IEC/TR 62713

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TECHNICAL REPORT

RAPPORT TECHNIQUE

colour inside

Safety procedures for reduction of risk outside a structure

Procédures de sécurité pour la réduction des risques à l'extérieur d'une structure

IEC/TR 62713:2013

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CONTENTS

FOREWORD 3
INTRODUCTION 5
1 Scope 6
2 Normative references 6
3 Terms and definitions 6
4 General 8
4.1 Introductory remark 8
4.2 Lightning damage to human beings 9
4.2.1 General 9
4.2.2 Direct strikes 9
4.2.3 Side flash 9
4.2.4 Touch or contact voltages 10
4.2.5 Step voltages 10
5 Effects of lightning strikes to human beings 11
5.1 Possible injuries 11
5.2 How injured people can be helped 12
6 How to act in the presence of a thunderstorm 14
6.1 How to detect a lightning risk 14
6.2 Where to find safe locations 14
6.3 What to do outdoors 15
6.4 Hazardous situation in a car 17
6.5 What to do when camping 17
6.6 Thunderstorms in mountainous regions 18
6.7 What to do on water 18
6.8 What to do at open air festivals 19
6.9 What to do when playing outdoor sports 19
Bibliography 21

Figure 1 – Examples of roofs and facades damaged by lightning 8
Figure 2 – Direct strike 9
Figure 3 – Side flash 9
Figure 4 – Unsuitability of metallic structures when not earthed 10
Figure 5 – Electrization by touch voltage 10
Figure 6 – Current flow through body due to by step voltage 11
Figure 7 – Lichtenberg figures on human skin [1] 12
Figure 8 – Cardiopulmonary resuscitation (CPR) 13
Figure 9 – How to avoid strikes inside a house 15
Figure 10 – Avoid the highest point in this area 16
Figure 11 – Safety distance (10 m) under a tree 16
Figure 12 – Generally, a car acts as a Faraday cage 17
Figure 13 – Example of a lightning protection system on a sailing boat 19

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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SAFETY PROCEDURES FOR REDUCTION OF RISK OUTSIDE A STRUCTURE

FOREWORD

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IEC/TR 62713, which is a technical report, has been prepared by IEC technical committee 81: Lightning protection.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
81/427/DTR	81/429/RVC

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 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 web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
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- 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.

INTRODUCTION

IEC/TR 62713, which is a technical report, is informative, with the purpose of giving the lay person, i. e. a non-specialist in lightning protection and a non-medically trained person, appropriate action to reduce risk from lightning to people outside fixed structures, i. e. in a variety of everyday outdoor activities, including immediate action to take in the event of a person being injured by lightning. Part of these precautions includes taking shelter in either a lightning protected structure or an unprotected structure. Any action in the long term to ensure that such structures are suitably protected should be designed by a lightning protection specialist based on the requirements of the appropriate parts of IEC 62305 as listed in the normative references of this report. It is not the purpose of this report to quantify the risk reduction achieved by taking the precautions suggested in it.

SAFETY PROCEDURES FOR REDUCTION OF RISK OUTSIDE A STRUCTURE

1 Scope

This technical report introduces lightning to the layman, noting the right action in the presence of thunderstorms, as well as protective measures against lightning. It also contributes to the prevention of lightning injuries and damages.

It should be noted that so far there are no means to avoid lightning. However, by following some elementary rules, people can be protected against its deleterious effects.

2 Normative references

None.

3 Terms and definitions

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

3.1
aphasia
inability to express thought in words or inability to understand thought as expressed in spoken or written words or others

3.2
apnoea
cessation of breathing, asphyxia

3.3
arrhythmia
irregularity of the heartbeat

3.4
asystolic
relating to the inability of the heart to empty itself

3.5
ataxia
inability to co-ordinate voluntary movements

3.6
barotrauma
damage to the ears caused by rapid change of pressure

3.7
bradycardia
slowness of the heartbeat

3.8
bronchospasm
sustained involuntary muscular contractions of the windpipe

3.9
cardiopulmonary
relating to the heart and lungs

3.10
cardiovascular
relating to the heart and vessels

3.11
cutaneous
belonging to or relating to the skin

3.12
electrization
process of electrification, not necessarily resulting in death (electrocution)

3.13
erythemateous
reddening of the skin

3.14
hypertension
high blood pressure

3.15
hypotension
low blood pressure

3.16
keraunoparalysis
paralysis caused by thunderstorms

3.17
macular puncture
puncturing of the eye's macula, or 'yellow spot', a small area at the centre of the retina at which vision is most distinct

3.18
nystagmus
spasmodic involuntary lateral oscillatory movement of the eyes

3.19
otorrhea
discharge from the ear

3.20
papillary
like, or of the nature of, or having papillae – small nipple like protuberances

3.21
paeresthesia
paresthesia
abnormal sensation in any part of the body

3.22
pathognomic
indicative of a particular disease

3.23
sequela
any abnormal condition following or relating to a previous disease; the psychological after-effect of any trauma

3.24
tachycardia
abnormal rapidity of the heartbeat

3.25
tympanic membrane
membrane separating the middle ear form the outer ear

3.26
ventricular fibrillation
uncontrolled rapid electric activity of a heart ventricle

4 General

4.1 Introductory remark

Generally, the instantaneous power brought by lightning is very high. Indeed, this energy acts on an object for less than a few milliseconds (ms). High voltages can occur and currents as large as 200 kA can flow. Consequently, thin wires melt and objects are heated up so strongly that highly flammable substances ignite or explode.

If the lightning current finds its way into structures containing trapped moisture such as damp walls, joists, roofs or trees these can suddenly explode. Indeed, objects struck by lightning can explode or ignite (see Figure 1).

Lightning currents can penetrate into buildings and structures, along telecommunication lines and power lines, destroying electrical and electronic equipments.

IEC 811/13

Figure 1 – Examples of roofs and facades damaged by lightning

4.2 Lightning damage to human beings

4.2.1 General

In open spaces, people are susceptible to direct strikes (more likely when they are standing up), to side flashes, induced discharges, touch voltages and step voltages.

4.2.2 Direct strikes

The direct lightning strike is the most dangerous of the lightning threats. The lightning current flows through a person and causes unconsciousness, inner or outer burning, apnoea, cardiac arrest or paralysis (see Figure 2).

Figure 2 – Direct strike

4.2.3 Side flash

It is dangerous to stay under an isolated tree (or by a mast) because if the human body is less than several metres from the trunk, it may experience a side flash at the head or shoulder level (see Figure 3).

Figure 3 – Side flash

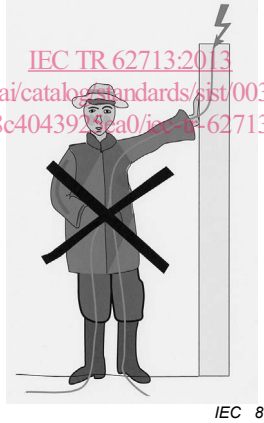
Generally, all unprotected structures should be avoided as a means of shelter, especially small isolated structures such as huts and small barns. Structures with metallic roofs and non-metallic supports may give rise to an electrical discharge (see Figure 4).

IEC 814/13

Figure 4 – Unsuitability of metallic structures when not earthed

4.2.4 Touch or contact voltages

Metallic structures not only present a threat due to arcing resulting from induced voltages but also due to touch or contact voltages. To reduce the risk of electrical shock due to touch voltages it is advisable to stay away from potential lightning current conductors when storms are in the vicinity. Electrization by touch voltages (or contact voltages) occurs when people, with feet in contact with sufficiently conductive ground, touch a conductive structure that may be at a different potential due to a lightning strike (see Figure 5).



IEC 815/13

Figure 5 – Electrization by touch voltage

4.2.5 Step voltages

When lightning strikes the ground, the lightning current is spread out through the various layers of the soil. A high potential rise occurs at the point of strike. Step voltage can be experienced near this point. However, when lightning strikes buildings, structures or trees, the lightning current flows into the ground through the earthing devices of buildings or structures, or the roots of trees, and produces dangerously high potentials on the ground. Human beings may suffer dangerous step voltages close to buildings, structures or trees.

People can experience step voltage when standing with their feet apart or when walking (see Figure 6), when lightning strikes in the vicinity. This situation is more hazardous if the ground resistivity is higher, the distance to the strike point is smaller and/or the distance between the two feet is larger.

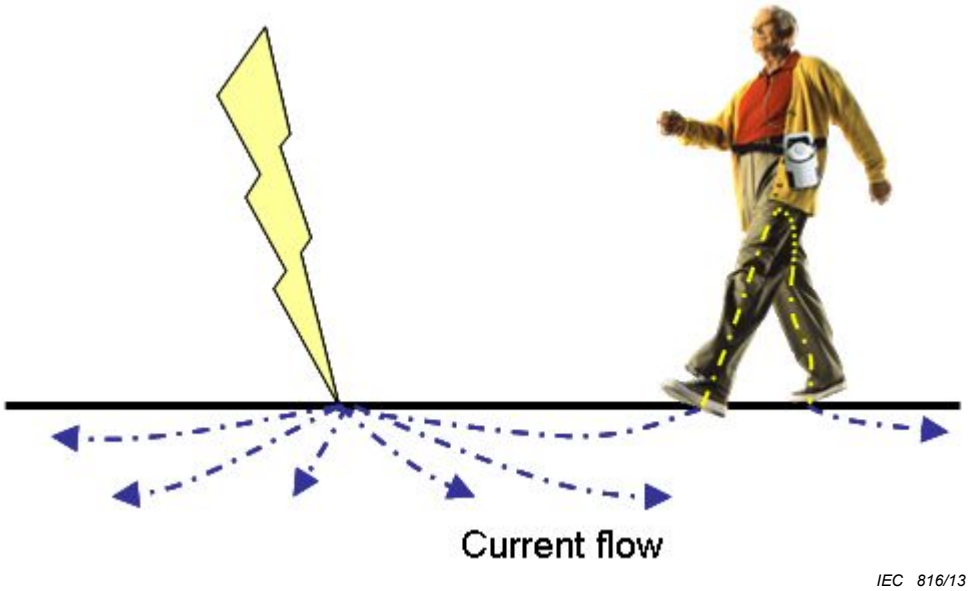


Figure 6 – Current flow through body due to by step voltage

5 Effects of lightning strikes to human beings

5.1 Possible injuries

When a human being is directly struck by lightning, the voltage climbs up to about 300 kV (100 kV to 500 kV) from feet to head. The far larger portion of the lightning current does not flow through the body but on its surface. Due to this effect, many people have survived after a direct lightning strike.

Physiological effects range from being dazzled to almost instantaneous death (full cardiac arrest), through neurological troubles, visual loss or cataract, deafness or ruptured eardrum, paralysis, temporary fainting (sometimes with short respiratory arrest) and short or long-duration comas.

The body-crossing from feet (tree-like burns) to head (electrically, the human body behaves like a gel, with an internal resistance of about 300 Ω) leads to serious or even fatal injuries. Nevertheless, ionized skin and wet clothes represent a preferred path for the electrical discharge, which licks the body under the clothes, avoiding the whole lightning current crossing through the body itself. Clothes tear under the violently generated pressure wave. Even shoes can be blown to large distances. This thermal shock is so short that only superficial burns can occur, but metallic objects (e. g. necklaces) can reach high temperatures (at least superficially) leading to deeper burns.

Generally, burns are superficial (deeply cutaneous close to the incoming and outgoing points, linearly superficial, corresponding to the quickly bypassing electrical discharge, or superficial but spread out by the electrical arc). Those occurring through hot metallic objects are more serious.

Lightning victims can also have erythemateous tree-like discharges or Lichtenberg figures (see Figure 7), which are initiated by a leader circulating between clothes and skin. These pathognomonic figures, which testify to the current flow, do not become white on pressure and disappear after one or two days. The lightning current also burns hair.