

INTERNATIONAL STANDARD



Protection against lightning –
Part 3: Physical damage to structures and life hazard

iteh Standards
(<https://standards.iteh.ai>)
Document Preview

[IEC 62305-3:2010](#)

<https://standards.iteh.ai/catalog/standards/iec/9b1a5c9b-ee6b-4d37-a995-ac286c957885/iec-62305-3-2010>



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2010 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, 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 either IEC or IEC's member National Committee in the country of the requester.

If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

- Catalogue of IEC publications: www.iec.ch/searchpub

The IEC on-line Catalogue enables you to search by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, withdrawn and replaced publications.

- IEC Just Published: www.iec.ch/online_news/justpub

Stay up to date on all new IEC publications. Just Published details twice a month all new publications released. Available on-line and also by email.

- Electropedia: www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing more than 20 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary online.

- Customer Service Centre: www.iec.ch/webstore/custserv

If you wish to give us your feedback on this publication or need further assistance, please visit the Customer Service Centre FAQ or contact us:

Email: csc@iec.ch

Tel.: +41 22 919 02 11

Fax: +41 22 919 03 00

<http://www.iec.ch/standards>

<https://standards.iteh.ai/document/preview/iec/9b1a5c9b-ee6b-4d37-a995-ac286c957885/iec-62305-3-2010>



IEC 62305-3

Edition 2.0 2010-12

INTERNATIONAL STANDARD



Protection against lightning –
Part 3: Physical damage to structures and life hazard

Document Preview

[IEC 62305-3:2010](#)

<https://standards.iteh.ai/catalog/standards/iec/9b1a5c9b-ee6b-4d37-a995-ac286c957885/iec-62305-3-2010>

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 29.020; 91.120.40

ISBN 978-2-88912-282-0

CONTENTS

FOREWORD.....	7
INTRODUCTION	10
1 Scope.....	11
2 Normative references.....	11
3 Terms and definitions.....	12
4 Lightning protection system (LPS).....	15
4.1 Class of LPS	15
4.2 Design of the LPS	16
4.3 Continuity of steelwork in reinforced concrete structures	16
5 External lightning protection system	17
5.1 General.....	17
5.1.1 Application of an external LPS.....	17
5.1.2 Choice of external LPS	17
5.1.3 Use of natural components.....	17
5.2 Air-termination systems	18
5.2.1 General.....	18
5.2.2 Positioning	18
5.2.3 Air-terminations against flashes to the side of tall structures.....	19
5.2.4 Construction	20
5.2.5 Natural components	20
5.3 Down-conductor systems	21
5.3.1 General.....	21
5.3.2 Positioning for an isolated LPS	22
5.3.3 Positioning for a non-isolated LPS	22
5.3.4 Construction	23
5.3.5 Natural components	23
5.3.6 Test joints	24
5.4 Earth-termination system	24
5.4.1 General.....	24
5.4.2 Earthing arrangement in general conditions	25
5.4.3 Installation of earth electrodes.....	26
5.4.4 Natural earth electrodes.....	27
5.5 Components	27
5.5.1 General.....	27
5.5.2 Fixing.....	28
5.5.3 Connections	28
5.6 Materials and dimensions.....	29
5.6.1 Materials	29
5.6.2 Dimensions	29
6 Internal lightning protection system	31
6.1 General.....	31
6.2 Lightning equipotential bonding	32
6.2.1 General.....	32
6.2.2 Lightning equipotential bonding for metal installations.....	32
6.2.3 Lightning equipotential bonding for external conductive parts.....	33
6.2.4 Lightning equipotential bonding for internal systems	34

6.2.5	Lightning equipotential bonding for lines connected to the structure to be protected	34
6.3	Electrical insulation of the external LPS.....	35
6.3.1	General.....	35
6.3.2	Simplified approach.....	36
6.3.3	Detailed approach	36
7	Maintenance and inspection of an LPS	37
7.1	General.....	37
7.2	Application of inspections	37
7.3	Order of inspections	37
7.4	Maintenance.....	37
8	Protection measures against injury to living beings due to touch and step voltages	37
8.1	Protection measures against touch voltages	37
8.2	Protection measures against step voltages	38
Annex A (normative)	Positioning the air-termination system	39
Annex B (normative)	Minimum cross-section of the entering cable screen in order to avoid dangerous sparking.....	45
Annex C (informative)	Evaluation of the separation distance s	46
Annex D (normative)	Additional information for LPS in the case of structures with a risk of explosion	52
Annex E (informative)	Guidelines for the design, construction, maintenance and inspection of lightning protection systems	59
Bibliography.....		156
Figure 1	– Protection angle corresponding to the class of LPS	19
Figure 2	– Loop in a down-conductor.....	23
Figure 3	– Minimum length l_1 of each earth electrode according to the class of LPS.....	25
Figure A.1	– Volume protected by a vertical air-termination rod.....	39
Figure A.2	– Volume protected by a vertical air-termination rod.....	40
Figure A.3	– Volume protected by a wire air-termination system	40
Figure A.4	– Volume protected by isolated wires combined in a mesh according to the protection angle method and rolling sphere method	41
Figure A.5	– Volume protected by non-isolated wires combined in a mesh according to the mesh method and the protection angle method	42
Figure A.6	– Design of an air-termination system according to the rolling sphere method.....	43
Figure C.1	– Values of coefficient k_C in the case of a wire air-termination system	46
Figure C.2	– Values of coefficient k_C in the case of multiple down-conductors system.....	47
Figure C.3	– Values of coefficient k_C in the case of a sloped roof with air-termination on the ridge.....	49
Figure C.4	– Examples of calculation of the separation distance in the case of multiple down-conductors with an interconnecting ring of the down-conductors at each level.....	50
Figure C.5	– Values of coefficient k_C in the case of a meshed air-termination system, with a multiple down-conductors system	51
Figure E.1	– LPS design flow diagram	61
Figure E.2	– LPS design for a cantilevered part of a structure	67
Figure E.3	– Measuring the overall electrical resistance	68

Figure E.4 – Equipotential bonding in a structure with a steel reinforcement	70
Figure E.5 – Typical methods of joining reinforcing rods in concrete (where permitted).....	71
Figure E.6 – Example of clamps used as joints between reinforcing rods and conductors.....	72
Figure E.7 – Examples for connection points to the reinforcement in a reinforced concrete wall.....	73
Figure E.8 – Use of metallic facade as natural down-conductor system and connection of facade supports.....	77
Figure E.9 – Connection of the continuous strip windows to a metal facade covering.....	78
Figure E.10 – Internal down-conductors in industrial structures	81
Figure E.11 – Installation of bonding conductors in reinforced concrete structures and flexible bonds between two reinforced concrete parts.....	83
Figure E.12 – Protection angle method air-termination design for different heights according to Table 2	87
Figure E.13 – Isolated external LPS using two isolated air-termination masts designed according to the protection angle air-termination design method.....	88
Figure E.14 – Isolated external LPS using two isolated air-termination masts, interconnected by horizontal catenary wire.....	89
Figure E.15 – Example of design of an air-termination of a non-isolated LPS by air- termination rods	90
Figure E.16 – Example of design of an air-termination of a non isolated LPS by a horizontal wire according to the protection angle air-termination design method.....	91
Figure E.17 – Protected volume of an air- termination rod on a sloped surface using the protection angle design method.....	92
Figure E.18 – Design of an LPS air-termination conductor network on a structure with complicated shape.....	93
Figure E.19 – Design of an LPS air-termination according to the protection angle method, mesh method and general arrangement of air-termination elements	94
Figure E.20 – Space protected by two parallel air-termination horizontal wires or two air-termination rods ($r > h_t$).....	95
Figure E.21 – Three examples of design of non-isolated LPS air-termination according to the mesh method air-termination design.....	98
Figure E.22 – Four examples of details of an LPS on a structure with sloped tiled roofs.....	100
Figure E.23 – Air-termination and visually concealed conductors for buildings less than 20 m high, with sloping roofs	101
Figure E.24 – Construction of an LPS using natural components on the roof of the structure.....	103
Figure E.25 – Positioning of the external LPS on a structure made of isolating material e.g. wood or bricks with a height up to 60 m with flat roof and with roof fixtures	104
Figure E.26 – Construction of air-termination network on a roof with conductive covering where puncturing of the covering is not acceptable	105
Figure E.27 – Construction of external LPS on a structure of steel-reinforced concrete using the reinforcement of the outer walls as natural components	106
Figure E.28 – Example of an air-termination stud used on car park roofs.....	107
Figure E.29 – Air-termination rod used for protection of a metallic roof fixture with electric power installations which are not bonded to the air-termination system.....	108
Figure E.30 – Method of achieving electrical continuity on metallic parapet capping	109
Figure E.31 – Metallic roof fixture protected against direct lightning interception, connected to air-termination system	112

Figure E.32 – Examples of lightning protection of a house with a TV antenna	115
Figure E.33 – Installation of lightning protection of metallic equipment on a roof against a direct lightning flash	116
Figure E.34 – Connection of natural air-termination rod to air-termination conductor	118
Figure E.35 – Construction of the bridging between the segments of the metallic facade plates	119
Figure E.36 – Installation of external LPS on a structure of insulating material with different roof levels	122
Figure E.37 – Five examples of geometry of LPS conductors	123
Figure E.38 – Construction of an LPS using only two down-conductors and foundation earth electrodes	124
Figure E.39 – Four examples of connection of earth-termination to the LPS of structures using natural down-conductors (girders) and detail of a test joint	128
Figure E.40 – Construction of foundation earth ring for structures of different foundation design	132
Figure E.41 – Two examples of vertical electrodes in type A earthing arrangement	134
Figure E.42 – Meshed earth-termination system of a plant	137
Figure E.43 – Example of an equipotential bonding arrangement	144
Figure E.44 – Example of bonding arrangement in a structure with multiple point entries of external conductive parts using a ring electrode for interconnection of bonding bars	145
Figure E.45 – Example of bonding in the case of multiple point entries of external conductive parts and an electric power or communication line using an internal ring conductor for interconnection of the bonding bars	146
Figure E.46 – Example of bonding arrangement in a structure with multiple point entries of external conductive parts entering the structure above ground level	147
Figure E.47 – Directions for calculations of the separation distance, s , for a worst case lightning interception point at a distance l from the reference point according to 6.3	149
Table 1 – Relation between lightning protection levels (LPL) and class of LPS (see IEC 62305-1)	16
Table 2 – Maximum values of rolling sphere radius, mesh size and protection angle corresponding to the class of LPS	19
Table 3 – Minimum thickness of metal sheets or metal pipes in air-termination systems	21
Table 4 – Typical preferred values of the distance between down-conductors according to the class of LPS	22
Table 5 – LPS materials and conditions of use	28
Table 6 – Material, configuration and minimum cross-sectional area of air-termination conductors, air-termination rods, earth lead-in rods and down-conductors	30
Table 7 – Material, configuration and minimum dimensions of earth electrodes	31
Table 8 – Minimum dimensions of conductors connecting different bonding bars or connecting bonding bars to the earth-termination system	33
Table 9 – Minimum dimensions of conductors connecting internal metal installations to the bonding bar	33
Table 10 – Isolation of external LPS – Values of coefficient k_1	35
Table 11 – Isolation of external LPS – Values of coefficient k_m	35
Table 12 – Isolation of external LPS – Approximated values of coefficient k_c	36
Table B.1 – Cable length to be considered according to the condition of the screen	45
Table E.1 – Suggested fixing centres	99

Table E.2 – Maximum period between inspections of an LPS 151

iTeh Standards
(<https://standards.iteh.ai>)
Document Preview

[IEC 62305-3:2010](#)

<https://standards.iteh.ai/catalog/standards/iec/9b1a5c9b-ee6b-4d37-a995-ac286c957885/iec-62305-3-2010>

INTERNATIONAL ELECTROTECHNICAL COMMISSION

PROTECTION AGAINST LIGHTNING –

Part 3: Physical damage to structures and life hazard

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.

International Standard IEC 62305-3 has been prepared by IEC technical committee 81: Lightning protection.

This second edition cancels and replaces the first edition, published in 2006, and constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- 1) Minimum thicknesses of metal sheets or metal pipes given in Table 3 for air-termination systems are assumed as not able to prevent hot-spot problems.
- 2) Steel with electro-deposited copper is introduced as material suitable for LPS.
- 3) Some cross-sectional areas of LPS conductors were slightly modified.
- 4) For bonding purposes, isolating spark gaps are used for metal installations and SPD for internal systems.

- 5) Two methods – simplified and detailed – are provided for evaluation of separation distance.
- 6) Protection measures against injuries of living beings due to electric shock are considered also inside the structure.
- 7) Improved information for LPS in the case of structures with a risk of explosion are given in Annex D (normative).

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

FDIS	Report on voting
81/372/FDIS	81/382/RVD

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 closely as possible, in accordance with the ISO/IEC Directives, Part 2.

A list of all the parts in the IEC 62305 series, under the general title *Protection against lightning*, can be found on the IEC website.

iTeh Standards
(<https://standards.iteh.ai>)
Document Preview

[IEC 62305-3:2010](#)

<https://standards.iteh.ai/catalog/standards/iec/9b1a5c9b-ee6b-4d37-a995-ac286c957885/iec-62305-3-2010>

The committee has decided that the contents of this publication will remain unchanged until the stability 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.

In the United States, based on the requirements of NFPA 780: Standard for the Installation of Lightning Protection Systems:2008 ^[1] 1 and practical experience in the use of horizontal earth electrodes, the minimum length of horizontal earth electrodes is not required to be twice that required for vertical electrodes.

In France and Portugal:

- natural components cannot substitute as lightning protection components but may be used to complete/enhance the LPS;
- aluminium solid round diameters should be increased from 8 mm to 10 mm;
- stranded conductors cannot be used as down-conductors;
- diameter of solid round conductors should be increased from 16 mm to 18 mm;
- hot dip galvanized steel solid tape thickness should be increased from 2 mm to 3,5 mm.

In Russia the use of piping carrying and tanks containing readily-combustible or explosive materials as air-termination natural components or down-conductor natural components are not allowed in any case.

In Japan the minimum values of the cross-section are reduced from:

- 16 mm² to 14 mm² for copper and 25 mm² to 22 mm² for aluminium, for bonding conductors connecting different bonding bars and conductors connecting the bars to the earth-termination system;
- 6 mm² to 5 mm² for copper, 10 mm² to 8 mm² for aluminium and 16 mm² to 14 mm² for steel, for bonding conductors connecting internal metal installations to the bonding bars.

A bilingual version of this publication may be issued at a later date.

IMPORTANT – The 'colour inside' logo on the cover page of this publication 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.

¹ References in square brackets refer to the bibliography.

INTRODUCTION

This part of IEC 62305 deals with the protection, in and around a structure, against physical damage and injury to living beings due to touch and step voltages.

The main and most effective measure for protection of structures against physical damage is considered to be the lightning protection system (LPS). It usually consists of both external and internal lightning protection systems.

An external LPS is intended to

- a) intercept a lightning flash to the structure (with an air-termination system),
- b) conduct the lightning current safely towards earth (using a down-conductor system),
- c) disperse the lightning current into the earth (using an earth-termination system).

An internal LPS prevents dangerous sparking within the structure using either equipotential bonding or a separation distance (and hence electrical insulation) between the external LPS (as defined in 3.2) components and other electrically conducting elements internal to the structure.

Main protection measures against injury to living beings due to touch and step voltages are intended to:

- 1) reduce the dangerous current flowing through bodies by insulating exposed conductive parts, and/or by increasing the surface soil resistivity,
- 2) reduce the occurrence of dangerous touch and step voltages by physical restrictions and/or warning notices.

The type and location of an LPS should be carefully considered in the initial design of a new structure, thereby enabling maximum advantage to be taken of the electrically conductive parts of the structure. By doing so, design and construction of an integrated installation is made easier, the overall aesthetic aspects can be improved, and the effectiveness of the LPS can be increased at minimum cost and effort.

Access to the ground and the proper use of foundation steelwork for the purpose of forming an effective earth-termination may well be impossible once construction work on a site has commenced. Therefore, soil resistivity and the nature of the earth should be considered at the earliest possible stage of a project. This information is fundamental to the design of an earth-termination system and may influence the foundation design work for the structure.

Regular consultation between LPS designers and installers, architects and builders is essential in order to achieve the best result at minimum cost.

If lightning protection is to be added to an existing structure, every effort should be made to ensure that it conforms to the principles of this standard. The design of the type and location of an LPS should take into account the features of the existing structure.

PROTECTION AGAINST LIGHTNING –

Part 3: Physical damage to structures and life hazard

1 Scope

This part of IEC 62305 provides the requirements for protection of a structure against physical damage by means of a lightning protection system (LPS), and for protection against injury to living beings due to touch and step voltages in the vicinity of an LPS (see IEC 62305-1).

This standard is applicable to:

- a) design, installation, inspection and maintenance of an LPS for structures without limitation of their height,
- b) establishment of measures for protection against injury to living beings due to touch and step voltages.

NOTE 1 Specific requirements for an LPS in structures dangerous to their surroundings due to the risk of explosion are under consideration. Additional information is provided in Annex D for use in the interim.

NOTE 2 This part of IEC 62305 is not intended to provide protection against failures of electrical and electronic systems due to overvoltages. Specific requirements for such cases are provided in IEC 62305-4.

NOTE 3 Specific requirements for protection against lightning of wind turbines are reported in IEC 61400-24^[2].

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 60079-10-1:2008, *Explosive atmospheres – Part 10-1: Classification of areas – Explosive gas atmospheres*

IEC 60079-10-2:2009, *Explosive atmospheres – Part 10-2: Classification of areas – Combustible dust atmospheres*

IEC 60079-14:2007, *Explosive atmospheres – Part 14: Electrical installations design, selection and erection*

IEC 61557-4, *Electrical safety in low-voltage distribution systems up to 1 000 V a.c. and 1 500 V d.c. – Equipment for testing, measuring or monitoring of protective measures – Part 4: Resistance of earth connection and equipotential bonding*

IEC 61643-1, *Low-voltage surge protective devices – Part 1: Surge protective devices connected to low-voltage power distribution systems – Requirements and tests*

IEC 61643-21, *Low-voltage surge protective devices – Part 21: Surge protective devices connected to telecommunications and signalling networks – Performance requirements and testing methods*

IEC 62305-1, *Protection against lightning – Part 1: General principles*

IEC 62305-2, *Protection against lightning – Part 2: Risk management*

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

IEC 62561 (all parts)², *Lightning protection system components (LPSC)*

IEC 62561-1³, *Lightning protection system components (LPSC) – Part 1: Requirements for connection components*

IEC 62561-3³, *Lightning protection system components (LPSC) – Part 3: Requirements for isolating spark gaps*

ISO 3864-1, *Graphical symbols – Safety colours and safety signs – Part 1: Design principles for safety signs in workplaces and public areas*

3 Terms and definitions

For the purposes of this document, the following terms and definitions, some of which have already been cited in Part 1 but are repeated here for ease of reference, as well as those given in other parts of IEC 62305, apply.

3.1

lightning protection system

LPS

complete system used to reduce physical damage due to lightning flashes to a structure

NOTE It consists of both external and internal lightning protection systems.

3.2

external lightning protection system

part of the LPS consisting of an air-termination system, a down-conductor system and an earth-termination system

[IEC 62305-3:2010](https://standards.iteh.ai/catalog/standards/iec/9b1a5c9b-ee6b-4d37-a995-ac286c957885/iec-62305-3-2010)

<https://standards.iteh.ai/catalog/standards/iec/9b1a5c9b-ee6b-4d37-a995-ac286c957885/iec-62305-3-2010>

3.3

external LPS isolated from the structure to be protected

LPS with an air-termination system and down-conductor system positioned in such a way that the path of the lightning current has no contact with the structure to be protected

NOTE In an isolated LPS, dangerous sparks between the LPS and the structure are avoided.

3.4

external LPS not isolated from the structure to be protected

LPS with an air-termination system and down-conductor system positioned in such a way that the path of the lightning current can be in contact with the structure to be protected

3.5

internal lightning protection system

part of the LPS consisting of lightning equipotential bonding and/or electrical insulation of external LPS

3.6

air-termination system

part of an external LPS using metallic elements such as rods, mesh conductors or catenary wires intended to intercept lightning flashes

² In preparation.