Protection against lightning –
Part 1:
General principles
Protection against lightning –
Part 1:
General principles

© IEC 2006 Copyright - all rights reserved

No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from the publisher.

International Electrotechnical Commission, 3, rue de Varembé, PO Box 131, CH-1211 Geneva 20, Switzerland
Telephone: +41 22 919 02 11  Telefax: +41 22 919 03 00  E-mail: inmail@iec.ch  Web: www.iec.ch
# CONTENTS

## FOREWORD

INTRODUCTION

1. **Scope**  
   2. **Normative references**  
   3. **Terms and definitions**  
   4. **Lightning current parameters**  
   5. **Damage due to lightning**
   
   - 5.1 **Damage to a structure**  
   - 5.2 **Damage to a service**  
   - 5.3 **Types of loss**
   6. **Need and economic convenience for lightning protection**
   
   - 6.1 **Need for lightning protection**  
   - 6.2 **Economic convenience of lightning protection**
    
7. **Protection measures**
   
   - 7.1 **Protection measures to reduce injury of living beings due to touch and step voltages**  
   - 7.2 **Protection measures to reduce physical damage**  
   - 7.3 **Protection measures to reduce failure of electrical and electronic systems**  
   - 7.4 **Protection measures selection**
   8. **Basic criteria for protection of structures and services**
    
   - 8.1 **Lightning protection levels (LPL)**  
   - 8.2 **Lightning protection zones (LPZ)**  
   - 8.3 **Protection of structures**  
   - 8.4 **Protection of services**

---

Annex A (informative) **Parameters of lightning current**

Annex B (informative) **Time functions of the lightning current for analysis purposes**

Annex C (informative) **Simulation of the lightning current for test purposes**

Annex D (informative) **Test parameters simulating the effects of lightning on LPS components**

Annex E (informative) **Surges due to lightning at different installation points**

Bibliography
Figure 1 – Types of loss and corresponding risks resulting from different types of damage..................................................................................................................................................39
Figure 2 – LPZ defined by an LPS (IEC 62305-3)..................................................................................................................................................................................49
Figure 3 – LPZ defined by protection measures against LEMP (IEC 62305-4) ..................................................................................................................................................................................51
Figure A.1 – Definitions of short stroke parameters (typically $T_2 < 2$ ms)................................................................................................................................................................................................59
Figure A.2 – Definitions of long stroke parameters (typically $2$ ms $< T_{\text{long}} < 1$ s)................................................................................................................................................................................................61
Figure A.3 – Possible components of downward flashes (typical in flat territory and to lower structures)..................................................................................................................................................................................61
Figure A.4 – Possible components of upward flashes (typical to exposed and/or higher structures)................................................................................................................................................................................................63
Figure A.5 – Cumulative frequency distribution of lightning current parameters (lines through 95 % and 5 % value)..................................................................................................................................................................................69
Figure B.1 – Waveshape of the current rise of the first short stroke ........................................................................................................................................................................................................77
Figure B.2 – Waveshape of the current tail of the first short stroke ........................................................................................................................................................................................................79
Figure B.3 – Waveshape of the current rise of the subsequent short strokes ........................................................................................................................................................................................................81
Figure B.4 – Waveshape of the current tail of the subsequent short strokes ........................................................................................................................................................................................................83
Figure B.5 – Amplitude density of the lightning current according to LPL I..........................................................................................................................................................................................................85
Figure C.1 – Example test generator for the simulation of the specific energy of the first short stroke and the charge of the long stroke ........................................................................................................................................................................................................89
Figure C.2 – Definition for the current steepness in accordance with Table C.3 ........................................................................................................................................................................................................91
Figure C.3 – Example test generator for the simulation of the front steepness of the first short stroke for large test items ........................................................................................................................................................................................................93
Figure C.4 – Example test generator for the simulation of the front steepness of the subsequent short strokes for large test items ........................................................................................................................................................................................................93
Figure D.1 – General arrangement of two conductors for the calculation of electrodynamic force .........................................................................................................................................................................................................109
Figure D.2 – Typical conductor arrangement in an LPS ......................................................................................................................................................................................................................109
Figure D.3 – Diagram of the stresses for the configuration of Figure D.2 .............................................................................................................................................................................................................111
Figure D.4 – Force per unit length along the horizontal conductor of Figure D.2 .............................................................................................................................................................................................................111

Table 1 – Effects of lightning on typical structures ..........................................................................................................................................................................................................................29
Table 2 – Effects of lightning on typical services ..........................................................................................................................................................................................................................33
Table 3 – Damages and loss in a structure according to different points of strike of lightning ........................................................................................................................................................................................................37
Table 4 – Damages and loss in a service according to different points of strike of lightning ........................................................................................................................................................................................................37
Table 5 – Maximum values of lightning parameters according to LPL ..................................................................................................................................................................................................................47
Table 6 – Minimum values of lightning parameters and related rolling sphere radius corresponding to LPL ..........................................................................................................................................................................................................53
Table 7 – Probabilities for the limits of the lightning current parameters ..........................................................................................................................................................................................................53
Table A.1 – Tabulated values of lightning current parameters taken from CIGRE (Electra No. 41 or No. 69) [3], [4] ........................................................................................................................................................................................................65
Table A.2 – Logarithmic normal distribution of lightning current parameters – Mean $\mu$ and dispersion $\sigma_{\log}$ calculated from 95 % and 5 % values from CIGRE (Electra No. 41 or No. 69) [3], [4] ..........................................................................................................................................................................................................67
Table B.1 – Parameters for Equation B.1 ................................................................. 75
Table C.1 – Test parameters of the first short stroke ............................................. 89
Table C.2 – Test parameters of the long stroke ..................................................... 89
Table C.3 – Test parameters of the short strokes .................................................. 91
Table D.1 – Summary of the lightning threat parameters to be considered in the
calculation of the test values for the different LPS components and for the different LPL...... 97
Table D.2 – Physical characteristics of typical materials used in LPS components .......... 103
Table D.3 – Temperature rise for conductors of different sections as a function of \( \frac{W}{R} \) ...... 103
Table E.1 – Conventional earthing impedance values \( Z \) and \( Z_1 \) according to the
resistivity of the soil ........................................................................................................ 127
Table E.2 – Expected surge overcurrents due to lightning flashes ............................ 129
INTERNATIONAL ELECTROTECHNICAL COMMISSION

PROTECTION AGAINST LIGHTNING –

Part 1: General principles

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 provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.

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.

International Standard IEC 62305-1 has been prepared by IEC technical committee 81: Lightning protection.

The IEC 62305 series (Parts 1 to 5), is produced in accordance with the New Publications Plan, approved by National Committees (81/171/RQ (2001-06-29)), which restructures and updates in a more simple and rational form the publications of the IEC 61024 series, the IEC 61312 series and the IEC 61663 series.

The text of this first edition of IEC 62305-1 is compiled from and replaces

The text of this standard is based on the following documents:

<table>
<thead>
<tr>
<th>FDIS</th>
<th>Report on voting</th>
</tr>
</thead>
<tbody>
<tr>
<td>81/262/FDIS</td>
<td>81/267/RVD</td>
</tr>
</tbody>
</table>

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

This publication has been drafted, as close as possible, in accordance with the ISO/IEC Directives, Part 2.

IEC 62305 consists of the following parts, under the general title Protection against lightning:

Part 1: General principles
Part 2: Risk management
Part 3: Physical damage to structures and life hazard
Part 4: Electrical and electronic systems within structures
Part 5: Services¹

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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

¹ To be published
INTRODUCTION

There are no devices nor methods capable of modifying the natural weather phenomena to the extent that they can prevent lightning discharges. Lightning flashes to, or nearby, structures (or services connected to the structures) are hazardous to people, to the structures themselves, their contents and installations as well as to services. This is why the application of lightning protection measures is essential.

The need for protection, the economic benefits of installing protection measures and the selection of adequate protection measures should be determined in terms of risk management. Risk management is the subject of IEC 62305-2.

The criteria for design, installation and maintenance of lightning protection measures are considered in three separate groups:

- the first group concerns protection measures to reduce physical damage and life hazard in a structure is given in IEC 62305-3,
- the second group concerns protection measures to reduce failures of electrical and electronic systems in a structure is given in IEC 62305-4,
- the third group concerns protection measures to reduce physical damage and failures of services connected to a structure (mainly electrical and telecommunication lines) is given in IEC 62305-5.
1 Scope

This part of IEC 62305 provides the general principles to be followed in the protection against lightning of
– structures including their installations and contents as well as persons,
– services connected to a structure.

The following cases are outside the scope of this standard:
– railway systems;
– vehicles, ships, aircraft, offshore installations;
– underground high pressure pipelines;
– pipe, power and telecommunication lines not connected to a structure.

NOTE Usually these systems are under special regulations made by various specific authorities.

2 Normative references

The following referenced documents are indispensable for the application 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 62305-2, Protection against lightning – Part 2: Risk management

IEC 62305-3, Protection against lightning – Part 3: Physical damage to structures and life hazard

IEC 62305-4, Protection against lightning – Part 4: Electrical and electronic systems within structures

IEC 62305-5, Protection against lightning – Part 5: Services

2 To be published.