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Section 442 – Protection des installations
à basse tension contre les défauts à la terre
dans les installations à haute tension

Electrical installations of buildings

Part 4:

Protection for safety

Chapter 44: Protection against overvoltages

Section 442 – Protection of low-voltage
installations against faults between high-voltage
systems and earth

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Bureau Central de la Commission Electrotechnique Internationale 3, rue de Varembe Genève, Suisse



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTRICAL INSTALLATIONS OF BUILDINGS

Part 4: Protection for safety
Chapter 44: Protection against overvoltages
Section 442 – Protection of low-voltage installations
against faults between high-voltage systems and earth

FOREWORD

- 1) The formal decisions or agreements of the IEC on technical matters, prepared by Technical Committees on which all the National Committees having a special interest therein are represented, express, as nearly as possible, an international consensus of opinion on the subjects dealt with.
- 2) They have the form of recommendations for international use and they are accepted by the National Committees in that sense.
- 3) In order to promote international unification, the IEC expresses the wish that all National Committees should adopt the text of the IEC recommendation for their national rules in so far as national conditions will permit. Any divergence between the IEC recommendation and the corresponding national rules should, as far as possible, be clearly indicated in the latter.

This International Standard has been prepared by Technical Committee No. 64: Electrical installations of buildings.

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

Six Months' Rule	Report on Voting
64(CO)175	64(CO)213

Full information on the voting for the approval of this standard can be found in the Voting Report indicated in the above table.

Annex A is for information only.

INTRODUCTION

The rules of this section do not apply to systems which are wholly or partly under control of public power supply companies (see scope of IEC 364-1).

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 section, 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.

ELECTRICAL INSTALLATIONS OF BUILDINGS

Part 4: Protection for safety

Chapter 44: Protection against overvoltages

Section 442 – Protection of low-voltage installations against faults between high-voltage systems and earth

442.1 General

442.1.1 *Scope and object*

The rules of this section 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.

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 44 A.

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 44 A.

NOTES

- 1 The power-frequency stress-voltage is the voltage which appears across the insulation.
- 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 clause 442.3.

Table 44 A

Permissible stress-voltages in LV installations V	Time s
$1,5 U_n$	> 5
$1,5 U_n + 750$	≤ 5

U_n nominal voltage line-to-earth of the low-voltage system.

442.1.4 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this section. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this section are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid international standards.

IEC 364-1: 1992, *Electrical installations of buildings – Part 1: Scope, object and fundamental principles*

IEC 364-4-41: 1992, *Electrical installations of buildings – Part 4: Protection for safety – Chapter 41: Protection against electric shock.*

IEC 479-1: 1984, *Effects of current passing through the human body – Part 1: General aspects – Chapter 1: Electrical impedance of the human body – Chapter 2: Effects of alternating current in the range of 15 Hz to 100 Hz – Chapter 3: Effects of direct current.*

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-voltage 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 subclause 442.4 and 442.5 are deemed to be complied with if one or both of the conditions stated in subclause 442.3.1 or the condition in subclause 442.3.2 are met. Where none of the conditions of subclauses 442.3.1 or 442.3.2 is met the requirements of subclauses 442.4 and 442.5 shall be applied.

442.3.1 The transformer sub-stations are connected to:

- high-voltage cables with suitable earthed metallic coverings or
- low-voltage cables with suitable earthed metallic coverings or
- a combination of both high- and low-voltage cables with suitable earthed metallic coverings

and in all cases:

- the length of these cables exceeds 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 44 A, 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 44 B).

NOTE - If the exposed-conductive-part of the low voltage equipment of the consumer system is within the zone of influence of the main equipotential bonding, the touch voltage is zero (see section 413 of IEC 364-4-41).

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 44 B). In this case, the conditions of 442.5.1 apply.

442.4.3 TT-systems

a) When the relation between the stress-voltage ($R \times I_m + U_0$) and the disconnecting time given in table 44 A 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 44 C).

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 44 C). In this case, the conditions of 442.5.1 apply.

If the exposed-conductive-parts of the low-voltage equipment of the consumer system are within the zone of influence of the main equipment bonding the touch voltage is zero.

442.4.4 IT-systems

a) When the fault-voltage $R \times I_m$ is disconnected within a time given in figure 44 A, 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 44 D, 44 J and 44 K).

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 44 E to 44 H).

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 44 A 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 44 E).

If this condition is not fulfilled, the neutral impedance shall be earthed via an electrically independent earth electrode (see figures 44 F and 44 H). 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 sub-station (see figures TN - b in figure 44 B and TT - b in figure 44 C), 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 44 A.

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 44 F, 44 G and 44 H), 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.