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**Protection of structures against
lightning**

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Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of Land, Infrastructure and Transport through deliberations at the Japanese Industrial Standards Committee, as the result of proposal for revision of Japanese Industrial Standard submitted by The Institute of Electrical Installation Engineers of Japan (IEIEJ) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law applicable to the case of revision by the provision of Article 14. Consequently **JIS A 4201 : 1992** is replaced with this Standard.

In this revision, in order to conform Japanese Industrial Standard to International Standard, **IEC 61024-1 : 1990** *Protection structures against lightning—Part 1 : General principles* has been used as a base reference.

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In the event of any doubts arising as to the contents,
the original JIS is to be the final authority.

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Protection of structures against lightning

Introduction This Japanese Industrial Standard has been prepared based on the first edition of IEC 61024-1 : 1990 *Protection of structures against lightning—Part 1 : General principles* published in 1990 with some modifications of the technical contents.

Portions with continuous sidelines or dotted underlines are the matters in which the contents of the original International Standard have been modified. The list of modifications is shown in Annex 2 (informative) with the explanations.

It should be noted that a lightning protection system cannot prevent the formation of lightning.

A lightning protection system, designed and installed in accordance with this Standard, cannot guarantee absolute protection to structures, persons, or objects; however, application of this Standard will significantly reduce risk of damage caused by lightning to the structure protected by it.

The type and location of a lightning protection system should be carefully considered at the design stage 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 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 which may influence the foundation design work of architects.

To avoid unnecessary work, regular consultation between lightning protection system designers, architects, and builders is essential.

This Standard provides information on setting up Lightning Protection Systems (LPS) for common structures.

The design, installation and materials of LPS should fully comply with the provisions of this Standard.

1 General

1.1 Scope and object

1.1.1 Scope This Standard is applicable to the design and installation of Lightning Protection Systems (LPS) for structures, or installations such as chimneys, towers, oil tanks, or the like (hereafter referred to as “structures”).

The following cases are outside the scope of this Standard:

- a) railway systems;

- b) electrical transmission, distribution and generating systems external to a structure (excluding those incidental to a structure);
- c) telecommunication systems external to a structure (excluding those incidental to a structure);
- d) vehicles, ships, aircraft, offshore installations.

Remarks : The International Standard corresponding to this Standard is as follows:

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21**.

IEC 61024-1 : 1990 *Protection of structures against lightning—Part 1 : General principles* (MOD)

1.1.2 Object This Standard provides information for the design, installation, inspection and maintenance of an effective system for the protection of structures against lightning as indicated in Sub-clause 1.1.1, as well as for persons, installations and contents in or on them.

1.2 Terms and definitions For the purpose of this Standard, the following definitions apply:

1.2.1 Lightning flash to earth An electrical discharge of atmospheric origin between cloud and earth consisting of one or more strokes.

1.2.2 Lightning stroke A single electrical discharge in a lightning flash to earth.

1.2.3 Point of strike A point where a lightning stroke contacts the earth, a structure or an LPS.

Note : A flash may have more than one point of strike.

1.2.4 Space to be protected The part of a structure or region for which protection against the effects of lightning in accordance with this Standard is required.

1.2.5 Lightning protection system (LPS) The complete system used to protect a space against the effects of lightning. It consists of both external and internal lightning protection systems.

Note : In particular cases, an LPS may consist of an external LPS or an internal LPS only.

1.2.6 External lightning protection system This system consists of an air-termination system, a down-conductor system and an earth-termination system.

1.2.7 Internal lightning protection system All measures additional to those given in Sub-clause 1.2.6 which would reduce the electromagnetic effects of lightning current within the space to be protected including the ensuring of equipotential bonding and safety distance.

1.2.8 Equipotential bonding (EB) That part of an internal LPS which reduces potential differences caused by lightning current, which is achieved by connecting the differences directly by means of conductors or by surge suppressors.

1.2.9 Air-termination system That part of an external LPS which is intended to intercept lightning flashes.

1.2.10 Down-conductor That part of an external LPS which is intended to conduct lightning current from the air-termination system to the earth-termination system.

1.2.11 Earth-termination system That part of an external LPS which is intended to conduct and disperse lightning current to the earth.

Note : In high resistivity soils the earth-termination system may intercept lightning currents flowing through the soil due to lightning flashes to the earth in the neighbourhood.

1.2.12 Earth electrode A part or group of parts of the earth-termination system which provides direct electrical contact with and disperses the lightning current to the earth.

1.2.13 Ring earth electrode An earth electrode forming a closed loop around the structure below or on the surface of the earth.

1.2.14 Foundation earth electrode An earth electrode embedded in the concrete foundation of a structure.

1.2.15 Equivalent earth resistance The ratio of the peak values of the earth-termination voltage and the earth-termination current which, in general, do not occur simultaneously. It is conventionally used to indicate the efficiency of the earth-termination system.

1.2.16 Earth-termination voltage The potential difference between an earth-termination system and the earth.

1.2.17 “Natural” component of an LPS A component which performs a lightning protection function but is not installed specifically for that purpose.

Note : Some examples of the use of this term are as follows:

- “natural” air-termination;
- “natural” down-conductor;
- “natural” earth electrode.

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

1.2.19 Bonding bar A bar on which metal installations, extraneous conductive parts, electrical power and telecommunication lines, and other cables can be bonded to an LPS.

1.2.20 Bonding conductor A conductor for bonding used to equalize a potential between the separate parts of equipment.

1.2.21 Interconnected reinforcing steel Steelwork within a structure which is considered to be electrically continuous.

1.2.22 Dangerous sparking An unacceptable electrical discharge caused by lightning current inside the space to be protected.

1.2.23 Safety distance The minimum distance between two conductive parts within the space to be protected between which no dangerous sparking can occur.

1.2.24 Surge suppressor A device designed to limit the surge voltage between two parts within the space to be protected, such as a spark gap, surge diverter or semiconductor device.

1.2.25 Test joint A joint which is designed and situated to facilitate electrical testing and measurement of LPS components.

1.2.26 External LPS isolated from the space to be protected An 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 space to be protected.

1.2.27 External LPS not isolated from the space to be protected An 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 space to be protected.

1.2.28 Common structures Common structures are structures used for ordinary purposes whether commercial, industrial, agricultural, institutional or residential.

1.2.29 Protection level A term denoting the classification of an LPS according to its efficiency.

Note : It is expressed by the probability with which an LPS protects a space against the effects of lightning.

1.3 Reinforced concrete structures Steelwork within reinforced concrete structures is considered to be electrically continuous provided that it fulfils the following conditions:

- a) approximately 50 % of interconnections of vertical and horizontal bars are welded or are securely tied;
- b) vertical bars are welded or are overlapped a minimum of 20 times their diameters and securely tied;
- c) electrical continuity of the reinforcing steel is established between individual precast concrete units and other adjacent precast concrete units.

2 External lightning protection system (LPS)

2.1 Air-termination systems

2.1.1 General The probability of a lightning stroke penetrating the space to be protected 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;
- b) stretched wires;
- c) meshed conductors.

2.1.2 Positioning The arrangement of the air-termination system is adequate if the requirements of Table 1 have been fulfilled. In designing the air-termination system, the following methods can be used independently or in any combination:

- a) protective angle;
- b) rolling sphere;
- c) mesh size.

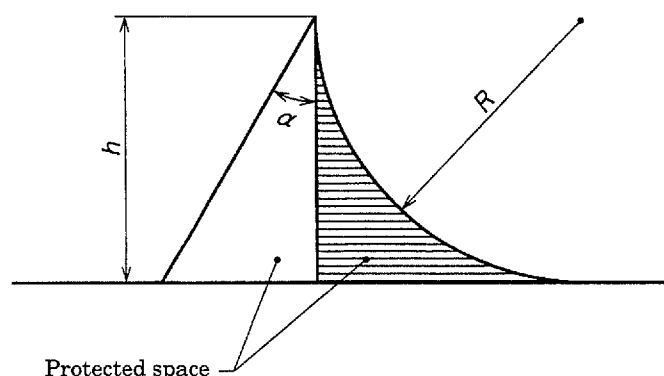
Table 1 Positioning of air-termination according to the protection level

Protection level	Rolling sphere method R (m)	Protective angle method h (m)					Mesh width (m)
		20	30	45	60	Over 60	
		α (°)	α (°)	α (°)	α (°)	α (°)	
I	20	25	*	*	*	*	5
II	30	35	25	*	*	*	10
III	45	45	35	25	*	*	15
IV	60	55	45	35	25	*	20

* Rolling sphere and mesh only apply in these cases.

Notes 1 R is the radius of sphere in the rolling sphere method.

- 2 h shall be the height from ground level to the upper part of air-termination. However, for the flat roof portion, h may be the height from the flat roof to the upper part of air-termination.



2.1.3 Construction For isolated LPS the distance between the air-termination system and any metal installation within the space to be protected shall be greater than the safety distance according to Sub-clause 3.2.

In the case of an LPS not isolated from the space to be protected, the air-termination system may be installed directly on the roof or with small spacing, providing that damage will not be caused by the effect of the lightning current.

For the determination of the volume protected against a lightning stroke, only the real dimensions of the metal air-termination system shall be considered.

2.1.4 “Natural” components The following parts of a structure may be considered as “natural” air-termination components:

- a) metal sheets covering the space to be protected providing that:
 - the electrical continuity between the various parts is made durable;
 - the thickness of the metal sheet is not less than the value t given in Table 2 if it is necessary to take precautions against puncture or to consider hot spot problems;
 - the thickness of the metal sheet is not less than the value t' given in Table 2 if it is not important to prevent puncture of the sheeting or to consider ignition of any combustible materials underneath;
 - they are not clad in insulating material;
- b) metal components of roof construction (trusses, interconnected reinforcing steel, etc.);
- c) metal parts such as gutters, ornamentations, railings, etc., whose cross-section is not less than that specified for standard air-termination components;
- d) metal pipes and tanks, providing that they are constructed of material not less than 2.5 mm thick, and that a dangerous or otherwise unacceptable situation will not be created if they become punctured;
- e) metal pipes and tanks in general, providing that they are constructed of material whose thickness is not less than the appropriate value of t given in Table 2 and that the temperature rise of the inner surface at the point of strike does not constitute a danger.

Notes 1 A light coating of protective paint or 0.5 mm asphalt or 1 mm PVC is not regarded as an insulator.

2 The piping for passing combustible or explosive liquids of which the joint packing is made of nonmetal shall not be used as a “natural” air-termination.