is met by any lamp that exceeds the limits for Risk Group 1 (Low-Risk), but that does not pose an actinic ultraviolet hazard (E_S) within 1,000 s exposure, nor a near ultraviolet hazard (E_{UV}) within 100 s, nor an infrared cornea/lens hazard (E_{IR}) within 10 s, nor a retinal thermal hazard (L_R), nor the blue-light hazard (L_B) within 0.25 s (aversion response), and such lamps are in Risk Group 2 (Moderate-Risk). Also, lamps that emit infrared radiation without a strong visual stimulus (i.e., less than 10 cd • m^{-2}) and do not pose a near-infrared retinal hazard (L_{IR}) within 10 s are in Risk Group 2 (Moderate-Risk).

4.3.4 *Risk Group 3 (High-Risk).* The philosophical basis for this classification is that the lamp may pose a hazard even for momentary or brief exposure. Lamps which exceed the limits for Risk Group 2 (Moderate-Risk) are in Risk Group 3 (High-Risk).

5.0 EMISSION LIMITS

5.1 General
Personnel working with or in the vicinity of lamps and lamps systems should not be exposed to harmful levels of ultraviolet, visible, and infrared radiation. Actual exposure depends on factors beyond those of the lamp itself, e.g., the luminaire or optical device

characteristics, the spatial location of exposure, and the duration of exposure. Consequently, lamp evaluation and subsequent risk labeling of lamps must involve assumptions about the use of lamps.

5.2 Basis for Evaluation

Threshold Limit Values of the American Conference of Governmental Industrial Hygienists (see RP-27.1, Section 4.0) are applied under either standardized typical or potentially worst exposure conditions. These criteria values are recognized as guides in the control of exposure to ultraviolet, visible, and infrared radiation and are not to be taken as fine lines between safe and dangerous exposure. Emission limits are defined for each Risk Group and are based upon reasonably foreseeable conditions of exposure as described in **Section 4**. Thus, the emission limits incorporate both the concepts of exposure duration and exposure distance and are derived from exposure limits.

5.3 Evaluation Categories

5.3.1 *General Lighting Source (GLS) Lamps.* These are lamps for which sound assumptions of typical use can be made. They are to be evaluated at:

- a distance where illuminance from the lamp is 500 lux, or,
- a distance of 20 cm from the outermost integral bulb surface of the lamp if the 500 lux distance is less than 20 cm.

Figure 1 shows the process of identifying GLS lamps.

Note: The 500 lux value does not represent illuminance values for spaces that GLS lamps are intended to light (see **Section 3.7**). The UV irradiance at this distance from a lamp correlates with the typically highest time-weighted average values that can occur with conventional general lighting systems.

Table 1: Spectral Weighting Function for Assessing Ultraviolet Hazards

Wavelength[1] λ, nm	UV Hazard Function S(λ)	Wavelength λ, nm	UV Hazard Function S(λ)
		310	0.015
		313*	0.006
200	0.030	315	0.003
205	0.051	316	0.0024
210	0.075	317	0.0020
215	0.095	318	0.0016
220	0.120	319	0.0012
225	0.150	320	0.0010
230	0.190	322	0.00067
235	0.240	323	0.00054
240	0.300	325	0.00050
245	0.360	328	0.00044
250	0.430	330	0.00041
254*	0.500	335	0.00034
255	0.520	340	0.00028
260	0.650	345	0.00024
265	0.810	350	0.00020
270	1.000	355	0.00016
275	0.960	360	0.00013
280*	0.880	365*	0.00011
285	0.770	370	0.000093
290	0.640	375	0.000077
295	0.540	380	0.000064
297*	0.460	385	0.000053
300	0.300	390	0.000044
303*	0.120	395	0.000036
305	0.060	400	0.000030
308	0.026		

[1] Wavelengths chosen are representative; other values should be interpolated at intermediate wavelengths.
* Emission lines of a mercury discharge spectrum.

5.3.2 *Non General Lighting Source Lamps.* Lamps in this category are those for which assumptions about typical conditions of use are uncertain and those that are more likely to represent a significant hazard under a broad range of use conditions. These lamps are to be evaluated at a probable worst case distance of 20 cm from the effective radiating surface.

5.3.3 *Special Case Lamps.* Certain lamps may not be uniquely identified as being in the category 5.3.1 or 5.3.2 or may require special consideration. In such situations, individual documents in the RP-27 series will be used to address the issues.

5.4 Continuous Wave Lamp Emission Limits

These equations relate to radiance and irradiance as applied directly to the Continuous Wave Lamp (non pulsed lamp) criteria. (See **Section 5.7** for Pulsed Lamp equations). Refer to RP-27.1, Section 4.0 for relevant background information.

5.4.1 *E_S-S(λ) Weighted Ultraviolet Irradiance.* To evaluate the actinic ultraviolet hazard criterion by the spectrally weighted ultraviolet irradiance, E_S, the following formula shall be used:

$$E_S = \sum_{200}^{400} E_\lambda \bullet S(\lambda) \bullet \Delta\lambda \qquad (1)$$

where:

E_S is the S(λ) weighted ultraviolet irradiance in $W \bullet cm^{-2}$

E_λ is the spectral irradiance in $W \bullet cm^{-2} \bullet nm^{-1}$

S(λ) is the ultraviolet hazard weighting function (see **Table 1**)

Δλ is the calculation interval in nm

the summation extends from 200 nm to 400 nm

5.4.2 *E_{UV} - Unweighted Ultraviolet Irradiance.* To evaluate the 320 nm to 400 nm ultraviolet hazard criterion by the unweighted ultraviolet irradiance, E_{UV}, the following formula shall be used:

$$E_{UV} = \sum_{200}^{800} E_\lambda \bullet \Delta\lambda \qquad (2)$$

where:

E_{UV} is the unweighted ultraviolet irradiance in $W \bullet cm^{-2}$

E_λ is the spectral irradiance in $W \bullet cm^{-2} \bullet nm^{-1}$

Δλ is the calculation interval in nm

the summation extends from 320 nm to 400 nm

*Notes for **Section 5.4.1** and **Section 5.4.2:***

Note 1: The above ultraviolet irradiances, E_S and E_{UV}, apply to sources that subtend an angle of less than 80° (1.4 radian), i.e., sources within 40° of the normal to the irradiance area. Sources that subtend a greater angle need to be measured only over an angle of 80°.

Note 2: A limiting aperture no greater than 2.5 cm diameter shall be used with sources producing a uniform optical radiation pattern. However, with sources of optical radiation that do not produce a uniform optical radiation pattern (i.e., contain hot spots less than 2.5 cm), a 7 mm aperture shall be used to assess the effect of hot spots. The measurement shall be made in that position of the beam giving the maximum reading.

5.4.3 *L_R-R(λ) Weighted Radiance.* To evaluate the retinal thermal hazard criterion by the spectrally weighted radiance L_R, the following formula shall be used:

$$L_R = \sum_{400}^{1400} L_\lambda \bullet R(\lambda) \bullet \Delta\lambda \qquad (3)$$

where:

L_R is the R(λ) weighted radiance in $W \bullet cm^{-2} \bullet sr^{-1}$

L_λ is the spectral radiance expressed in $W \bullet cm\text{-}2 \bullet sr^{-1} \bullet nm^{-1}$

Δλ is the calculation interval in nm

R(λ) is the burn hazard weighting function from **Table 2**

the summation extends from 400 nm to 1400 nm

The angle α (see **Table 3**) is needed in applying the L_R criterion, and α is the angular subtense of the source in radians defined by the 50 percent peak radiance points. For a non-circular projected source area, α is determined from the arithmetic mean of the shortest and the longest dimensions. For example, α for a 20 cm long by 3 cm diameter tubular source at a viewing distance of r = 200 cm in a direction normal to the lamp axis would be determined from the mean dimension, ℓ = (20+3)/2 = 11.5 cm.

$$\alpha = \ell / r = 11.5/200 = 0.058 \text{ radian}$$

If the calculated α exceeds 0.1 radian, use α = 0.1 in conjunction with **Equation 3**. If the calculated α is less than 0.011 radian, use α = 0.011 radian in conjunction with **Equation 3**.

Note 1: L_λ shall be averaged over a right circular cone field-of-view of 0.011 radian included angle.

Note 2: In the case of multiple source elements that are not contiguous, this criterion applies to a single source element. Also, it applies to the source as a whole when the average radiance over the full source is used.

Note 3: For a 10 s exposure a 3 mm diameter ocular pupil is assumed.

5.4.4 *L_B - B(λ) Weighted Radiance.* To evaluate the retinal photochemical blue light hazard criterion

Table 2: Spectral Weighting Functions for Assessing Retinal Hazards from Broad-Band Optical Sources

Wavelength nm	Blue-Light Hazard Function B (λ)	Retinal Thermal Hazard Function R (λ)
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	0.0063
385	0.0125	0.0125
390	0.025	0.025
395	0.05	0.05
400	0.10	0.10
405	0.20	0.20
410	0.40	0.40
415	0.80	0.80
420	0.90	0.90
425	0.95	0.95
430	0.98	0.98
435	1.0	1.0
440	1.0	1.0
445	0.97	1.0
450	0.94	1.0
455	0.90	1.0
460	0.80	1.0
465	0.70	1.0
470	0.62	1.0
475	0.55	1.0
480	0.45	1.0
485	0.40	1.0
490	0.22	1.0
495	0.16	1.0
500-600	$10^{[(450-\lambda)/50]}$	1.0
600-700	0.001	1.0
700-1050	N/A	$10^{[(700-\lambda)/500]}$
1050-1150	N/A	0.2
1150-1200	N/A	$0.2 \times 10^{[0.02(1150-\lambda)]}$
1200-1400	N/A	0.02

N/A = Not Applicable

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

Risk	Metric	Formula in Section:	Notes	Exempt	RG-1 (Low-Risk)	RG-2 (Moderate-Risk)	Units
				Risk Group			
Actinic UV, S(λ)	E_S	5.4.1		0.1	0.3	3.0	μW/cm²
Near UV, 320-400 nm	E_{UV}	5.4.2		1.0	3.3	10.	mW/cm²
Retinal Thermal, R (λ)	L_R	5.4.3		2.8/α	2.8/α	7.1/α	W/(cm²sr)
Blue Light, B(λ)	L_B	5.4.4		0.01	1.0	400	W/(cm²sr)
Blue Light, B(λ)	E_B	5.4.5	Small Source Alternative	100*	100	900*	μW/cm²
Cornea/Lens, IR	E_{IR}	5.4.6		10.	57.	320.	mW/cm²
Low Luminance, Retinal IR	L_{IR}	5.4.7	Non GLS Only	0.6/α	0.6/α	0.6/λ	W/(cm²sr)

Note 1: Refer to specific sections for averaging requirements on radiance and irradiance measurements and for definition of angle α.

Note 2: L_{IR} applies only to sources where $L \leq 10$ cd/m².

Note 3: General Lighting Source (GLS) lamps are evaluated at a distance where direct light from the lamp produce 500 lux but not at a distance less than 20 cm. (See **Section 5.3.1.**)

Note 4: Non General Lighting Source lamps are evaluated at a distance of 20 cm.

Note 5: A lamp exceeding any Exposure Limit of RG-2 is in RG-3.

* See **Section 5.4.4**, Note 1.

---

by the spectrally weighted radiance L_B, the following formula shall be used:

$$L_B = \sum_{300}^{700} L_\lambda \bullet B(\lambda) \bullet \Delta\lambda \qquad (4)$$

where:

L_B is the B(λ) weighted radiance in W • cm^{-2} • sr^{-1}

L_λ is the spectral radiance expressed in W • cm^{-2} • sr^{-1} • nm^{-1}

Δλ is the calculation interval in nm

B(λ) is the blue light hazard weighting function from **Table 2**

the summation extends from 300 nm to 700 nm

Note 1: Lλ shall be averaged over a right circular cone field-of-view of 0.11 radian included angle for the Exempt Group (i.e., 10,000 s criterion). The 0.11 radian field-of-view used herein is greater than the 0.011 radian field-of-view specified in RP-27.1. In evaluating the *potential* of risk (see **Section 4.3**), it is assumed that an individual will not maintain a stable fixation on a very small light source for prolonged periods of time and that a spatial averaging of the source image will occur over a reasonable retinal area. For a 0.25 s exposure, the limited eye movement reduces the field of view to 0.0017 radian.

Note 2: L_λ shall be averaged over a right circular cone field-of-view of 0.011 radian included angle for the Risk Group-1 and 0.0017 radian included angle for Risk Group-2 criteria.

Note 3: In the case of multiple source elements that are not contiguous, this criterion applies to a single source element. Also, it applies to the source as a whole when the average radiance over the full source is used.

5.4.5 *E_B - B(λ) Weighted Irradiance - Small Source.* To evaluate the retinal photochemical blue light hazard criterion for a source subtending an angle less than 0.011 radian (11 milliradian) by the spectrally weighted irradiance at the cornea, E_B, the following formula shall be used:

$$E_B = \sum_{300}^{700} E_\lambda \bullet B(\lambda) \bullet \Delta\lambda \qquad (5)$$

where:

E_B is the B(λ) weighted irradiance in W • cm^{-2}

E_λ is the spectral irradiance in W • cm^{-2} • nm^{-1}

Δλ is the calculation interval in nm

B(λ) is the blue light hazard weighting function from **Table 2**

the summation extends from 300 nm to 700 nm

Note 1: A limiting aperture no greater than 2.5 cm diameter shall be used with sources producing a uni-

form optical radiation pattern. However, with sources of optical radiation that do not produce a uniform optical radiation pattern (i.e., contain hot spots less than 2.5 cm), a 7 mm aperture shall be used to assess the effect of hot spots. The measurement shall be made in that position of the beam giving the maximum reading.

Note 2: This small source equation is equivalent to using **Section 5.4.4** (L_B) with the spatial averaging for small sources specified in "Note 1" of that section.

5.4.6 E_{IR} - *Unweighted Infrared Irradiance.* To evaluate the ocular lens and corneal hazard criterion by the unweighted infrared irradiance, E_{IR}, the following formula shall be used:

$$E_{IR} = \sum_{770}^{3000} E_\lambda \bullet \Delta\lambda \qquad (6)$$

where:

E_{IR} is the unweighted infrared irradiance in W • cm^{-2}
E_λ is the spectral irradiance in W • cm-2 • nm-1
$\Delta\lambda$ is calculation interval in nm
the summation extends from 770 nm to 3000 nm

Note: A limiting aperture no greater than 2.5 cm diameter shall be used with sources producing a uniform optical radiation pattern. However, with sources of optical radiation that do not produce a uniform optical radiation pattern (i.e., contain hot spots less than 2.5 cm), a 7 mm aperture shall be used to assess the effect of hot spots. The measurement shall be made in that position of the beam giving the maximum reading.

5.4.7 L_{IR} - *Unweighted Infrared Radiance.* To evaluate the retinal hazard criterion for near infrared sources where a strong visual stimulus is absent by the unweighted infrared radiance, L_{IR}, the following formula shall be used:

$$L_{IR} = \sum_{770}^{1400} L_\lambda \bullet \Delta\lambda \qquad (7)$$

where:

L_{IR} is the unweighted infrared radiance in W • cm^{-2} • sr^{-1}
L_λ is the spectral radiance in W • cm^{-2} • sr^{-1} • nm^{-1}
$\Delta\lambda$ is the calculation interval in nm
the summation extends from 770 nm to 1400 nm

The angle α (in radians) (see **Table 3**) as described in **Section 5.4.3** is needed (including issues of non circular sources and averaging over a 0.011 radian field-of-view) when applying **Equation 7**.

A strong visual stimulus is defined herein as one whose maximum luminance (averaged over a circular field-of-view subtending 0.011 radian) is greater than 10 cd • m^{-2}.

Note: L_λ shall be averaged over a right circular cone field-of-view of 0.011 radian included angle.

5.5 Risk Group Evaluation for Continuous Wave Lamps

- A lamp shall be evaluated either as a General Lighting Source lamp (see **Section 5.3.1**) or as a Non General Lighting Source lamp (see **Section 5.3.2**).

- Emission Limits for determination of Risk Group classification are given in **Table 3**.

Note 1: These Emission Limits are derived from the Risk Group time criteria of **Section 4.3** as summarized in Table 4 together with the Exposure Limits defined in RP-27.1, **Section 4.0**.

Note 2: Calculational equations for lamp emission quantities together with the ancillary measurement requirements are given in **Section 5.4**.

- If the emissions of a lamp do not exceed any of the Emission Limits for the Exempt Group, then the lamp is in the Exempt Group.

- If a lamp is not in the Exempt Group and if its emissions do not exceed any of the Emission Limits for Risk Group 1, then the lamp is in Risk Group 1 (Low-Risk).

- If a lamp is not in the Exempt Group, nor in Risk Group 1, and if its emissions do not exceed any of the Emission Limits for Risk Group 2, then the lamp is in Risk Group 2 (Moderate-Risk).

- If a lamp is not in the Exempt Group, nor in Risk Group 1, nor in Risk Group 2, then the lamp is in Risk Group 3 (High-Risk).

- Continuous Wave Lamps shall be evaluated at the highest nominal power loading. This shall be established by the manufacturer's specified operating conditions.

5.6 Risk Group Evaluation of Pulsed Lamps

Pulsed Lamp criteria shall apply both to a single pulse and to any group of pulses within 0.25 second.

Note: Pulsed Lamp criteria do not apply to General Lighting Source lamps.

- A lamp that passes the Pulsed Lamp emission limits of **Section 5.7** shall be in the Exempt Group except as qualified in the next paragraph. A lamp that does not pass the Pulsed Lamp emission limits of **Section 5.7** shall be in Risk Group 3.

Table 4: Risk Group Time Criteria for Continuous Wave (Non-Pulsed) Lamps

Risk	Metric	Formula in Section:	Risk Group: Exempt	RG-1 (Low-Risk)	RG-2 (Moderate-Risk)
Actinic UV, S(λ)	E_S	5.4.1	8 hr	10,000 s	1,000 s
Near UV, 320-400 nm	E_{UV}	5.4.2	1,000 s	300 s	100 s
Retinal Thermal, R(λ)	L_R	5.4.3	10 s	10 s	0.25 s
Blue Light, B(λ)	L_B	5.4.4	10,000 s	100 s	0.25 s
Blue Light, B(λ)*	E_B	5.4.5	10,000 s	100 s	0.25 s
Cornea/Lens IR	E_{IR}	5.4.6	1,000 s	100 s	10 s
Low Luminance, Retinal IR	L_{IR}	5.4.7	1,000 s	100 s	10 s

*Small Source Alternative

- Pulsed lamps that are repetitively pulsed and that fall in the Exempt Group per the criteria of **Section 5.7** shall further be evaluated by the Continuous Wave Lamp criteria for Risk Group assessment. The criteria for Continuous Wave Lamps shall be applied to the time averaged values of repetitively pulsed lamps.

- A Pulsed Lamp shall be evaluated at its highest nominal energy loading. This shall be established by the manufacturer's specified operating conditions.

5.7 Pulsed Lamp Emission Limits

The nominal pulse duration, Δt, for Pulsed Lamp evaluation is determined by the time interval between the half-power points on the leading and trailing edges of the pulse. The energy integration time, t, is the full pulse width, with t limited to a maximum of 0.25 s.

5.7.1 *H_S - S(λ) Weighted Ultraviolet Radiant Exposure*

$$H_S = \int_t E_S \bullet dt \qquad (8)$$

where:

H_S is the (λ) weighted ultraviolet radiant exposure in J • cm^{-2}

E_S is the weighted spectral irradiance in W • cm^{-2} as defined in **Section 5.4.1**

t is time in seconds

A lamp is not in the Exempt Group if:
$H_S > 0.003$ J • cm^{-2}

5.7.2 *H_{UV} - Unweighted Ultraviolet Radiant Exposure.*

$$H_{UV} = \int_t E_{UV} \bullet dt \qquad (9)$$

where:

H_{UV} is the unweighted ultraviolet radiant exposure in J • cm^{-2}

E_{UV} is the unweighted ultraviolet irradiance in W • cm^{-2} as defined in **Section 5.4.2**

t is time in seconds

A lamp is not in the Exempt Group if: $H_{UV} > 1.0$

5.7.3 *(L_R • t) - R(λ) Weighted Radiance Dose.*

$$(L_R \bullet t) = \int_t L_R \bullet dt \qquad (10)$$

where:

(L_R • t) is the R(λ) weighted radiance dose in J • cm^{-2} • sr^{-1}

L_R is the weighted spectral radiance in W • cm^{-2} • sr^{-1} as defined in **Section 5.4.3**

t is time in seconds

However, for Pulsed Lamp evaluation if the 0.011 radian field-of-view is insufficiently small to measure hot-spots the spectral radiance, L_λ, shall be averaged over a right circular cone field-of-view of 0.00175 radian included angle.

A lamp is not in the Exempt Group if:
$(L_R \bullet t) > 5(\Delta t)^{0.75}/\alpha$

Note: Angle α (in radians) is defined in **Section 5.4.3**, and Δt is defined in **Section 5.7**.

5.7.4 *(L_B • t) - B(λ) Weighted Radiance Dose.*

$$(L_B \bullet t) = \int_t L_B \bullet dt \qquad (11)$$

where:

(L_B • t) is the B(λ) weighted radiance dose in J • cm^{-2} • sr^{-1}

L_B is the weighted spectral radiance in W • cm^{-2} • sr^{-1} as defined in **Section 5.4.4** except that for Pulsed Lamp evaluation the spectral radiance, L_λ, shall be averaged over a right circular cone field-of-view of 0.011 radian included angle.

t is time in seconds

A lamp is not in the Exempt Group if: (L_B •t) > 100

5.7.5 *H_{IR} - Unweighted Infrared Radiant Exposure.*

$$H_{IR} = \int_t E_{IR} \bullet dt \qquad (12)$$

where:
H_{IR} is the unweighted infrared radiant exposure in $J \bullet cm^{-2}$
E_{IR} is unweighted infrared irradiance in $W \bullet cm^{-2}$ as defined in **Section 5.4.6**
t is time in seconds

A lamp is not in the Exempt Group if:
$H_{IR} > 1.8(\Delta t)^{0.25}$

5.7.6 (L_{IR}•t) - Unweighted Infrared Radiance Dose.

$$(L_{IR} \bullet t) = \int_t L_{IR} \bullet dt \qquad (13)$$

where
(L_{IR}•t) is the unweighted infrared radiance dose in $J \bullet cm^{-2} \bullet sr^{-1}$
L_{IR} is the unweighted infrared radiance in $W \bullet cm^{-2} \bullet sr^{-1}$ as defined in **Section 5.4.7**
t is time in seconds

However, for Pulsed Lamp evaluation if the 0.011 radian field-of-view is insufficiently small to measure hot-spots, the spectral radiance L_λ shall be averaged over a right circular cone field-of-view of 0.00175 radian included angle.

A lamp is not in the Exempt Group if:
$(L_{IR} \bullet t) > 20(\Delta t)^{0.75}/\alpha$

Note 1: Angle α is defined in **Section 5.4.3**, and t is defined in **Section 5.7**.

Note 2: This criterion, as does **Section 5.4.7**, applies to near infrared sources where a strong visual stimulus is absent. A strong visual stimulus is defined herein as one whose maximum time integrated luminance (averaged over a circular field-of-view subtending 0.00175 radian) is greater than $3 lm \bullet s \bullet m^{-2} \bullet sr^{-1}$.

6.0 SPECIFIC LABELING REQUIREMENTS

6.1 Labeling Equivalency

Caution labels are intended to inform and instruct both Original Equipment Manufacturers and end users regarding pertinent safety related information that should be communicated for lamps that are classified by the manufacturer under Risk Groups 1, 2, or 3.

A caution label shall provide these elements of information in an abbreviated or simplified manner, and, variations in specific language shall still convey the same basic information elements to be considered "equivalent." The elements are:

- A statement of "caution" or "warning," sometimes called the signal word.
- A statement of the potential hazard. This should simply advise as to what might be expected to occur (i.e., skin irritation, or eye injury).
- A list of what precautions could or should be taken to avoid the risk. Examples include information on shielding or a warning against staring at a particular source.
- An abbreviated statement that specifies the Risk Group Classification for Risk Groups 1, 2, or 3 (i.e., ANSI RG1, ANSI RG2, ANSI RG3 or RG-1, RG-2, RG-3).

6.2 Product Identification

Each RG-1, RG-2, or RG-3 lamp with unique or distinctive spectral emissions that would influence its photochemical effectiveness at wavelengths less than 400 nm shall be identified with a corresponding unique coding, designation, or other identification in lamp product information, catalogs, lamp packaging, and in other information provided to the user or purchaser.

6.3 Labeling

6.3.1 *Risk Group 1 (RG-1).* ALSO KNOWN AS LOW RISK

6.3.2 *Risk Group 2 (RG-2)* ALSO KNOWN AS MODERATE RISK

6.3.3 *Risk Group 3 (RG-3).* ALSO KNOWN AS LAMPS NOT ALLOWED TO BE USED BY THE GENENERAL PUBLIC

6.4 Labeling Examples

The following labels (or their equivalent) shall appear on packaging, as applicable:

6.4.1 Ultraviolet Hazard, E_S and E_{UV}
Exempt Group: Not required. ALSO KNOWN AS NO RISK

RG-1: CAUTION. UV emitted from this lamp. Minimize exposure. Shielding lamps via glass or plastic normally produces adequate protection.

RG-1 Alternate: CAUTION. UV emitted from this lamp. Skin or eye irritation. Minimize exposure.

RG-2: CAUTION. UV emitted from this lamp. Possible skin or eye irritation can result from exposures exceeding 15 minutes in a day. Use appropriate shielding.

RG-3: WARNING. UV emitted from this lamp. Skin or eye injury could result. Avoid exposure of eyes and skin to unshielded lamp.

6.4.2 *Retinal Thermal and Blue Light Hazards, L_R and L_B or E_B*

Exempt Group: Not required.

RG-1: Not required.

RG-2: CAUTION. Do not stare at exposed lamp in operation. May be harmful to the eyes.

RG-3: WARNING. Do not look at exposed lamp in operation. Eye injury can result.

6.4.3 *Cornea/Lens Infrared Hazard, E_{IR}*

Exempt Group: Not required.

RG-1: CAUTION. IR emitted from this lamp. Appropriate eye protection should be used when daily exposure at short distances is greater than 15 minutes.

RG-2: CAUTION. IR emitted from this lamp. Appropriate eye protection should be used when working in the vicinity of this lamp.

RG-3: WARNING. IR emitted from this lamp. Avoid eye exposure without appropriate protection.

6.4.4 *Retinal Thermal, Low Visible Light, L_{IR}*
Exempt Group: Not required

RG-1: CAUTION. IR emitted from this lamp. Do not stare at exposed lamp.

RG-2: CAUTION. IR emitted from this lamp. Do not stare at exposed lamp.

RG-3: WARNING. IR emitted from this lamp. Do not look at this lamp from distances less than _____ meters (or feet).

6.5 Technical Information

A lamp manufacturer shall provide or cause to be provided upon request representative spectral distribution data for the lamps it manufactures in the form of: (1) spectral radiant power, or (2) spectral radiance, or (3) spectral intensity, or (4) spectral irradiance, and the lumen-to-radiant power conversion factor. The data shall be provided over the wavelength range 300-800 nm. If there is potentially hazardous emission in the range 200-1400 nm, the data range shall be extended to include it.

The manufacturer should provide, upon request, available radiometric information relating to the potential hazards associated with the lamps it manufactures (e.g., effective ultraviolet irradiance at a reference distance or alternatively, for general lighting sources at a reference illuminance level of 500 lux [50 footcandles], the lamp's luminance and radiance). This may also include engineering design suggestions for protective enclosures, globes, fixtures, and luminaires.

A lamp manufacturer should provide (or cause to be provided upon request), representative spectral irradiance in SI units at reference conditions [as specified in the first paragraph of **Section 6.5**] for lamps it manufacturers to clearly specify the spectral emissions of the lamps over the wavelength range from 200 nm to 1400 nm.