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Note d'introduction

Introductory note

This document has been prepared based on the decisions taken at the last TC 81 meeting, (see 81/236/RM item 7). According to these decisions National Committees are asked (see 81/239/DC) for opinion on the following editorial proposal:

1. to delete in IEC 62305-3 the Annex B (informative): Lightning current flowing through external conductive parts and installations entering the structure (see doc. 81/240/CDV)
2. to delete in IEC 62305-4 the Annex E (informative): Surges due to lightning at different installation point(see doc. 81/238/CDV)
3. to add to IEC 62305-1 a new Annex E (informative) incorporating the Annex B of IEC 62305-3 and the Annex E of IEC 62305-4. The proposed new Annex E of IEC 62305-1 is attached.

ATTENTION	ATTENTION
CDV soumis en parallèle au vote (CEI) et à l'enquête (CENELEC)	**Parallel IEC CDV/CENELEC Enquiry**

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

IEC 62305 – PROTECTION AGAINST LIGHTNING

IEC 62305-3 Part 3: PHYSICAL DAMAGE TO STRUCTURES AND LIFE HAZARD

FOREWORD

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International Standard IEC 62305-3 has been prepared by IEC Technical Committee 81: Lightning protection.

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 in accordance with the ISO/IEC Directives, Part 3.

Annexes B, D, E and F are for information only.

Annexes A and C form an integral part of this standard.

The committee has decided that the contents of this publication will remain unchanged until _____. At this date, the publication will be

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- withdrawn;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

INTRODUCTION

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

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

External LPS is intended to:

a) intercept a direct lightning strike 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).

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 injuries to living beings due to touch and step voltages are intended to:

a) reduce the dangerous current flowing through the bodies by insulation of exposed conductive parts, and/or by increasing the surface soil resistivity;

b) reduce the occurrence of dangerous touch and step voltages by physical restrictions and/or by 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. Thus design and construction of an integrated installation is made easier, the overall aesthetic aspects can be improved, and the effectiveness of the lightning protection system can be increased at minimum cost and effort.

Access to 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 this 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 complies with the principles of this standard. The design of the type and location of LPS should take into account the features of the existing structure.

IEC 62305 – PROTECTION AGAINST LIGHTNING

IEC 62305-3 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 damages by means of a lightning protection system (LPS), and for protection against injuries to living beings due to touch and step voltages in the vicinity of LPS (see IEC 62305-1).

This standard is applicable to:

a) design, installation, inspection and maintenance of LPS for structures without limitation of their height;

b) erection of measures for protection against injuries of living beings due to touch and step voltages.

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

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 62305. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of IEC 62305 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60079-10,1995: Electrical apparatus for explosive gas atmospheres – Part 10:Classification of hazardous areas

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 62305-5 (*) : Protection against lightning – Part 5: Services

IEC 61643-1, 2002: Surge protective devices connected to low-voltage power distribution systems – Part 1: Performance requirements and testing methods

IEC 61643-12,2002: Surge protective devices connected to low voltage power distribution systems. Part 12 : Selection and application principles.

IEC 60479 (*) : Effects of current on human body and livestock- New Part 4: Effects of lightning strokes on human beings and livestock

(*) to be published

3 Terms and definitions

For the purpose of this part of IEC 62305, the following definitions apply as well as those given in other parts of IEC 62305.

3.1 Lightning protection system (LPS)

Complete system used to reduce physical damages due to lightning flashes striking a structure. 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

NOTE Typically these parts are outside the structure.

3.3 External LPS isolated from the structure to be protected

LPS whose air termination system and down-conductor system are 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 LPS and the structure are avoided.

3.4 External LPS not isolated from the structure to be protected

LPS whose air termination system and down-conductor system are 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 compliance with the separation distance within the structure to be protected

3.6 Air-termination system

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

3.7 Down-conductor system

Part of an external LPS which is intended to conduct lightning current from the air-termination system to the earth-termination system.

3.8 Ring conductor

Conductor forming a loop around the structure and interconnecting the down-conductors for distribution of lightning current among them.

3.9 Earth-termination system

Part of an external LPS which is intended to conduct and disperse lightning current into the earth.

3.10 Earthing electrode

Part or a group of parts of the earth-termination system which provides direct electrical contact with the earth and disperses the lightning current to the earth.

3.11 Ring earthing electrode

Earthing electrode forming a closed loop around the structure below or on the surface of the earth.

3.12 Foundation earthing electrode

Reinforced steel of foundation or additional conductor embedded in the concrete foundation of a structure and used as an earthing electrode.

3.13 Conventional earth impedance

Ratio of the peak values of the earth-termination voltage and the earth-termination current which, in general, do not occur simultaneously.

3.14 Earth-termination voltage

Potential difference between the earth-termination system and the remote earth.

3.15 "Natural" component of LPS

Conductive component installed not specifically for lightning protection which can be used in addition to the LPS or in some cases could provide the function of one or more parts of the LPS.

NOTE - Examples of the use of this term include:

- "natural" air termination;
- "natural" down-conductor;
- "natural" earthing electrode.

3.16 Connecting component

That part of an external LPS which is used for the connection of conductors to each other or to metallic installations.

3.17 Fixing component

That part of an external LPS which is used to fix the elements of the LPS to the structure to be protected.

3.18 Metal installations

Extended metal items in the structure to be protected which may form a path for lightning current, such as pipe-work, staircases, elevator guide rails, ventilation, heating and air conditioning ducts, and interconnected reinforcing steel.

3.19 External conductive parts

Extended metal items entering or leaving the structure to be protected such as pipe works, cable metallic elements, metal ducts, etc. which may carry a part of the lightning current

3.20 Electrical system

A system incorporating low voltage power supply components and possibly electronic components.

3.21 Electronic system

A system incorporating sensitive electronic components such as communication equipment, computer, control and instrumentation systems, radio systems, power electronic installations.

3.22 Internal system

Electrical and electronic systems within a structure

3.23 Lightning equipotential bonding (EB)

Bonding to LPS of separated conducting parts, by direct connections or via surge protective devices, to reduce potential differences caused by lightning current.

3.24 Bonding bar

Metal bar on which metal installations, external conductive parts, electric power and telecommunication lines, and other cables can be bonded to an LPS.

3.25 Bonding conductor

Conductor connecting separated conducting parts to LPS.

3.26 Interconnected reinforcing steel

Steelwork within a concrete structure which is considered electrically continuous.

3.27 Dangerous sparking

Electrical discharge due to lightning which causes physical damages in the structure to be protected.

3.28 Separation distance

Distance between two conductive parts at which no dangerous sparking can occur

3.29 Surge protective device (SPD)

Device that is intended to limit transient overvoltages and divert surge currents. It contains at least one non-linear component (Defined as in IEC 61643-12).

3.30 Test joint

Joint designed to facilitate electrical testing and measurement of LPS components.

3.31 Type of LPS

Number denoting the classification of an LPS according to the lightning protection level for which it is designed.

3.32 Lightning protection designer

Specialist competent and skilled in the design of the LPS

3.33 Lightning protection installer

A person competent and skilled in the installation of LPS

4 Lightning Protection System (LPS)

4.1 Type of LPS

The characteristics of an LPS are determined by the characteristics of the structure to be protected and by the considered lightning protection level.

Four types of LPS (I to IV) are defined in this standard corresponding to lightning protection levels defined in IEC 62305-1(see Table 1).

Each type of LPS is characterised by:

a) Data depending on the type of LPS:

– lightning parameters (Table 3 and 4 in IEC 62305-1)

– rolling sphere radius, mesh size and protection angle (Table 2)

– typical distances between down-conductors and between ring conductors (Table 4)

– separation distance against dangerous sparking (Tables 10, 11, 12)

– minimum length of earth electrodes (see 5.4.2, 5.4.3 and figure 2)

b) Data not depending on the type of LPS:

– lightning equipotential bonding (see 6.2)

– minimum thickness of metal sheets or metal pipes in air-termination systems (Table 3)

– LPS materials and conditions of use (see 5.5, 5.6 and table 5)

– Material, configuration and minimum dimensions for air terminations, down-conductors and earth terminations (Table 6 and 7)

– Minimum dimensions of connecting conductors (Tables 8 and 9)

Performance of each type of LPS is reported in IEC 62305-2, Annex B.

The type of required LPS shall be selected on the basis of a risk assessment (see IEC 62305-2).

4.2 Design of the LPS

A technically and economically optimised design of an LPS is possible especially if the steps in the design and construction of the LPS are co-ordinated with the steps in the design and construction of the structure to be protected. In particular, the possible utilisation of metal parts of a structure as parts of the LPS should be foreseen in the design of the structure itself.

The design of the type and location of the LPS for existing structures shall take into account the constraints of the existing situation.

The design documentation of an LPS shall contain all the information necessary to ensure correct and complete installation. For detailed information see Annex F.

4.3 Continuity of steelwork in reinforced concrete structures

Steelwork within reinforced concrete structures is considered to be electrically continuous provided that the major part of interconnections of vertical and horizontal bars are welded or otherwise securely connected. Connections of vertical bars are to be welded, overlapped a minimum of 20 times their diameters or otherwise securely connected.

For new structures, the connections between reinforcement elements shall be specified by the designer or installer, in co-operation with the builder and the civil engineer.

For structures utilizing steel reinforced concrete (including pre-cast, pre-stressed reinforced units), the electrical continuity of the reinforcing bars shall be determined by electrical testing between the uppermost part and ground level. The overall electrical resistance should not be greater than 0,2 ohm, measured using test equipment suitable for this purpose. If this value is not achieved or it is not practical to conduct such testing, the reinforcing steel shall not be used as a natural down conductor as discussed in 5.3.5. In this case it is recommended that an external down conductor be installed.

In the case of structures of precast reinforced concrete, the electrical continuity of the reinforcing steel shall be established between individual adjacent precast concrete units.

NOTE 1 For further information on the continuity of steelwork in reinforced concrete structures see Annex F.

NOTE 2 In several countries, the use of reinforced concrete as a part of the LPS is not allowed.

5 External lightning protection system

5.1 General

5.1.1 Scope of an external LPS

The external LPS is intended to intercept direct lightning strokes to the structure, including flashes to the side of structure, to conduct lightning current from the point of strike to ground. The external LPS is also intended to disperse this current to earth without causing thermal or mechanical damage, nor dangerous sparking which may trigger fire or explosions.

5.1.2 Choice of external LPS

In most cases, the external LPS may be attached to the structure to be protected.

An isolated external LPS should be considered when the thermal and explosive effects at the point of strike or on the conductors carrying the lightning current may cause damage to the structure or to the contents (see Annex E). Typical examples include structures with combustible covering, structures with combustible walls and areas with danger of explosion and fire.

NOTE 1 The use of an isolated LPS may be convenient where it is predicted that changes in the structure, its contents or its use will require modifications to the LPS.

Dangerous sparking between LPS and the structure shall be avoided:

- in an isolated external LPS, by separation in accordance with 6.3;
- in a non-isolated external LPS, by bonding, in accordance with 6.2, or by insulation or separation in accordance with 6.3.

5.1.3 Use of natural components

Natural components made of conductive materials which will always remain in the structure and will not be modified (e.g. interconnected reinforced steel, metal framework of the structure, etc.) may be used as parts of an LPS.

Other natural components should be considered as being additional to an LPS.

NOTE For further information, see Annex F.

5.2 Air termination systems

5.2.1 General

The probability of structure penetration by a lightning current is considerably decreased by the presence of a properly designed air termination system.

The air termination systems can be composed of any combination of the following elements:

a) Rods (including free-standing masts);

b) catenary wires;

c) meshed conductors.

To comply with this standard all types of air termination systems shall be positioned in accordance with 5.2.2, 5.2.3 and Annex A.

Radio-active air terminals are not allowed.

5.2.2 Positioning

Air termination components installed on a structure should be located at corners, exposed points, and edges (especially on the upper level of its facades) in accordance with one or more of the following methods.

Acceptable methods to be used in determining the position of the air termination system. are the “protection angle” method, the “rolling sphere” method and the “mesh” method.

The rolling sphere method is suitable in all cases.

The protection angle method is suitable for simple shaped buildings but it is subject to limits of air termination height indicated in Table 2.

The mesh method is a suitable form of protection where plane surfaces are to be protected.

The values for the protection angle, rolling sphere radius and mesh size for each type of LPS are given in Table 2. Detailed information on the positioning of the air termination system is given in Annex A.

5.2.3 Air terminations against flashes to the side of tall structures

On structures taller than 60 m, flashes to the side may occur; especially to points, corners and edges of surfaces.

NOTE In general the risk due to these flashes is low, because only a few percent of all flashes to tall structures will be flashes to the side and moreover their parameters are significantly lower than those of flashes to the top. However Electrical and electronic equipment on the wall outside the structure may be destroyed even by lightning strokes with low current peak values.

An air termination systems shall be installed to protect the upper part of tall structures (i.e. typically the topmost 20% of the height of the structure) and the equipment installed on it (see Annex A).

The rules for positioning air termination systems on the roof shall also apply to those upper parts of the structure.

In addition, for building higher than 120 m, all parts which may be endangered above 120 m should be protected.

5.2.4 Construction

Air terminations of LPS not isolated from the structure to be protected may be installed as follows:

- if the roof is made of non-combustible material the air termination conductors may be positioned on the surface of the roof;
- if the roof is made of readily combustible material, due to care needs to be taken with regard to the distance between the air termination conductors and the material. For thatched roofs this distance should be a minimum of 30 cm. For other combustible materials a distance not lower than 10 cm is considered adequate.
- Easily combustible parts of the structure to be protected shall not remain in a direct contact with the components of external LPS and shall not remain directly under any roofing membrane that might be punctured by a lightning stroke (see 5.2.5).

Account shall also be taken of less combustible membranes such as wooden sheets.

NOTE If it is likely that water may accumulate on flat roof, air terminations should be installed above the maximum probable water level.

5.2.5 "Natural" components

The following parts of a structure should be considered as “natural” air termination components and part of an LPS in accordance with 5.1.3:

a) metal sheets covering the structure to be protected providing that

- the electrical continuity between the various parts is made durable (e.g. by means of brazing, welding, crimping, seaming, screwing or bolting);
- the thickness of the metal sheet is not less than the value *t’* given in Table 3 if it is not important to prevent puncture of the sheeting or to consider ignition of any readily combustible materials underneath;
- the thickness of the metal sheet is not less than the value *t* given in Table 3 if it is necessary to take precautions against puncture or to consider hot spot problems;
- they are not clad with insulating material;

b) metal components of roof construction (trusses, interconnected reinforcing steel, etc.), underneath non-metallic roofing, providing that this latter part can be excluded from the structure to be protected;

c) metal parts such as gutters, ornamentation, railings, pipes, coverings of parapets, etc., whose cross-section is not less than that specified for standard air termination components;

d) metal pipes and tanks on the roof, providing that they are constructed of material whose thickness and cross section are in accordance with table 6;

e) metal pipes and tanks carrying readily combustible or explosive mixtures, providing that they are constructed of material whose thickness is not less than the appropriate value of

t given in table 3 and that the temperature rise of the inner surface at the point of strike does not constitute a danger (for detailed information see Annex F).

If the conditions for thickness are not fulfilled, the pipes and tanks shall be integrated into the structure to be protected.

Piping carrying readily combustible or explosive mixtures shall not be considered as air termination natural components if the gasket in the flange couplings is not metallic or if the flange-sides are not otherwise properly bonded.

NOTE A thin coating of protective paint or about 1 mm asphalt or 0,5 mm PVC is not regarded as an insulator. Detailed information is given in Annex F.

5.3 Down-conductor systems

5.3.1 General

In order to reduce the probability of damage due to lightning current flowing in the LPS, the down-conductors shall be arranged in such a way that from the point of strike to earth :

a) several parallel current paths exist;

b) the length of the current paths is kept to a minimum;

c) equipotential bonding to conducting parts of the structure is performed according to the requirements of 6.2.

NOTE 1 Lateral connection of down-conductors at ground level and every 10 to 20 m of height, in accordance with table 4, is considered to be good practice.

The geometry of the down-conductors and of the ring conductors affects the separation distance (see 6.3).

NOTE 2 The installation of as many down-conductors as possible at equal spacing around the perimeter interconnected by ring conductors, reduces the probability of dangerous sparking and facilitates the protection of internal installations (see IEC 62305-4). This condition is fulfilled in metal framework structures and in reinforced concrete structures in which the interconnected steel is electrically continuous.

Typical values of the distance between down-conductors and between horizontal ring conductors are given in table 4.

More information on partitioning of the lightning current amongst down-conductors is given in Annex D.

5.3.2 Positioning for isolated LPS

a) If the air termination consists of rods on separate masts (or one mast) not made of metal or interconnected reinforcing steel, at least one down-conductor is needed for each mast. No additional down-conductors are required for masts made of metal or interconnected reinforcing steel.

NOTE 2 In several countries, the use of reinforced concrete as a part of the LPS is not allowed.

b) If the air termination consists of catenary wires (or one wire), at least one down-conductor is needed at each supporting structure.

c) If the air termination forms a network of conductors, one down-conductor is needed at least at each supporting wire end.

5.3.3 Positioning for non-isolated LPS

In every case of not isolated LPS the number of down conductors shall not be less than two and should be distributed around the perimeter of the structure to be protected, subject to architectural and practical constraints.

An equal spacing of the down-conductors is preferred around the perimeter. Typical values of the distance between down-conductors are given in Table 4.

NOTE The value of the distance between down-conductors is correlated with the separation distance given in 6.3

A down-conductor should be installed at each exposed corner of the structure, where this is possible.

The individual air termination rods should be connected together at roof level to ensure current division.