IEC TR 62471-4

Edition 1.0 2022-09

TECHNICAL REPORT

colour inside

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.

® Registered trademark of the International Electrotechnical Commission

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*