



**Illuminating**  
ENGINEERING SOCIETY

**ANSI/IES RP-27.2-00/R17**

# **Recommended Practice for Photobiological Safety for Lamps and Lamp Systems – Measurement Techniques**



## **Recommended Practice for Photobiological Safety for Lamps and Lamp Systems-Measurement Techniques**

Publication of this Recommended Practice  
has been approved by IES.  
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Prepared by:  
The Photobiology Committee of the  
Illuminating Engineering Society

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*Approved by the IES Board of Directors, Nov. 7, 2010, as a Transaction of the Illuminating Engineering Society.*

*Approved as an American National Standard, Jan. 5, 2011.*

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Published by the Illuminating Engineering Society, 120 Wall Street, New York, New York 10005.

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ISBN # 978-0-87995-321-8

Printed in the United States of America.

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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 of Lamps and Lamp Systems—Measurement Techniques

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## 1.0 INTRODUCTION

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This standard is the second in a series of standards relating to the photobiological safety of lamps and lamp systems and is devoted to measurement of sources for the purpose of hazard evaluation.

Following the recommendations of this standard, an experienced practitioner with adequate equipment and time will achieve precision and accuracy necessary for the classification of lamps and lamp systems and the verification of results.

The measurement of optical radiation for the purpose of computing photobiological effective quantities as used in the ANSI/IES RP-27 series poses a significant challenge. Photobiological action spectra, such as the UV Hazard Weighting Function,  $S(\lambda)$ , have rapidly changing values with slight changes in wavelength. Furthermore, sources such as lamps with glass envelopes have rapidly increasing output within the same ultraviolet wavelength band where the UV Hazard Weighting Function  $S(\lambda)$  is rapidly decreasing. This can be seen in **Annex C, Figure C-5**. Hence, substantial inaccuracies in weighted results can arise from small measurement uncertainties.

The testing done for this series of standards shall include a full analysis of the uncertainty in the results. This requirement leads to several corollary requirements.

- The testing shall be done by persons experienced in radiometry.
- The equipment used shall be fully characterized.
- The testing shall be scrutinized for all influences and sources of error.

This standard recommends a double monochromator system for measurements used in classifying sources, although such instrumentation may not be practical for some types of testing. The standard therefore provides guidance on the use of other methods and when they may be appropriate. Alternative measurement methods described shall be used with full understanding of the limitations of each, and the method selected should be traceable back to spectral measurements. Further, the testing shall include a full analysis of the uncertainty of the results. The equipment used shall be fully characterized and all sources of error documented.

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## 2.0 SCOPE

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The ANSI/IES RP-27 series of standards applies to all electrically powered sources of optical radiation that emit in the wavelength range from 200 nm to 3,000 nm. The standards do not apply to any lasers or to those light emitting diodes used in optical fiber communication systems.

This standard is to be used by the radiometrist for guidance regarding special problems related to photobiological hazard measurements. Additionally, specific recommendations are included to provide consistency and to reduce test design time and effort.

It is impractical for this standard to teach all of the concepts or provide all experience needed to make accurate photobiological safety measurements.

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## 3.0 REFERENCES

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### 3.1 Normative References

The following documents contain provisions which, through reference in this text, constitute provisions of the American National Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this American National Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

ANSI/IESNA RP-27.1-1996, *Photobiological Safety of Lamps and Lamp Systems - General Requirements*. New York: Illuminating Engineering Society of North America.

ANSI/IESNA RP-16-1996, *Nomenclature and Definitions for Illuminating Engineering*. New York: Illuminating Engineering Society of North America.

IESNA LM-9-2000, *Electrical and Photometric Measurements of Fluorescent Lamps*. New York: Illuminating Engineering Society of North America.

IESNA LM-20-1994, *Method for Photometric Testing of Reflector Type Lamps*. New York: Illuminating Engineering Society of North America.

IESNA LM-45-2000, *Electrical and Photometric Measurements of General Service Incandescent Filament Lamps*. New York: Illuminating Engineering Society of North America.