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Evaluation des risques de dommages liés à la foudre

Amendment 1

Assessment of the risk of damage due to lightning

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FOREWORD

This amendment has been prepared by IEC technical committee 81: Lightning protection.

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

Committee draft	Report on voting
81/67/CDV	81/81/RVC

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

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Add the title of annex C as follows:

C Structures containing electronic systems

Page 11

1.2 *Normative references*

Add to the existing list the title of the following standard:

IEC 1312-1: 1995, *Protection against lightning electromagnetic impulse – Part 1: General principles*

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Add, after annex B, the new annex C as follows:

Annex C
(normative)

Structures containing electronic systems

Introduction

Considering the development of electronic systems with increasing sensitivity to lightning electromagnetic impulse (LEMP), and the serious consequential effects due to damage which may involve essential services to the public as well as other important environmental risks to society, special attention is given in the present annex to the specific case of structures containing such systems.

For the purposes of this annex, electronic systems such as communications equipment, computer, control and instrumentation systems, radio systems and power electronics installations, and similar equipment incorporating electronic components, are referred to as electronic systems.

The risk assessment depends upon a wide range of factors among which the most important are

- the nature of the structure which contains the electronic system;
- the type and physical lay-out of the electronic system;
- the services including all mains and data and communications lines entering or leaving the structure;
- any protection measures incorporated in the structure, in the installation of the electronic systems, in the mains and data and communication lines, and any SPDs on those lines.

Damage to electronic systems is associated with direct strikes to the building containing the system, to the surrounding ground, to the services incoming to the building and to nearby structures (associated structure) containing systems linked to the main building system.

Although damage to electronic systems might result as a consequence of fire or explosion within the building, lightning overvoltages are the primary source of damage to them.

Lightning overvoltages which affect electronic systems are due to ground potential increase around struck buildings (and the resulting currents in mains and communication cables), and to magnetic field coupling both within the buildings housing the system and with the overhead lines entering the structure.

Normally the effects of damage to an electronic system involve financial costs due to the system damage, and consequential costs arising from loss of the function hitherto performed by the electronic system.

The consequential effects of damage to an electronic system may involve

- severe environmental or other risks to society, where the electronic system performs highly critical control or safety functions in nuclear plant, chemical plant or other;
- injury or loss of human life from fire where the electronic system is for fire detection or for automatic fire extinguishers;
- loss of a service to the public;
- financial losses caused by plant stoppages, communication links failures, security risks and business systems failures.

Therefore, the increasing use of electronic systems on complex and safety critical industry plant and systems might increase the overall risk of damage from lightning, owing to damage resulting from the loss of function of the electronic system.

In this annex the risk evaluation is performed taking into account also the effects of direct magnetic coupling of electronic systems with the current of lightning which strikes the earth nearby the structure.

As a consequence of such effects two further components of damage should be considered respectively due to fire, explosion and to overvoltages.

C.1 General

C.1.1 *Scope and object*

This annex is applicable to the assessment of the risk of damage of structures containing electronic systems.

The object of this annex is to give a procedure to evaluate the risk of damage of a structure containing electronic systems due to direct strikes to the structure, to the surrounding ground, to nearby structures containing electric or electronic equipment linked to the main building, and to the services entering the building.

C.1.2 *Terms and definitions*

For the purpose of this annex, all terms and definitions defined in IEC 1024-1, IEC 1024-1-1 and IEC 1312-1 apply.

C.2 Frequency of lightning flashes: *N*

The expected number of flashes N which may influence a structure containing an electronic system, directly or by the incoming services, may be divided into different groups:

- the number N_d intercepted directly by the structure;
- the number N_r and N_m of flashes intercepted by the ground surface surrounding the structure, taking into account respectively the influence by the resistive and inductive effects of lightning current;
- the number N_k of flashes intercepted either by the incoming services or by the adjacent associated structures.

N_d, N_r, N_m, N_k may be calculated respectively, by the product of the annual flash density N_g and the respectively collection areas A_e, A_r, A_m, A_k which correspond to the different groups of flashes above.

A_e, A_r and A_k shall be evaluated according to 2.2.

NOTE – A self-powered electronic circuit housed within an electrically continuous, metal-clad building and which has data lines that are free of conducting material will not be at risk from lightning. However, a data line containing conductors or a low voltage supply line connected to the same electronic circuit could dramatically increase the risk of lightning damage. Similarly, a fiber optic cable with a metallic bearer wire penetrating the protected structure can also increase the risk to an electronic circuit.

C.2.1 *Collection area A_m for assessment of magnetic effects of nearby flashes*

A_m is the area surrounding the structure where a stroke to ground causes a magnetic field which may have an influence by direct coupling with the electronic system.

It extends up to the border line at the distance of 500 m away from the structure.

The collection area of the surrounding ground A_m for assessment of magnetic effects of nearby flashes may be evaluated by the difference of the area enclosed by such border line and the effective collection area of the structure.

C.3 Probability of damage

The probability of damage of structures containing electronic systems should be evaluated according to this technical report, but p'_2, k_2 and k_3 need a more detailed evaluation: therefore, in the case of structures containing electronic systems, tables 6, 7 and 8 should be replaced by the following tables C.1,C.2 and C.3 respectively.

Table C.1 – Values of probability of damage $p'_1 = p'_2$

Kind of structure	$p'_1 = p'_2$
Brick, masonry or wood, i.e. non-conducting and no LPS	1
Steel frame or reinforced concrete columns spaced 10 m to 20 m or protection level III-IV LPS	0,1 to 0,2
Steel frame or reinforced concrete columns spaced 3 m to 6 m or protection level I-II LPS	0,05 to 0,08
Metallic façade or reinforced concrete without windows or with small windows of less than 20 % of the building wall area	0,005 to 0,01

Table C.2 – Values of $k_1 = k_2$ relevant to protection measures for reduction of probability $p'_1 = p'_2$

Protective measures	k_1 and k_2
All unshielded cables, no special routing precautions, no attempt to avoid loops	1
Shielded cables or avoid loops	10^{-1} to 10^{-2}
Both shielded cables and avoid loops	10^{-2} to 10^{-3}
Fibre optic cable with no metal	0

NOTES

1 The range takes into account the effectiveness of shielding or loop avoiding.

2 If different cables are present, as a simplification, only the highest value of k_1 is to be assumed.

3 If different protective measures are provided on the same internal installation, the resulting reduction factor is the product of the relevant reduction factors.

Table C.3 – Values of k_3 relevant to protection measures for reduction of probability p'_3

Protective measures	k_3
No precautions on entry	1
Isolation transformer	10^{-1}
SPD on service entrance/exit	10^{-1} to 10^{-3} depending on the type of SPD and its installation details
Screen bonded to earth both ends	10^{-1} to 10^{-3} depending on the quality of the screen, and the number and length of the cables
Fibre optic cable with no metal	0

NOTES

1 If different protective measures are provided on the same incoming service, the resulting reduction factor is the product of the relevant reduction factors.

2 It is assumed that external conductive parts are bonded to the structure's earthing system.

C.4 Frequency of damage due to lightning flashes

In evaluating the annual frequency of damage F of structures containing electronic systems, besides the component of damage listed in 2.4, the following components shall be taken into account:

Component of the frequency of damage due to fire, explosion caused by overvoltages by the magnetic effect of strokes to ground nearby the structure: B'

This component is evaluated by the following expression:

$$B' = N_m \, p_t \, p_2 \qquad \text{(C.1)}$$

where N_m is calculated as indicated in C.2 and C.2.1, and p_t, p_2 are calculated with formula (11) and (13) of this technical report respectively.

Component of the frequency of damage due to overvoltages by the magnetic effect of strokes to ground nearby the structure: E'

This component is evaluated by the following expression:

$$E' = N_m \, p_2 \qquad \text{(C.2)}$$

where N_m is calculated as indicated in C.2 and C.2.1, and p_2 is calculated with formula (13).