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Recommended Practice for Photobiological Safety for Lamps and Lamp Systems –General Requirements



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**Recommended Practice for
Photobiological Safety
for Lamps and Lamp Systems –
General Requirements**

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has been approved by IES.
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directed to IES.

Prepared by:
The Photobiology Committee of the
Illuminating Engineering Society of North America

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Prepared by
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1.0 INTRODUCTION

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 optical elements, diffusers, lenses, and the like, as well as variations in operating voltage.

To evaluate a broad-band optical source, such as an arc lamp, an incandescent lamp, a fluorescent lamp, an array of lamps or a lamp system, it first 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 lighting 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 should be characterized in the retinal hazard spectral region. Thirdly, it may be necessary to determine the variation of irradiance and projected radiance (see the **Glossary**) with distance. The performance of the necessary measurements is not an easy task without sophisticated instruments. Users should normally rely upon the expertise of manufacturers for information on lamps and lamp systems. Safety requirements and reference measurement techniques for lamps and specific lamp systems are provided in later standards of this series (i.e., *ANSI/IES RP-27.2-00/R2010 Recommended Practice for Photobiological Safety for Lamps & Lamp Systems – Measurement Techniques* and *ANSI/IES RP-27.3-07 Recommended Practice for Photobiological Safety for Lamps – Risk Group Classification Labeling*).

Finally, there are well known optical radiation hazards associated with some lamps and lamp systems. The purpose of these standards is to inform the public and original equipment manufacturers (OEMs) 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.

2.0 SCOPE

This Recommended Practice covers the evaluation and control of optical radiation hazards from all electrically powered sources of optical radiation that emit in the wavelength range from 200 nm through 3,000 nm (3.0 μm [micrometers]) except for light emitting diodes (LEDs) used in optical fiber communication systems and for lasers which are covered in a separate series of ANSI (American National Standards Institute) standards (Series Z136). Federal mandatory requirements for lamps subject to specific Federal Regulations take precedence over requirements in subsequent standards included in this series.

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/IES RP-16-2010, Nomenclature and Definitions for Illuminating Engineering*. Certain frequently used terms are defined in the **Glossary**.

3.1 Assessment Distance

Distance for Risk Group classification is based upon reasonably foreseeable worst-case exposure. This is not generally the measurement distance, e.g., the distance to an illuminance of $>500 \text{ lx}$ (46.5 fc) for a GLS (general lighting source) lamp or luminaire.

3.2 Blue Light Hazard

There is 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** (see **Annex Section A3.3** for Ham reference).

3.3 Continuous Wave (CW) Lamp

Defined as 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, GLS lamps are defined to be Continuous Wave lamps.



3.4 Emission Limit

The limiting value of radiance or irradiance at the assessment distance for a specific potential photobiological hazard for a given Risk Group.

3.5 Erythema

The temporary reddening of the skin such as the delayed reddening produced by exposure to actinic ultraviolet radiation or the rapid reddening produced by heat, such as from exposure to intense infrared radiation (see **Section 3.12**).

Note: The degree of delayed erythema is used as a guide to dosages applied in ultraviolet therapy.

3.6 Exposure Limit

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

3.7 Effective Exposure Distance

Nearest points of human exposure consistent with the time-weighted average (TWA) exposure specified for the application of the lamp (e.g., at 500 lx (46.5 fc) for GLS).

3.8 General Lighting Source, GLS

A general term for lamps 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, "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 3.19**). Although lamps with un-doped quartz outer envelopes may be used in locations typically occupied by people, their potential to emit ultraviolet power requires that they be more carefully evaluated. The process for classifying lamps is described in sections of the third document in this series, *ANSI/IES RP 27.3 Recommended Practice for Photobiological Safety for Lamps - Risk Group Classification and Labeling*.

3.9 Hazard Distance

See Skin Hazard Distance (**Section 3.18**) or Ocular Hazard Distance (**Section 3.13**).

3.10 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 the spectral total radiation per unit area (irradiance) incident upon a surface. Examples of applications 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.

3.11 Lamp

The generic name for a man-made source of light is "lamp." As used in this standard, the term means an electrically powered source, other than an LED 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. Examples include a lens-end lamp, and a PAR (parabolic reflector) lamp with a reflector or lens cover.

Note: A device consisting of a lamp with shade, reflector, enclosing globe, housing, or other accessories has often been 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.

3.12 Lamp System

Any manufactured product or assemblage of components which incorporates, or is intended to incorporate a lamp is considered to be a "lamp system," e.g., a luminaire.

3.13 Lamp Packaging

Any 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 is considered to be "lamp packaging."



3.14 Minimal Perceptible Erythema (MPE)

The minimum erythema dose (MED) is the radiant exposure density, e.g., $J \cdot m^{-2}$, that is just sufficient to elicit a perceptible delayed erythema, i.e., a minimum perceptible erythema (MPE). The MED varies with skin type, time between exposure and evaluation, and ultraviolet spectral distribution (see **Section 3.3**).

3.15 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**) viewing.

3.16 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.

3.17 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 than **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, GLS lamps are defined to be Continuous Wave lamps (see **Section 3.2**). Examples of pulsed lamps include photoflash lamps, flash lamps in photocopy machines, and strobe lights.

3.18 Retinal Thermal Hazard

A photochemical or thermal retinal lesion.

3.19 Retinal Hazard Spectral Region

The spectral region from 380 nm to 1400 nm (visible plus IR-A) within which the normal ocular media transmit optical radiation to the retina.

3.20 Skin Hazard Distance

The distance at which the irradiance exceeds the applicable RG-2 emission limit for TWA (time weighted exposure) exposure.

3.21 Time-Weighted-Average (TWA) Exposure

The time-integrated-average exposure equivalent to that which would apply to the exposure dose of a potential photochemical (UV or blue-light) hazard without the movement of the individual or the source (refer to **Section 3.1** for distance information).

3.22 Ultraviolet Radiation

For practical purposes, UV radiation is 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 some sub-sectors of 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 ~180-200 nm is considered vacuum ultraviolet radiation. Note that the radiation between 380 nm and 400 nm is also considered visible radiation (see **Section 3.21**) although it also is within the formal definition of the ultraviolet band – the overlap intended to stress the transition band.

3.23 Visible Radiation

Radiation within the wavelength range from 380 nm to 780 nm is considered to be visible radiation (See “light” in the **Glossary**).

3.24 Visual Angle

The angle subtended by an object or detail at the point of observation is considered to be the visual angle. It usually is measured in radians, milliradians, degrees, or minutes of arc.

4.0 EXPOSURE LIMITS

4.1 General

Personnel working with or in the vicinity of lamps and lamp systems should not be exposed to levels exceeding the following limits.

These criteria are based on recommendations for Threshold Limit Values (TLVs®) of the American Conference of Governmental Industrial Hygienists and recommendations in publications of the International Commission on Non-ionizing Radiation Protection (ICNIRP) (see Bioeffect Datasheet #7). The specific techniques of applying these criteria to lamps and lamp systems are given in later standards

