

TECHNICAL REPORT



Photobiological safety of lamps and lamp systems – Part 4: Measuring methods

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 29.140.01, 31.260

ISBN 978-2-8322-5734-0

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD	5
INTRODUCTION	7
1 Scope	8
2 Normative references	8
3 Terms, definitions and abbreviated terms	8
3.1 Terms and definitions	8
3.2 Abbreviated terms	10
4 Application	10
4.1 General	10
4.2 Safety precautions	10
4.3 Hazard assessment overview	10
4.4 Selection of hazards	11
4.5 Assessment levels	11
4.6 Initial filtering	12
4.7 Measurement quantities	12
4.7.1 Emission wavelengths	12
4.7.2 Irradiance	13
4.7.3 Radiance	14
4.7.4 Source size and location	16
4.7.5 Temporal emission	18
4.8 Measurement uncertainty	18
5 Test conditions	19
5.1 General	19
5.2 Dark room (level A)	19
5.3 Environmental conditions (level A)	19
5.4 Power supply	19
5.5 Product configuration	19
5.5.1 General	19
5.5.2 Warm up	20
5.5.3 Measurement distance	20
5.6 Optical alignment	22
6 Performance characteristics: level A instruments	22
6.1 General	22
6.2 Spectral irradiance and radiance	23
6.2.1 Spectral analysis	23
6.2.2 Entrance optics	25
6.2.3 Calibration standards	26
6.3 Imaging devices	27
6.4 Temporal emission	27
6.5 Source size and location	28
7 Performance characteristics: level B instruments	28
7.1 General	28
7.2 Irradiance or radiance	28
7.2.1 General	28
7.2.2 UV lines	29

7.2.3	Narrow band sources	29
7.2.4	Known spectral distribution	29
7.2.5	Luminance-based	30
7.3	Apparent source location and subtense	31
7.4	Temporal emission	31
Annex A (informative) Hazard selection		32
Annex B (informative) Instrumentation description		33
B.1	Double monochromators	33
B.2	Single monochromators	33
B.3	Array spectrometers	33
B.4	Detectors	33
B.5	Entrance optics	34
B.6	Measurement geometries	36
B.6.1	Irradiance	36
B.6.2	Radiance	36
B.7	2D imaging detector	39
Annex C (informative) Extrapolation of spectral irradiance for thermal radiators		41
Annex D (informative) Temporal emission measurement		43
D.1	General	43
D.2	Pulse duration	43
D.3	Averaged irradiance and averaged radiance	44
Annex E (informative) Uncertainty analysis		47
Annex F (informative) Application examples		48
F.1	General	48
F.2	Example 1 – LED flashlight	48
F.3	Example 2 – Infrared tungsten filament lamp	49
F.4	Example 3 – Compact fluorescent lamp (CFL)	51
F.5	Example 4 – LED bulb	53
Annex G (informative) Stray radiation		54
Annex H (informative) Report		56
H.1	General	56
H.2	Report	56
Annex I (informative) Relationship between "true" source radiance and spatially averaged radiance		58
Bibliography		62
Figure 1 – Schematic representation of irradiance measurement		14
Figure 2 – Consideration of filling of FOV		15
Figure 3 – Example of a direct measurement of radiance using a lens and aperture		15
Figure 4 – Indirect measurement of radiance		16
Figure 5 – Example of a rectangular source		18
Figure 6 – Example of the non-uniform radiance distribution		18
Figure 7 – Example of the emission profiles		22
Figure B.1 – Examples of the diffuser optics		35
Figure B.2 – Schematic representation of irradiance measurement		36
Figure B.3 – Geometry of radiance measurement with a single thin lens		37

Figure B.4 – Geometry of a general radiance measurement	38
Figure B.5 – Setup of the aperture stop behind the lens	38
Figure B.6 – Setup of the aperture stop in front of the lens	39
Figure B.7 – Example of a 2D imaging detector	40
Figure D.1 – Example of temporal pulse wave	44
Figure D.2 – Example of a colour-tunable white LED lamp	44
Figure D.3 – A single pulse wave	45
Figure D.4 – Example of a spectrally variable pulse	46
Figure F.1 – Example of a LED flashlight	48
Figure F.2 – Example of a radiance profile	49
Figure F.3 – Spectral radiance distribution	49
Figure F.4 – Example of an infrared tungsten filament lamp	50
Figure F.5 – Example of a radiance profile	50
Figure F.6 – Spectral radiance and irradiance distributions	51
Figure F.7 – Radiance profile of the lamp	51
Figure F.8 – Example of a compact fluorescent lamp (CFL)	51
Figure F.9 – Example of a radiance profile	52
Figure F.10 – Spectral radiance and irradiance distribution	52
Figure F.11 – Example of a radiance profile	53
Figure F.12 – Example of a LED bulb	53
Figure I.1 – Usual measurement conditions for the determination of (time integrated) radiance	59
Figure I.2 – $B(\lambda)$ -weighted radiance distribution of a phosphor-coated white LED component	60
Table 1 – Optical radiation hazards considered by IEC 62471	11
Table 2 – Recommended wavelength accuracy	24
Table 3 – Recommended bandwidths	24
Table A.1 – Examples of potential risk categories	32

INTERNATIONAL ELECTROTECHNICAL COMMISSION

PHOTOBIOLOGICAL SAFETY OF LAMPS AND LAMP SYSTEMS –**Part 4: Measuring methods**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

IEC TR 62471-4 has been prepared by IEC technical committee 76: Optical radiation safety and laser equipment. It is a Technical Report.

The text of this Technical Report is based on the following documents:

Draft	Report on voting
76/654/DTR	76/707/RVDTR

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this Technical Report is English.

A list of all the parts in the IEC 62471 series, under the general title *Photobiological safety of lamps and lamp systems*, can be found on the IEC website.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

Most lamps and lamp systems are safe and do not pose photobiological hazards except under unusual exposure conditions, whilst a full photobiological safety assessment requires sophisticated instrumentation and detailed analysis.

In order to provide a framework for the application of detailed measurement only where such is necessary, this document introduces two measurement approaches. Level A encompasses high accuracy, laboratory-based techniques whilst level B represents an estimation of the accessible emission using readily available instrumentation.

PHOTOBIOLOGICAL SAFETY OF LAMPS AND LAMP SYSTEMS –

Part 4: Measuring methods

1 Scope

This part of IEC 62471, which is a Technical Report, provides manufacturers, test houses, safety personnel and others with practical guidance on methods to perform radiometric and spectroradiometric measurements to determine the level of accessible optical radiation emitted by lamps and lamp systems in accordance with IEC 62471.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 62471:2006, *Photobiological safety of lamps and lamp systems*