IEC 62793

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INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Thunderstorm warning systems – Protection against lightning

Systèmes d'alerte aux orages – Protection contre la foudre

IEC 62793:2020-09(en-fr)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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THUNDERSTORM WARNING SYSTEMS – PROTECTION AGAINST LIGHTNING

FOREWORD

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International Standard IEC 62793 has been prepared by IEC technical committee 81: Lightning protection.

This second edition cancels and replaces the first edition, published in 2016. This edition constitutes a technical revision.

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

- portable devices are no longer covered by this standard;
- in Clause 5, classes of TWS have been deleted;
- in Clause 6, updated figures and more detailed text are provided to better illustrate the alarm timeline;
- in Clause 9, the text has been summarized and refers now to the application guide given in Annex F;
- annexes have been reorganized;
- Annex E is normative.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
81/640/FDIS	81/641/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

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

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document 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- withdrawn,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 properties. Every year severe injuries and 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, when in the open field; events may have to be suspended and people evacuated in the case of a risk of a 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 and losses per year due to the wider use of electronic 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 to a large extent on the risk involved and the planned decisions to be taken. This document gives an informative list of possible actions (see Annex C).

Lightning and thunderstorms, as many natural phenomena, are subject to statistical uncertainties. It is therefore not possible to achieve precise information on when and where an individual lightning will strike but statistical parameters are defined in this document to help the user in selecting proper measures.

THUNDERSTORM WARNING SYSTEMS – PROTECTION AGAINST LIGHTNING

1 Scope

This document describes the characteristics of thunderstorm warning systems (TWSs) in order to implement lightning hazard preventive measures.

Single sensors and/or a network of sensors (e.g. lightning location system) can be used as a TWS.

This document provides requirements for sensors and networks collecting accurate data of the relevant parameters, giving real-time information on lightning and atmospheric electric activity. It describes the application of the data collected by these sensors and networks in the form of warnings and historical data.

This document includes:

- a general description of available techniques for TWSs;
- guidelines for alarming methods;
- informative examples of possible preventive actions.

The following aspects are outside the scope of this document:

a) lightning protection systems: such systems are covered by IEC 62305 (all parts) [1][1];

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

c) satellite and radar based thunderstorm detection techniques;

d) portable devices (a device where the sensor is not fixed).

NOTE It is possible that calibration and testing of portable devices will not be sufficient to provide efficient warning.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 62561-4, *Lightning protection system components (LPSC) – Part 4: Requirements for conductor fasteners*

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

IEC 60068-2-75:2014, *Environmental testing – Part 2-75: Tests – Test Eh: Hammer tests*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

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1 Numbers in square brackets refer to the bibliography.

IEC 61180, *High-voltage test techniques for low voltage equipment – Definitions, test and procedure requirements, test equipment*

IEC 61000-6-4, *Electromagnetic compatibility (EMC) – Part 6-4: Generic standards – Emission standard for industrial environments*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1.1
alarm
information indicating that a defined area is likely to be affected by thunderstorms and the accompanying lightning related events (LREs)

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 (DE) and/or accuracy to give a warning

3.1.4
detection efficiency
DE
percentage of lightning discharges that is detected by a sensor or a network

3.1.5
effective alarm
EA
alarm where a lightning related event (LRE) occurs in the surrounding area (SA) during the total alarm duration (TAD)

Note 1 to entry: An effective alarm can only be assessed when LREs are monitored. When LREs are not monitored the lightning related conditions (LRC) may define a valid alarm, see Figure 3 a).

3.1.6
effective alarm ratio
EAR
number of effective alarms (EAs) with respect to the total number of alarms (TNA)

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

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

3.1.9
failure to warn ratio
FTWR
number of failures to warn with respect to the total number of situations with lightning related events (LREs) affecting the surrounding area (SA)

3.1.10
false alarm
FA
alarm when there is no thunderstorm activity in the monitoring area (MA)

EXAMPLE An alarm due to TWS equipment malfunction or an alarm triggered by any signal not related to thunderstorm (snow, sand, electromagnetic disturbances, etc.).

3.1.11
false alarm ratio
FAR
number of false alarms with respect to the total number of alarms (TNA)

3.1.12
electrostatic field sensor
EFS
device for continuous monitoring of the atmospheric electrostatic field, where the sensor is located, associated with thunderstorms

EXAMPLE An electric field mill.

3.1.13
intra-cloud lightning
IC
electric discharge of atmospheric origin 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 (LRE) in the surrounding area (SA)

Note 1 to entry: Any efficient preventive action should be completed before the end of the lead time.

Note 2 to entry: A lead time can only be assessed when LREs are monitored. When LREs are not monitored the lightning related conditions (LRC) may define an estimated lead time, see Figure 3 a).

3.1.15
lightning related event
LRE
event where one or more cloud-to-ground lightning (CG) occurs inside the surrounding area (SA)

3.1.16
lightning related conditions
LRC
static electric field that has reached a level high enough so that lightning is expected to occur at any time in the surrounding area (SA)

3.1.17
median location accuracy
median value of the distances between real stroke locations and the stroke location given by a lightning location system

3.1.18
monitoring area
MA
geographic area where the lightning or upcoming lightning (lightning is expected to occur at any time) activity is monitored in order to provide a valid warning for the surrounding area (SA)

Note 1 to entry: The monitoring area is smaller or equal to the coverage area.

3.1.19
preventive action
action of a temporary nature, that should be completed before the end of the lead time (LT), taken on the basis of the preventive information and included in the emergency plans

3.1.20
surrounding area
SA
geographic area in which a lightning related event (LRE) causes a potential danger and which surrounds and includes the target (TA) to be protected

Note 1 to entry: Any lightning related event (LRE) occurring in the surrounding area (SA) is potentially dangerous for the target. This area is used when evaluating a thunderstorm warning system (TWS) to determine the performance parameters such as failure to warn ratio (FTWR).

3.1.21
target
TA
object or area for which a thunderstorm warning is needed

3.1.22
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.

Note 2 to entry: By definition, a thunderstorm only exists when the first lightning strike occurs.

3.1.23
thunderstorm warning system
TWS
system composed of thunderstorm detector(s) able to monitor the lightning or upcoming lightning activity in the monitoring area (MA) and tools for processing the acquired data to provide a valid alarm (warning) related to the lightning related events (LREs) or conditions (LRC) for a defined surrounding area (SA)

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

3.1.24
total alarm duration
TAD
time between the start and the end of an alarm

3.1.25
probability of detection
POD
number of effective alarms (EAs) with respect to the total number of situations with lightning related events (LREs) affecting the surrounding area (SA)

Note 1 to entry: POD = 1 – FTWR.

3.1.26
probability of detection with a lead time of x min
POD_x
number of effective alarms (EAs) delivered with a lead time (LT) greater or equal to x min with respect to the total number of situations with lightning related events (LREs) affecting the surrounding area (SA)

Note 1 to entry: POD_{10} is the percentage of alarms delivered with a lead time (LT) of more than or equal to 10 min.

3.1.27
non-effective alarm
NEA
alarm that occurred when there was no lightning related event (LRE) occurring in the surrounding area (SA) during the total alarm duration (TAD)

Note 1 to entry: An effective alarm can only be assessed when LREs are monitored. When LREs are not monitored the lightning related conditions (LRC) may define a valid alarm, see Figure 3 a).

3.1.28
total number of alarms
TNA
sum of the number of false alarms, effective alarms and non-effective alarms

Note 1 to entry: TNA = EA + FA + NEA

3.2 Abbreviated terms

CA	coverage area
CG	cloud-to-ground lightning
DC	direct current
DE	detection efficiency
EA	effective alarm
EAR	effective alarm ratio
EFS	electrostatic field sensor
EMC	electromagnetic compatibility
FA	false alarm
FAR	false alarm ratio
FTW	failure to warn
FTWR	failure to warn ratio
HV	high voltage
IC	intra-cloud lightning
IP	index of protection

LA	location accuracy
LF	low frequency
LLS	lightning location system
LPS	lightning protection system
LT	lead time
LRC	lightning related conditions
LRE	lightning related event
MA	monitoring area
MCS	mesoscale convective systems
MDF	magnetic direction finder
NEA	non-effective alarm
POD	probability of detection
POD_x	probability of detection with a lead time of x min
SA	surrounding area
TA	target
TAD	total alarm duration
TNA	total number of alarms
TOA	time of arrival
TTC	time to clear
TWS	thunderstorm warning system
UV	ultraviolet
VHF	very high frequency
VLF	very low frequency

4 Thunderstorm phases and detectable phenomena for alarming

Four distinct phases regarding detectable phenomena can be identified before the thunderstorm lifetime cycle (see Annex A):

- Phase 1 or initial phase

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. The electrostatic field or electrostatic field change is considered to be the first detectable phenomenon of a thunderstorm.

NOTE 1 Electrostatic fields can produce potential dangers such as electrostatic discharges even in the case of no lightning activity.

- Phase 2 or 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 IC appears after a partial development of the charge regions in the cloud. However, in some situations there is no clear time delay between the first IC and the first CG.

NOTE 2 IC typically represents the majority of the total lightning activity generated by a thunderstorm. Significant variation in the IC/CG rate is observed for individual storms.

- Phase 3 or mature phase

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

- Phase 4 or dissipation phase

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

5 Description of thunderstorm detectors and their properties

There are several ways to detect thunderstorms. These may be achieved by:

a) a local detector (for example field mill or electrostatic field sensor),

b) a network of detectors (for example field mills or electrostatic field sensors interconnected),

c) a lightning location system (see IEC 62858 [2]).

Table 1 gives the main parameters related to sensor technologies.

Table 1 – Parameters related to sensor technologies

Parameter	Electrostatic field sensor (local detector or network)	Electromagnetic sensor (local detector)	Lightning location system
CG		X[a]	X
EA	X	X	X
NEA	X	X	X
EAR	X	X	X
FTW	X	X	X
FTWR	X	X	X
IC		X[a]	X
LA			X
LT	X	X	X
LRC	X		
LRE	X	X	X
POD	X	X	X
POD_x	X	X	X
TAD	X	X	X
TTC	X	X	X

[a] The sensor may not be able to differentiate between cloud-to-ground (CG) and intra-cloud (IC).

A local detector detects a thunderstorm in the vicinity of the sensor. By detecting the electrostatic field, a local detector can provide a warning before the first IC/CG occurs in the surrounding area. A network of local detectors offers the same information but on a larger scale. An LLS offers local warnings based on a global view on a large area (uniform performance) with lightning location capabilities and tracking of thunderstorms allowing to provide a longer LT in case of thunderstorms approaching the target.

Local sensors are able to measure local conditions (electromagnetic or electrostatic fields). Their characteristics are described in Table 2.

A network of sensors is able, depending on its performance, to provide the distance and direction of the thunderstorm and location of single flashes (refer to IEC 62858).