INTERNATIONAL STANDARD

IEC 60364-4-44

Edition 1.1
2003-12

Edition 1:2001 consolidated with amendment 1:2003

Electrical installations of buildings –

Part 4-44: Protection for safety – Protection against voltage disturbances and electromagnetic disturbances

*This **English-language** version is derived from the original **bilingual** publication by leaving out all French-language pages. Missing page numbers correspond to the French-language pages.*

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTRICAL INSTALLATIONS OF BUILDINGS –

Part 4-44: Protection for safety – Protection against voltage disturbances and electromagnetic disturbances

FOREWORD

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International Standard IEC 60364-4-44 has been prepared by IEC technical committee 64: Electrical installations and protection against electric shock.

This consolidated version of IEC 60364-4-44 is based on the first edition (2001) and its amendment 1 (2003) [documents 64/1303/FDIS and 64/1329/RVD].

It bears the edition number 1.1.

A vertical line in the margin shows where the base publication has been modified by amendment 1.

The IEC 60364 series (parts 1 to 6), is currently being restructured, without any technical changes, into a more simple form (see annex C).

According to a unanimous decision by the Committee of Action (CA/1720/RV (2000-03-21)), the restructured parts of IEC 60364 have not been submitted to National Committees for approval.

Annexes A, B and C are for information only.

Annex D forms an integral part of this standard.

The committee has decided that the contents of the base publication and its amendment 1 will remain unchanged until 2005. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

440 Introduction

Part 4-44 of IEC 60364 provides rules for the protection against the effects of conducted and radiated disturbances on electrical installations.

The rules of this standard do not apply to systems which are wholly or partly under control of public power supply companies (see scope of IEC 60364-1).

The fault-current flowing in the earth electrode of the exposed-conductive-parts of the sub-station causes a significant rise of the potential of the exposed-conductive-parts of the sub-station to the general mass of the earth, i.e. a fault-voltage, whose magnitude is governed by

- the fault-current magnitude, and
- the resistance of the earth electrode of the exposed-conductive-parts of the sub-station.

The fault-current may cause

- a general rise of the potential of the low-voltage system with respect to earth, i.e. stress-voltages which may cause a breakdown of the insulation in low-voltage equipment,
- a general rise of the potential of the exposed-conductive-parts of the low-voltage system with respect to earth, which may give rise to fault-voltage and touch voltages.

  NOTE In this standard, the expression "high-voltage" (HV) refers to voltages exceeding the upper limit of voltage band II. The expression "low-voltage" (LV) refers to voltages not exceeding the upper limit of voltage band II.

Clause 443 is intended to describe the means by which transient voltages can be limited to reduce the risk to an acceptable level of failure in the installation and in electrical equipment connected to it. This approach is in line with the principles of insulation co-ordination contained in IEC 60664-1. IEC 60664-1 requires technical committees to specify an appropriate impulse withstand category (overvoltage category) for their equipment; that means a minimum impulse withstand voltage for the equipment, according to its application and the related impulse withstand categories.

NOTE In accordance with 2.2.2.1.1 of IEC 60664-1, technical committees should specify the relevant information. It is recommended to indicate the rated impulse withstand voltage applicable to the equipment and the way this is provided.

(Introduction IEC 60364-4-444, in part).

In clause 444, basic recommendations are described to mitigate electromagnetic disturbances. Actually electromagnetic interferences (EMI) can disturb or damage information technology systems or equipment, equipment with electronic components or circuits. Currents due to lightning, switching operations, short-circuits and other electromagnetic phenomena can cause overvoltages and electromagnetic interference.

These effects appear

- where large metal loops exist[1]; and
- where different electrical wiring systems are installed on different routes, e.g. for power supply and for signalling information technology equipment within a building.

[1] Equipotential bonding systems, structural metalwork or pipe systems for non-electrical supplies, e.g. for water, gas, heating or air conditioning, can create such induction loops.

The value of the induced voltage depends on the rate of rise (d*i*/d*t*) of the interference current, and on the size of the loop.

Power cables carrying large currents with a high rate of rise of current (d*i*/d*t*) (e.g. the starting current of lifts or currents controlled by rectifiers) can induce overvoltages in cables of information technology systems, which can influence or damage information technology or similar electrical equipment.

In or near rooms for medical use, electric or magnetic fields of electrical installations can interfere with medical electrical equipment.

Clause 445 deals with the precautions to be taken in the case of undervoltages.

ELECTRICAL INSTALLATIONS OF BUILDINGS –

Part 4-44: Protection for safety – Protection against voltage disturbances and electromagnetic disturbances

440.1 (442.1.1) Scope

The rules of this part of IEC 60364 are intended to provide for the safety of persons and equipment in a LV system in the event of a fault between the HV system and earth in the HV part of transformer stations which supply low-voltage systems.

440.2 (442.1.4) Normative references

The following referenced documents are indispensable for the application 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 60038:1983, *IEC standard voltages*

IEC 60050(604):1987, *International Electrotechnical Vocabulary – Chapter 604: Generation, transmission and distribution of electricity – Operation*

IEC 60050(826):1982, *International Electrotechnical Vocabulary – Chapter 826: Electrical installations of buildings*

IEC 60364-1:2001, *Electrical installations of buildings – Part 1: Scope, object and fundamental principles*

IEC 60364-4-41:2001, *Electrical installations of buildings – Part 4-41: Protection for safety – Protection against electric shock*

IEC 60364-4-42:2001, *Electrical installations of buildings – Part 4-42: Protection for safety – Protection against thermal effects*

IEC 60364-5-53:2001, *Electrical installations of buildings – Part 5-53: Selection and erection of electrical equipment – Isolation, switching and control*

IEC 60364-5-54, *Electrical installations of buildings – Part 5-54: Selection and erection of electrical equipment – Earthing arrangements and protective conductors and equipotential bonding* [1)]

IEC 60364-5-548:1996, *Electrical installations of buildings – Part 5: Selection and erection of electrical equipment – Section 548: Earthing arrangements and equipotential bonding for information technology installations*

IEC 60479-1:1994, *Effects of current on human beings and livestock – Part 1: General aspects*

[1)] To be published.

IEC 60664-1:1992, *Insulation co-ordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

IEC 60742:1983, *Isolating transformers and safety isolating transformers – Requirements*

IEC 61000-2-5:1995, *Electromagnetic compatibility (EMC) – Part 2: Environment – Section 5: Classification of electromagnetic environments. Basic EMC publication*

IEC 61024-1:1990, *Protection of structures against lightning – Part 1: General principles*

IEC 61312-1:1995, *Protection against lightning electromagnetic impulse – Part 1: General principles*

IEC 61643 (all parts), *Surge protective devices connected to low-voltage power distribution systems*

IEC 61662:1995, *Assessment of the risk of damage due to lightning*
Amendment 1 (1996)

441 (Number available)

NOTE This has been introduced to enable the later text to retain the original number.

442 Protection of low-voltage installations against temporary overvoltages and faults between high-voltage systems and earth

442.1 General requirements

NOTE The following clauses consider only four situations which generally cause the most severe temporary overvoltages such as defined in IEV 60050(604), definition 604-03-12:

- fault between the high-voltage system(s) and earth. The corresponding subclauses should be read in conjunction with annex A;
- loss of the neutral in a low-voltage TN and TT system (see 442.6);
- accidental earthing of a low-voltage IT system (see 442.7);
- short-circuit in the low-voltage installation (see 442.8).

442.1.2 Fault-voltage

The magnitude and the duration of the fault-voltage or the touch voltage due to an earth-fault in the high-voltage system shall not exceed the values given by curve F and T respectively of figure 44A.

442.1.3 Stress-voltage

The magnitude and the duration of the power-frequency stress voltage of the LV equipment in the consumer's installation due to an earth fault in the high voltage system shall not exceed the values of table 44A.

NOTE 1 The power-frequency stress voltage is the voltage which appears across the insulation.

NOTE 2 A higher stress voltage is permitted for the low-voltage equipment of the sub-station if the insulation level of the equipment is compatible and under the conditions of 442.3.

Table 44A – Permissible stress voltage

Permissible a.c. stress voltage on equipment in low-voltage installations V	Disconnecting time s
U_0 + 250 V	>5
U_0 + 1 200 V	≤5

NOTE 1 In particular cases (e.g. line conductor earthed), where the (highest) nominal voltage of the low-voltage system to earth is not U_0, this voltage shall be specified.

NOTE 2 The first line of the table relates to systems having long disconnection times, for example inductively earthed high-voltage system. The second line relates to systems having short disconnection times, for example solidly earthed high-voltage systems. Both lines together are relevant design criteria for insulation of low-voltage equipment with regard to temporary overvoltage (see 1.3.7.1 of IEC 60664-1).

NOTE 3 Such temporary a.c. overvoltage is also to be expected in basic, double and reinforced insulation of low-voltage equipment used outside the main equipotential bonding and connected to a TN system (whose neutral conductor is earthed in the transformer substation through the protective earth electrode of the high-voltage system). It is not necessary to expect such overvoltage within the area of main equipotential bonding which is connected to the protective conductor of a TN system at the origin of the installation of the building.

442.2 Earthing systems in transformer sub-stations

At the transformer sub-station, there shall be one earthing system to which shall be connected

- earth electrodes,
- the transformer tank,
- metallic coverings of high-voltage cables,
- metallic coverings of low-voltages cables except where the neutral conductor is earthed via a separate earth electrode,
- earth wires of high-voltage systems,
- the exposed-conductive-parts of high-voltage and low-voltage equipment,
- extraneous-conductive-parts.

442.3 Earthing arrangements in transformer sub-stations

The conditions enumerated under 442.4 and 442.5 are deemed to be complied with if one or both of the conditions stated in 442.3.1 or the condition in 442.3.2 is met. Where none of the conditions of 442.3.1 or 442.3.2 is met, the requirements of 442.4 and 442.5 shall be applied.

442.3.1 The transformer sub-stations shall be connected to cables with suitable earthed metallic coverings, whether high-voltage cables, low-voltage cables or a combination of both high- and low-voltage cables.

The total length of these cables shall exceed 1 km.

442.3.2 The earthing resistance of the exposed-conductive-parts of the transformer sub-station does not exceed 1 Ω.

442.4 Earthing arrangements with regard to type of earthing systems in LV installations

442.4.1 Symbols

In the following subclauses, the symbols are

I_m that part of the earth fault current in the high-voltage system that flows through the earth electrode of the exposed-conductive-parts of the transformer sub-station.

R is the resistance of the earth electrode of the exposed-conductive-parts of the transformer sub-station.

U_0 is the line-to-neutral voltage of the low-voltage system.

U is the line-to-line voltage of the low-voltage system.

U_f is the fault-voltage in the LV system between exposed-conductive-parts and earth.

U_1 is the stress-voltage in the LV equipment of the transformer sub-station.

U_2 is the stress-voltage in the LV equipment of the consumer's system.

442.4.2 TN systems

a) When the fault-voltage $R \times I_m$ is disconnected within a time given in figure 44A, the neutral conductor of the LV system may be connected to the earthing electrode of the exposed-conductive-parts of the transformer sub-station (see TN-a in figure 44B).

NOTE If the exposed-conductive-parts of the low-voltage equipment of the consumer's installation within the building are connected to the main equipotential bonding by a protective conductor, the touch voltage will be effectively zero.

b) If the condition under a) is not fulfilled, the neutral conductor of the LV system shall be earthed via an electrically independent earth electrode (see TN-b in figure 44B). In this case, the conditions of 442.5.1 apply.

442.4.3 systems

a) When the relation between the stress-voltage ($R \times I_m + U_0$) and the disconnecting time given in table 44A is complied with for the LV equipment of the consumer's installation, the neutral conductor of the LV system may be connected to the earthing electrode of the exposed-conductive-parts of the transformer sub-station (see TT-a in figure 44C).

b) If the condition under a) is not fulfilled, the neutral conductor of the LV system shall be earthed via an electrically independent earth electrode (see TT-b in figure 44C). In this case, the conditions of 442.5.1 apply.

If the exposed-conductive-parts of the low-voltage equipment of the consumer's installation within the building are connected to the main equipotential bonding by a protective conductor, the touch voltage will be effectively zero.

442.4.4 IT-systems

a) When the fault-voltage $R \times I_m$ is disconnected within a time given in figure 44A, the exposed-conductive-parts of the LV equipment of the consumer's installation may be connected to the earthing electrode of the exposed-conductive-parts of the sub-station (see figures 44D, 44J and 44K).

If this condition is not fulfilled, the exposed-conductive-parts of the LV equipment of the LV installation shall be connected to an earthing system electrically independent from the earthing electrode of the exposed-conductive-parts of the sub-station (see figures 44E to 44H).

b) When the exposed-conductive-parts of the LV equipment in the consumer's installation are earthed via an earth electrode electrically independent of the earth electrode of the transformer sub-station, and when the relation between the stress-voltage ($R \times I_m + U$) and the disconnecting time given in table 44A is complied with for the LV equipment of the consumer's installation, the neutral impedance of the LV system, if any, may be connected to the earth electrode of the exposed-conductive-parts of the transformer sub-station (see figure 44E).

If this condition is not fulfilled, the neutral impedance shall be earthed via an electrically independent earth electrode (see figures 44F and 44H). In this case, the conditions of 442.5.2 apply.

442.5 Limitation of stress-voltage in LV equipment of transformer sub-stations

442.5.1 TN and TT systems

When in TN and TT systems the neutral conductor is earthed via an earth electrode electrically independent of the earth electrode of the exposed-conductive-parts of the transformer substation (see figures TN – b in figure 44B and TT – b in figure 44C), the stress-voltage ($R \times I_m + U_0$) shall be disconnected in time compatible with the insulation level of the LV equipment of the transformer sub-station.

NOTE The insulation level of the LV equipment of the transformer sub-station may be higher than the value given in table 44A.

442.5.2 IT systems

When in IT systems both the exposed-conductive-parts of the consumer's installation and the neutral impedance, if any, are earthed via earth electrodes electrically independent of the earth electrode of the transformer sub-station (see figures 44F, 44G and 44H), the stress-voltage ($R \times I_m + U$) shall be disconnected in a time compatible with the insulation level of the LV equipment of the transformer sub-station.

442.6 Stress voltage in case of loss of the neutral conductor in a TN and TT system

Consideration shall be given to the fact that, if the neutral conductor in a three-phase TN or TT system is interrupted, basic, double and reinforced insulation as well as components rated for the voltage between line and neutral conductors can be temporarily stressed with the line-to-line voltage. The stress voltage can reach up to $U = \sqrt{3}\ U_0$.

442.7 Stress voltage in case of accidental earthing of an IT system

Consideration shall be given to the fact that, if a line conductor of an IT system is earthed accidentally, basic, double and reinforced insulation rated for the voltage between line and neutral conductors as well as components can be temporarily stressed with the line-to-line voltage. The stress voltage can reach up to $U = \sqrt{3}\ U_0$.

442.8 Stress voltage in case of a short-circuit between a line conductor and the neutral conductor

Consideration shall be given to the case of a short-circuit between a phase conductor and the neutral conductor where the stress can reach the value of 1,45 U_0 for a time up to 5 s.