AS/NZS 1768:2007

Australian/New Zealand Standard™

Lightning protection

This Joint Australian/New Zealand Standard was prepared by Joint Technical Committee EL-024, Protection Against Lightning. It was approved on behalf of the Council of Standards Australia on 13 September 2006 and on behalf of the Council of Standards New Zealand on 6 October 2006.
This Standard was published on 10 January 2007.

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This Standard was issued in draft form for comment as DR 06132.

Australian/New Zealand Standard™

Lightning protection

Originated in Australia as MC1—1969.
Originated in New Zealand as NZS/AS 1768:1991.
Previous edition AS/NZS 1768(Int):2003.
This edition AS/NZS 1768:2007.

Jointly published by Standards Australia, GPO Box 476, Sydney, NSW 2001 and Standards New Zealand, Private Bag 2439, Wellington 6020

ISBN 0 7337 7967 0

PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee EL-024, Protection against Lightning, to supersede AS/NZS 1768(Int):2003, *Lightning protection*.

This Standard is intended to provide authoritative guidance on the principles and practices of lightning protection for a wide range of structures and systems. It is not intended for mandatory application but, if called up in a contractual situation, compliance with this Standard requires compliance with all relevant clauses of the Standard such that the level of protection will be sufficient to achieve a tolerable level of risk as determined by the risk calculation.

In general, it is not economically possible to provide total protection against all the possible damaging effects of lightning, but the recommendations in this Standard will reduce the probability of damage to a calculated acceptable level, and will minimize any lightning damage that does occur. Guidance is given on methods of enhancing the level of protection against lightning damage, if this is required in a particular situation.

Where a new structure is to be erected, the matter of lightning protection should be considered in the planning stage, as the necessary measures can often be affected in the architectural features without detracting from the appearance of the building. In addition to the aesthetic considerations, it is usually less expensive to install a lightning protection system during construction than afterwards.

The decision to provide lightning protection may be taken without carrying out a risk assessment or regardless of the outcome of any risk assessment, for example, where there is a desire that there be no avoidable risk. Any decision not to provide lightning protection should only be made after considering the advice provided in this Standard. Where doubt exists as to the need for lightning protection, further advice should be sought from a lightning protection designer or installer.

Unless it has been specified that lightning protection must be provided, the first decision to make is whether the lightning protection is needed. Section 2 provides guidance to assist in this decision. Section 3 provides advice on the protection of persons from lightning, mainly relating to the behaviour of persons when not inside substantial buildings. Once a decision is made that lightning protection is necessary, Section 4 provides details on interception lightning protection for the building or structure. This includes information on the size, material, and form of conductors, the positioning of air terminals and downconductors, and the requirements for earth terminations. Persons and equipment within buildings can be at risk from the indirect effects of lightning and Section 5 gives recommendations for the protection of persons and equipment within buildings from the effects of lightning.

Section 6 describes methods of lightning protection of various items not covered in earlier sections, such as communications antennas, chimneys, boats, fences, and trees. A clause is included on methods for protecting domestic dwellings and assorted structures in public places, where a complete protection system may not be justified, but some protection is considered desirable.

Section 7 sets out recommendations for the protection of structures with explosive or highly-flammable contents. Section 8 gives advice on precautions to be taken during installation, inspecting, testing, and maintaining lightning protection systems.

A number of appendices are included that provide additional information and advice. The appendices form an integral part of this Standard unless specifically stated otherwise. i.e. appendices identified as ‘informative’ only provide supportive or background information and are therefore not an integral part of this Standard.

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S E C T I O N 1 S C O P E A N D G E N E R A L

1.1 SCOPE

This Standard sets out guidelines for the protection of persons and property from hazards arising from exposure to lightning. The recommendations specifically cover the following applications:

(a) The protection of persons, both outdoors, where they may be at risk from the direct effects of a lightning strike, and indoors, where they may be at risk indirectly as a consequence of lightning currents being conducted into the building.

(b) The protection of a variety of buildings or structures, including those with explosive or highly-flammable contents, and mines.

(c) The protection of sensitive electronic equipment (e.g. facsimile machines, modems, computers) from overvoltages resulting from a lightning strike to the building or its associated services.

The nature of lightning and the principles of lightning protection are discussed and guidance is given to assist in a determination of whether protective measures should be taken.

This Standard is applicable to conventional lightning protection systems (LPSs) that comprise air terminals, downconductors, earth termination networks and surge protective devices (SPDs). Nothing contained within this Standard either endorses or implies the endorsement of non-conventional LPSs that comprise air terminals that claim enhanced performance or downconductors that claim enhanced magnetic screening over conventional systems.

The performance of such systems is outside the scope of this Standard. Irrespective of claimed performance, air terminals shall be placed in accordance with Section 4 to comply with this Standard.

1.2 APPLICATION

This Standard does not override any statutory requirements but may be used in conjunction with such requirements.

Compliance with the recommendations of this Standard will not necessarily prevent damage or personal injury due to lightning but will reduce the probability of such damage or injury occurring.

1.3 INTRODUCTION

Thunderstorms are natural phenomena and there are no proven devices and methods capable of preventing lightning flashes. Direct and nearby cloud-to-ground lightning discharges can be hazardous to persons, structures, installations and many other things in or on them. Consideration should always be given to the application of lightning protection measures.

Realization that it is possible to provide effective protection against lightning began with Franklin and for over a hundred years national and international manuals and standards have been developed to provide guidance on the principles and practice of lightning protection. Until about ten years ago, risk assessment was used to determine if there was a need to provide lightning protection. However, the modern approach is that of risk management, which integrates the determination of the need for protection with the selection of adequate protection measures to reduce the risk to a tolerable level. This selection takes into account both the efficiency of the measures and the cost of their provision. In the risk management approach, the lightning threats that create risk are identified, the frequencies of all risk events are estimated, the consequences of the risk events are determined, and if these are above a tolerable level of risk, protection measures are applied to reduce the risk (R) to below the tolerable level (R_a). This involves a choice from a range of protection level efficiencies for protection against direct (d) strikes to the structure and decisions about the extent of other measures for protecting low-voltage and electronic equipment against indirect (i) lightning stresses incident from nearby strikes. In summary—

$$R = \sum R_x = \sum R_d + \sum R_i$$

$$R_x = N_x P_x \delta_x$$

$$P_x = k_x p_x$$

$$R \leq R_a$$

where N_x is the frequency of dangerous events, P_x is the probability of damage or injury, δ_x is the relative amount of damage or injury with any consequential effects, and k_x is a reduction factor associated with the protection measure adopted and which equals 1 in the absence of protection measures when $P_x = p_x$.

The lightning protection measures include an LPS for the structure and its occupants, protection against the lightning electromagnetic pulse (LEMP) caused by direct and nearby strikes, and transient protection (TP) of incoming services. The LPS for the structure comprises an air terminal network to intercept the lightning strike, a downconductor system to conduct the discharge current safely to earth and an earth termination network to dissipate the current into the earth. The LEMP protection includes a number of measures to protect sensitive electronic equipment such as the use of a mesh of downconductors to minimize the internal magnetic field, the selection of lightning protection zones, equipotential bonding and earthing, and the installation of SPDs. The TP for incoming services includes the use of isolation devices, the shielding of cables and the installation and coordination of SPDs.

1.4 REFERENCED DOCUMENTS

The documents referred to in this Standard are listed in Appendix G.

1.5 DEFINITIONS

For the purpose of this Standard, the definitions below apply.

1.5.1 Air terminal

A vertical or horizontal conductor of an LPS, positioned so as to intercept a lightning discharge, which establishes a zone of protection.

1.5.2 Air terminal network

A network of air terminals and interconnecting conductors, which forms the part of an LPS that is intended to intercept lightning discharges.

1.5.3 Base conductors

Conductors placed around the perimeter of a structure near ground level interconnected to a number of earth terminations to distribute the lightning currents amongst them.

1.5.4 Bond (bonding conductor)

A conductor intended to provide electrical connection between the LPS and other metalwork and between various metal parts of a structure or between earthing systems.

1.5.5 Damage (δ)

Mean relative amount of loss consequent to a specified type of damage due to a lightning event, when damage factors are not taken into account.

1.5.6 Direct lightning flash

A lightning discharge, composed of one or more strokes, that strikes the structure or its LPS directly.

1.5.7 Downconductor

A conductor that connects an air terminal network with an earth termination.

1.5.8 Earth impedance (*Z*)

The electrical impedance of an earthing electrode or structure to earth, derived from the earth potential rise divided by the impulse current to earth causing that rise. It is a relatively complex function and depends on—

(a) the resistance component (*R*) as measured by an earth tester;

(b) the reactance component (*X*), depending on the circuit path to the general body of earth; and

(c) a modifying (reducing) time-related component depending on soil ionization caused by high current and fast rise times.

1.5.9 Earth potential rise (EPR)

The increase in electrical potential of an earthing electrode, body of soil or earthed structure, with respect to distant earth, caused by the discharge of current to the general body of earth through the impedance of that earthing electrode or structure.

1.5.10 Earthing boss (terminal lug)

A metal boss specially designed and welded to process plant, storage tanks, or steelwork to which earthing conductors are attached by means of removable studs or nuts and bolts.

1.5.11 Earthing conductor

The conductor by which the final connection to an earthing electrode is made.

1.5.12 Earthing electrodes (earth rods or ground rods)

Those portions of the earth termination that make direct low resistance electrical contact with the earth.

1.5.13 Earthing resistance

The resistance of the LPS to the general mass of earth, as measured from a test point.

1.5.14 Earth termination (earth termination network)

That part of an LPS intended to discharge lightning currents into the general mass of the earth. All parts below the lowest test link in a downconductor are included.

1.5.15 Electricity supply service earthing electrode

An earthing electrode installed for the purposes of providing the connection of the electrical installation earthing system to the general mass of earth.

1.5.16 Explosive gas atmosphere

A mixture of flammable gas, vapour or mist with air in atmospheric conditions in which, after ignition, combustion spreads throughout the unconsumed mixture that is between the upper and lower explosive limits.

NOTE: The term refers exclusively to the danger arising from ignition. Where danger from other causes such as toxicity, asphyxiation, and radioactivity may arise this is specifically mentioned.

1.5.17 Finial

A term not used in this Standard owing to its confusion with architectural application but occasionally used elsewhere in other Standards as referring to short vertical air terminals.

1.5.18 Frequency of lightning flashes direct to a service (N_c)

Expected annual number of lightning flashes directly striking an incoming service.

1.5.19 Frequency of lightning flashes direct to a structure (N_d)

Expected annual number of lightning flashes directly striking the structure.

1.5.20 Frequency of lightning flashes to ground near a service (N_l)

Expected annual number of lightning flashes striking the ground surface near an incoming service.

1.5.21 Frequency of lightning flashes to ground near a structure (N_m)

Expected annual number of lightning flashes striking the ground surface near the structure.

1.5.22 Hazardous area

An area where an explosive atmosphere is, or may be expected to be present continuously, intermittently or due to an abnormal or transient condition (see AS/NZS 2430 series).

1.5.23 Incoming service

A service entering a structure (e.g. electricity supply service lines, telecommunications service lines or other services).

1.5.24 Indirect lightning flash

A lightning discharge, composed of one or more strokes, that strikes the incoming services or the ground near the structure or near the incoming services.

1.5.25 Internal installation

An installation or the part of an incoming service that is located inside the structure.

1.5.26 Joint

A mechanical and electrical junction between two or more sections of an LPS.

1.5.27 Lightning flash (lightning discharge)

An electrical discharge in the atmosphere involving one or more electrically charged regions, most commonly in a cumulonimbus cloud, taking either of the following forms:

(a) *Ground flash (earth discharge)* A lightning flash in which at least one lightning discharge channel reaches the ground.

(b) *Cloud flash* A lightning flash in which the lightning discharge channels do not reach the earth.

1.5.28 Lightning flash density (N_g)

The number of lightning flashes of the specified type occurring on or over unit area in unit time. This is commonly expressed as per square kilometre per year (km^{-2} $year^{-1}$). The ground flash density is the number of ground flashes per unit area and per unit time, preferably expressed as a long-term (>10 years) average value.

1.5.29 LPS (LPS Type I to IV)

Complete system used to reduce the danger of physical damages and of injuries due to direct flashes to the structure. It consists of both external and internal LPSs and is defined as a set of construction rules, based on corresponding protection level.

1.5.30 Lightning protection zone (LPZ)

With respect to the lightning threat, a zone may be defined, inside of which is sensitive equipment. Extra protection is applied at the zone boundary to minimize the risk of damage to equipment inside the zone.

1.5.31 Lightning strike

A term used to describe the lightning flash when the attention is centred on the effects of the flash at the lightning strike attachment point, rather than on the complete lightning discharge.

1.5.32 Lightning strike attachment point

The point on the ground or on a structure where the lower end of the lightning discharge channel connects with the ground or structure.

1.5.33 Lightning stroke

A term used to describe an individual current impulse in a complete ground flash.

1.5.34 Loss

Due to lightning strike, the loss can be of human life, loss of service to the public or economic loss.

1.5.35 Multiple earthed neutral (MEN) system

A system of earthing in which the parts of an electrical installation are connected to the general mass of earth and in addition are connected within the electrical installation to the neutral conductor of the supply system.

1.5.36 Partial probability of damage (p)

Probability of a lightning flash causing a specified type of damage to the structure, depending on one characteristic of the structure or of an incoming service.

1.5.37 Probability of damage (P)

Probability of a lightning flash causing a specified type of damage to the structure. It may be composed of one or more simple probabilities of damage.

1.5.38 Protection level (I to IV)

Four levels of lightning protection. For each protection level, a set of maximum (sizing criteria) and minimum (interception criteria) lightning current parameters is fixed, together with the corresponding rolling sphere radius.

1.5.39 Protection measures

Protection measures taken to reduce the probability of damage. These may include an LPS on the building, isolation transformers and/or surge protection on incoming services (primary protection) and internal equipment (secondary protection).