PD IEC TR 60479-4:2020

BSI Standards Publication

Effects of current on human beings and livestock

Part 4: Effects of lightning strokes

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National foreword

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A list of organizations represented on this committee can be obtained on request to its secretary.

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Effects of current on human beings and livestock – Part 4: Effects of lightning strokes

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

EFFECTS OF CURRENT ON HUMAN BEINGS AND LIVESTOCK –

Part 4: Effects of lightning strokes

FOREWORD

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The main task of IEC technical committees is to prepare International Standards. However, a technical committee may propose the publication of a Technical Report when it has collected data of a different kind from that which is normally published as an International Standard, for example "state of the art".

IEC TR 60479-4, which is a Technical Report, has been prepared by IEC technical committee 64: Electrical installations and protection against electric shock.

This third edition cancels and replaces the second edition published in 2011. This edition constitutes a technical revision.

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

a) lightning occurence and climatory effects around the world are depicted;
b) direct strike description is extended;
c) step voltage effects are expanded;
d) upward streamer explanation is enhanced;

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e) other direct or indirect related effects to lightning injuries to the human body are specified;

f) various safety procedures and related possibilities with respect to the personsal danger of lightning are presented.

The text of this Technical Report is based on the following documents:

Draft TR	Report on voting
64/2369/DTR	64/2398/RVDTR

Full information on the voting for the approval of this Technical Report 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.

A list of all parts in the IEC 60479 series, published under the general title *Effects of current on human beings and livestock*, can be found on the IEC website.

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.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

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INTRODUCTION

IEC 60479-1 and IEC 60479-2 deal with the effect of electric shock derived from electrical systems on the bodies of human beings and livestock. This document describes the influence and effect of electricity in the form of lightning strikes. Lightning current can consist of several uni-polar and/or bi-polar impulses with different peak values and durations; IEC 60479-2:2019, Clause 6 does not cover these effects.

The interaction of a lightning stroke with the body is often different from that of electric shock derived from electrical systems. If the head is struck, the electrical path may include the brain stem, which includes the respiratory centre.

IEC 60479-2 includes information related to the effects of short duration impulses which extend to the magnitude and duration of lightning impulses.

It is accepted that more than 70 % of lightning accidents involving humans are not fatal [36], [47][1]. Corresponding reliable data for livestock is not known. There is a large variation in outcome due to different environments, different activities of people and knowledge of first aid and quality of medical care [40],[47].

It has been necessary, therefore, to create a separate document concerning the special effects of lightning strokes. The physical behaviour of lightning is shown as a basis. The interaction with a living body is then described, followed by the ongoing life consequences.

[1] Numbers in square brackets refer to the bibliography.

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EFFECTS OF CURRENT ON HUMAN BEINGS AND LIVESTOCK –

Part 4: Effects of lightning strokes

1 Scope

This part of IEC 60479 summarizes the basic parameters for lightning and its variability insofar as they apply to human beings and livestock.

The possible direct and indirect interactions of strikes with bodies of living beings are indicated.

The resulting effects caused by lightning currents for the organism are described.

This document shows the differences of effects on human beings and livestock due to lightning strokes versus those effects of electric shocks derived from electrical systems.

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 60479-1, *Effects of current on human beings and livestock – Part 1: General aspects*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60479-1 and the following 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 Definitions of technical terms

3.1.1
lightning flash
<to earth> electrical discharge of atmospheric origin between cloud and earth consisting of one or more lightning strokes

3.1.2
lightning stroke
lightning impulse
single electrical discharge in a lightning flash to earth

3.1.3
lightning channel
conducting path of the lightning current

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3.1.4
stepped leader
faintly luminous channel of generally less than 10 C of charge with associated branches that develops in virgin air and progresses towards the earth in discrete steps

3.1.5
return stroke
bright highly visible channel carrying the impulse current of the stroke, which is initiated when the stepped leader and upward connecting streamers meet to form the channel

3.1.6
upward flash
lightning flash initiated by an upward leader from earth to cloud

3.1.7
continuing current
current with a magnitude of tens to hundreds of amperes and a duration up to hundreds of milliseconds often following a return stroke

Note 1 to entry Continuing currents with duration in excess of 40 ms are traditionally termed "long continuing currents".

3.1.8
lightning current
current flowing at the point of strike

3.1.9
current peak value
maximum value of the lightning current

3.1.10
upward streamer
pre-discharge phenomena induced by the stepped leader, one of which will connect with the stepped leader opening a lightning channel which becomes a lightning stroke

3.1.11
average steepness of impulse current
average rate of change of lightning current within a time interval bounded by the 10 % and 90 % values of the peak impulse current front

3.1.12
stroke duration
time in microseconds between the time the return stroke exceeds 2 kA and the time to half peak value on the tail of the current pulse

3.1.13
flash duration
time for which the lightning current flows at the point(s) of attachment

3.1.14
point(s) of attachment
point(s) at which the successful upward streamer was launched

EXAMPLE Object, human or otherwise.

3.1.15
remote earth
ideal earth of zero resistance and zero potential

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3.1.16
physical earth
earth as contact by objects

Note 1 to entry The difference between remote earth and physical earth allows the modelling of an earth resistance between the two, creating ground potential.

3.1.17
lightning ground flash density
measurement of the number of lightning strikes to ground, over a period of one year, per km^2

3.2 Definitions of interactions

3.2.1
direct strike
interaction whereby the lightning attaches directly to an object (including a living object)

3.2.2
contact voltage
potential difference between contacted points on an object, on which currents generated by a lightning event are present, or between an accessible point and an independent object (including earth) which could result in current flow through a living being

Note 1 to entry In some texts this has been referred to as "contact potential" or "touch voltage".

3.2.3
side flash
electric arc between two objects (including living objects), at least one of which is subject to partial lightning current

3.2.4
step voltage
step potential
potential difference between two points on the earth's surface due to a lightning stroke current being conducted through the earth

3.2.5
flashover
electric arc over the surface of an object carrying a significant proportion of the stroke current

3.2.6
streamer current
current, passing through an object, to establish an upward streamer, but which ultimately will not become a point of attachment

4 Basic physics of lightning

4.1 General

The explanation of the basic physical mechanisms for the onset and the dynamics of lightning is very complicated. Within a cloud, three layers are recognized, each with identifiable charges (see Figure 1). They are generated by microscopic charge transfer between soft hail particles (also called graupel) and ice crystals. The basal layer is normally negatively charged, with the layers successively positively and negatively charged in ascending order.

Lightning is a transient, high-current discharge whose path length is measured in kilometres. A lightning flash is a current phenomenon, and not a voltage phenomenon. More correctly, it is a "charge dumping" phenomenon, which occurs when the increasing electric field between two statically charged points exceeds a threshold.

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