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Edition 1.0 2016-05

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Protection against lightning – Thunderstorm warning systems

Protection contre la foudre – Systèmes d'alerte aux orages

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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PROTECTION AGAINST LIGHTNING – THUNDERSTORM WARNING SYSTEMS

FOREWORD

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

FDIS	Report on voting
81/508/FDIS	81/519/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.

The French version of this standard has not been voted upon.

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

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website 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- withdrawn,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.

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INTRODUCTION

Natural atmospheric electric activity and, in particular, cloud-to-ground lightning poses a serious threat to living beings and property. Every year severe injuries and even deaths of humans are caused as a result of direct or indirect lightning strikes.

Lightning:

- may affect sport, cultural and political events attracting large concentrations of people; events may have to be suspended and people evacuated in the case of a risk of thunderstorm;
- may affect industrial activities by creating power outages and unplanned interruptions of production processes;
- may interrupt all kinds of traffic (people, energy, information, etc.);
- has led to a steady increase in the number of accidents per year due to the wider use of electric components that are sensitive to the effects of lightning (in industry, transportation and communication);
- may be a hazard for activities with an environmental risk, for example handling of sensitive, inflammable, explosive or chemical products;
- may be a cause of fire.

During the last decades, technical systems including systems devoted to real-time monitoring of natural atmospheric electric activity and lightning, have experienced an extraordinary development. These systems can provide high quality and valuable information in real-time of the thunderstorm occurrence, making it possible to achieve information which can be extremely valuable if coordinated with a detailed plan of action.

Although this information allows the user to adopt anticipated temporary preventive measures, it should be noted that all the measures to be taken based on monitoring information are the responsibility of the system user according to the relevant regulations. The effectiveness will depend largely on the risk involved and the planned decisions to be taken. This International Standard gives an informative list of possible actions.

Lightning and thunderstorms, as with many natural phenomena, are subject to statistical uncertainty. It is not possible therefore to achieve precise information on when and where lightning will strike.

Other lightning protection standards do not cover the use of thunderstorm warning systems.

PROTECTION AGAINST LIGHTNING – THUNDERSTORM WARNING SYSTEMS

1 Scope

This International Standard describes the characteristics of thunderstorm warning systems and evaluation of the usefulness of lightning real time data and/or storm electrification data in order to implement lightning hazard preventive measures.

This standard provides the basic requirements for sensors and networks collecting accurate data of the relevant parameters, giving real-time information of lightning tracks and range. It describes the application of the data collected by these sensors and networks in the form of warnings and historical data.

This standard applies to the use of information from thunderstorm warning systems (systems or equipment providing real-time information) on atmospheric electric activity in order to monitor preventive measures.

This standard includes:

- a general description of available lightning and storm electrification hazard warning systems;
- a classification of thunderstorm detection devices and properties;
- guidelines for alarming methods;
- a procedure to determine the usefulness of thunderstorm information;
- some informative examples of possible preventive actions.

The following aspects are outside the scope of this standard:

a) lightning protection systems; such systems are covered by the IEC 62305 series;

b) other thunderstorm related phenomena such as rain, hail, wind;

c) satellite and radar thunderstorm detection techniques.

A non-exhaustive list of situations to which this standard could be applicable is given below:

- people in open areas involved in activities such as maintenance, labour, sports, competitions, agriculture and fisheries or situations where large crowds gather;
- wind farms, large solar power systems, power lines;
- occupational health and safety prevention;
- sensitive equipment such as computer systems, emergency systems, alarms and safety equipment;
- operational and industrial processes;
- storage, processing and transportation of hazardous substances (e.g. flammable, radioactive, toxic and explosive substances);
- determined environments or activities with special danger of electrostatic discharges (e.g. space and flight vehicle operations);
- operations in which the continuity of the basic services is very important (e.g. telecommunications, the generation, transport and distribution of energy, sanitary services and emergency services);
- infrastructures: ports, airports, railroads, motorways and cableways;

- civil defense of the environment: forest fires, land slide and floods;
- wide networks (e.g. power lines, telecommunication lines) may also benefit from having early detection of thunderstorms.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 62305 (all parts), *Protection against lightning*

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1.1
alarm
information indicating that the target or the surrounding area is likely to be affected by thunderstorms and the accompanying lightning related events

3.1.2
cloud-to-ground lightning
CG
electric discharge of atmospheric origin that is comprised of one or more cloud-to-ground lightning strokes that propagate from cloud to ground or vice versa and lead to a net transfer of charge between cloud and ground

3.1.3
coverage area
CA
area where a given warning equipment has a sufficient detection efficiency and/or accuracy to give a warning

3.1.4
detection efficiency
DE
percentage of cloud-to-ground discharges (flashes or strokes) that are detected and located by a sensor or a network

Note 1 to entry: As cloud-to-ground flashes are often composed of several strokes, there is a difference between flash detection efficiency and stroke detection efficiency. A flash is reported (detected) if at least one stroke (first or subsequent) is detected and therefore flash detection efficiency is always equal or higher than stroke detection efficiency.

3.1.5
dwell time
DT
time that an alarm is sustained after all warning criteria are no longer met

3.1.6
effective alarm
EA
alarm where a lightning related event occurs in the surrounding area during the total alarm duration

3.1.7
time to clear
TTC
time between the occurrence of the last lightning related event in the monitoring area and the time when the alarm is released

3.1.8
failure to warn
FTW
occurrence of a lightning related event in the surrounding area for which no alarm occurred

3.1.9
failure to warn ratio
FTWR
ratio of failure to warn with respect to the total number of situations with lightning related events affecting the surrounding area

3.1.10
false alarm
FA
alarm not followed by lightning-related events within the surrounding area

3.1.11
false alarm ratio
false alarm rate
FAR
ratio of false alarms to the total number of alarms

3.1.12
field strength meter
FSM
device for continuous monitoring of the atmospheric electrostatic field associated with thunderstorms

EXAMPLE: Field mill.

3.1.13
cloud lightning
IC
discharge occurring within or among thunderclouds or between thunderclouds and air and which does not have a ground termination

3.1.14
lead time
LT
time between the start of an alarm and the effective occurrence of the first lightning related event in the target area

3.1.15
lightning flash
electric discharge of atmospheric origin consisting of one or more strokes

Note 1 to entry: This discharge may occur within or between clouds, between the clouds and air and between a cloud and the ground.

3.1.16
lightning related event
LRE
CG lightning flash to or near the structure to be protected, or to or near a line connected to the structure to be protected

3.1.17
lightning stroke
single electric discharge in a lightning flash to earth

3.1.18
median location accuracy
LA
median value of the distances between real stroke locations and the stroke locations given by the lightning location system

3.1.19
monitoring area
MA
geographic area where the lightning activity is monitored in order to provide a valid warning for the target area

3.1.20
physical damage
damage to a structure (or to its contents) due to mechanical, thermal, chemical or explosive effects of lightning

3.1.21
preventive actions
actions of a temporary nature, taken on the basis of the preventive information and framed within the emergency plans of each organization which covers all that is required

3.1.22
point of strike
point where a lightning flash strikes the earth or protruding objects (e.g. structure, lightning protection system, line, tree)

Note 1 to entry: A lightning flash may have more than one point of strike.

3.1.23
surrounding area
SA
geographic area in which a lightning related event (LRE) causes a potential danger and which surrounds and includes the target area (TA)

Note 1 to entry: Any lightning related event occurring in the surrounding area is potentially dangerous. This area is used when evaluating a thunderstorm warning system to determine the false alarm ratio and other performance parameters.

3.1.24
target area
TA
geographic area where a warning is needed in order to facilitate decision-making and to activate preventive actions before a lightning related event occurs in that area

3.1.25
thunderstorm
local storm produced by atmospheric activity and accompanied by lightning and thunder

3.1.26
thunderstorm detector
equipment capable of evaluating one or more parameters associated with the electrical characteristics of the thunderstorm

Note 1 to entry: Thunderstorm detectors may consist of a single detector or of a network of connected detectors.

3.1.27
thunderstorm warning system
TWS
system composed of thunderstorm detectors able to monitor the thunderstorm activity in the monitoring area and means of processing the acquired data to provide a valid alarm (warning) related to the lightning related events for a defined target area

Note 1 to entry: Some countries refer to TWS as 'lightning warning systems'.

3.1.28
total alarm duration
TAD
time between triggering and the end of an alarm

3.1.29
percentage of alarms delivered
POD_x
percentage of alarms delivered with a lead time of more than or equal to x minutes

EXAMPLE: POD_{10} is the percentage of alarms delivered with a lead time of more than or equal to 10 min.

3.2 Abbreviations

CA	Coverage area
CG	Cloud to ground
DC	Direct current
DE	Detection efficiency
DT	Dwell time
EA	Effective alarm
EMC	Electromagnetic compatibility
EMI	Electromagnetic interference
FA	False alarm
FAR	False alarm ratio
FSM	Field strength meter
FTW	Failure to warn
FTWR	Failure to warn ratio
HV	High voltage
IC	Intercloud, intracloud or cloud to air discharges
IP	Index of protection
LA	Location accuracy
LF	Low frequencies
LLS	Lightning location system
LPS	Lightning protective system
LT	Lead time
LRE	Lightning related event
MA	Monitoring area
MCS	Mesoscale convective systems
MDF	Magnetic duration finder
OI	Optical imaging
POD_x	Percentage of alarms delivered

RFI Radio frequency interferometry
RFM RF signal strength measurement
RF Radio frequency
SA Surrounding area
TA Target area
TAD Total alarm duration
TOA Time of arrival
TTC Time to clear
TWS Thunderstorm warning system
UV Ultraviolet
VHF Very high frequencies
VLF Very low frequencies

4 Thunderstorm phases and detectable phenomena for alarming

4.1 Introductory remark

Four distinct stages can be identified during the thunderstorm life time cycle regarding detectable phenomena:

1) initial phase;
2) growth phase;
3) mature phase;
4) dissipation phase.

4.2 Phase 1 – Initial phase (cumulus stage)

This is the phase of cloud electrification by means of electric charge separation within the cloud. The charges are distributed in regions within the cloud and produce a measurable electrostatic field at ground level. It is considered the first detectable phenomenon before a thunderstorm.

NOTE Electrostatic fields can produce potential dangers such as electrostatic discharges even in the case of no lightning activity.

4.3 Phase 2 – Growth phase

This phase, sometimes also called the development phase, is characterized by the occurrence of the first lightning discharge (IC or CG). The first intra-cloud (IC) flashes appear after a certain development of the charge regions in the cloud. However, in some situations there is no clear time delay between the first IC flash and the first CG flash.

NOTE IC flashes typically represent the majority of the total lightning activity generated by a thunderstorm. Significant variation in the IC/CG rate is observed for individual storms.

4.4 Phase 3 – Mature phase

This stage is characterized by the presence of both CG and IC flashes.

4.5 Phase 4 – Dissipation phase

This phase is characterized by the decaying of both IC and CG flash rates and the reduction of the electrostatic field to the fair weather level.