SLOVENSKI STANDARD

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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

Elektrische Anlagen von Gebäuden -- Teil 4: Schutzmaßnahmen -- Kapitel 44: Schutz bei Überspannungen - Hauptabschnitt 442: Schutz von Niederspannungsanlagen bei Erdschlüssen in Netzen mit höherer Spannung

Installations électriques des bâtiments -- Partie 4: Protection pour assurer la sécurité -- Chapitre 44: Protection contre les surtensions - Section 442: Protection des installations à basse tension contre les défauts à la terre dans les installations à haute tension

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Descriptors: Low-voltage installation, high-voltage fault, protection, equipment stress

English version

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

Installations électriques des bâtiments
Partie 4: Protection pour assurer la sécurité
Chapitre 44: Protection contre les surtensions
Section 442: Protection des installations à basse tension contre les défauts à la terre dans les installations à haute tension

Elektrische Anlagen von Gebäuden
Teil 4: Schutzmaßnahmen
Kapitel 44: Schutz bei Überspannungen
Hauptabschnitt 442: Schutz von Niederspannungsanlagen bei Erdschlüssen in Netzen mit höherer Spannung

This Harmonization Document was approved by CENELEC on 1996-12-09. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for implementation of this Harmonization Document on a national level.

Up-to-date lists and bibliographical references concerning such national implementation may be obtained on application to the Central Secretariat or to any CENELEC member.

This Harmonization Document exists in three official versions (English, French, German).

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

This Harmonization Document was prepared by SC 64B, Protection against thermal effects, of Technical Committee CENELEC TC 64, Electrical installations of buildings.

The text of the draft was submitted to the Unique Acceptance Procedure and was approved by CENELEC as HD 384.4.442 S1 on 1996-12-09.

The following dates were fixed:

– latest date by which the existence of the HD has to be announced at national level	(doa)	1997-06-01
– latest date by which the HD has to be implemented at national level by publication of a harmonized national standard or by endorsement	(dop)	1997-12-01
– latest date by which the national standards conflicting with the HD have to be withdrawn	(dow)	1997-12-01

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INTRODUCTION

The fault-current flowing in the earthing arrangement of the transformer sub-station causes a significant rise of the potential with respect to earth whose magnitude is governed by:

- the fault-current magnitude, and
- the impedance of the earthing arrangement of the transformer sub-station.

The fault-current may cause:

- a general rise of the potential of the low-voltage system with respect to earth, i.e. power-frequency 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.

NOTE - In this section, the expression "high-voltage" refers to voltages exceeding the upper limit of voltage band II (See IEC 449). The expression "low-voltage" refers to voltages not exceeding the upper limit of voltage band II (See IEC 449).

442.1 General

442.1.1 Scope and object

The rules of this section provide requirements for the safety of persons and equipment in the low-voltage installation in the event of a fault between the high-voltage system and earth in the transformer sub-station which supplies the low-voltage installation.

The requirements for the connection of the exposed-conductive-parts of the transformer sub-station to the earthing arrangement of the transformer sub-station are given in prEN50179. (CENELEC TC 99X).

The rules of this section do not apply to low-voltage systems which are part of the public electricity supply network.

442.1.2 Power-Frequency Stress-Voltage

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

TABLE 44A

Permissible power-frequency stress-voltage on equipment in low-voltage installations (V rms)	Disconnecting time (s)
$U_o + 250$	> 5
$U_o + 1200$	≤ 5

In IT systems U_o shall be replaced by the line-to-line voltage.

Note: 1 The power-frequency stress-voltage is the voltage which appears across the insulation of low-voltage equipment and across surge protective devices connected to the low-voltage system.

Note: 2 The requirements in respect of the power-frequency stress-voltage for the low-voltage equipment of the transformer sub-station are given in clause 442.4

Note 3: The first line of the table relates to high-voltage systems having long disconnection times, for example, isolated neutral and resonant earthed high-voltage systems. The second line relates to high-voltage system having short disconnection times, for example low-impedance earthed high-voltage systems. Both lines together are relevant design criteria for insulation of low-voltage equipment with regard to temporary power-frequency over voltage (see 3.7.1 of IEC 664.1).

Note 4: In a system whose neutral is connected to the earthing arrangement of the transformer sub-station, such temporary power-frequency over voltage is also to be expected across insulation which is not in an earthed enclosure when the equipment is outside a building.

(Note Table 44A is based on the amendment proposed in IEC64(Sec)676 (also numbered IEC28A(Sec)81)).

442.1.3 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.

HD 384-1: Electrical installations of buildings - Part 1: Scope, object and fundamental principles

HD 384-4-41: Electrical installations of buildings - Part 4: Protection for safety - Chapter 41: Protection against electric shock.

IEC 479-1: 1994, 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.

prEN50179: Electrical power installations exceeding 1kV.

442.1.4 Symbols

In section 442 the following symbols are used:

I_E that part of the earth fault current in the high-voltage system that flows through the earthing arrangement of the transformer sub-station.

R_E is the resistance of the earthing arrangement of the transformer sub-station.

R_A is the resistance of the earthing arrangement of the exposed-conductive-parts of the equipment of the low-voltage installation.

R_B is the resistance of the earthing arrangement of the low-voltage system neutral, for low-voltage systems in which the earthing arrangement of the transformer sub-station and of the low-voltage system neutral are electrically independent.

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

U_f is the voltage which appears in the low-voltage system between exposed-conductive-parts and earth for the duration of the fault.

U_1 is the power-frequency stress-voltage in the low-voltage equipment of the transformer sub-station.

U_2 is the power-frequency stress-voltage in the low-voltage equipment of the low-voltage installation.

Note: The value of R_E and R_B may be influenced by the impedance to earth of the main equipotential bonding and of other earth electrodes.

The following additional symbols are used in respect of IT-systems in which the exposed-conductive-parts of the equipment of the low-voltage installation are connected to an earthing arrangement which is electrically independent of the earthing arrangement of the transformer sub-station.

I_h the fault current that flows through the earthing arrangement of the exposed-conductive-parts of the equipment of the low-voltage installation during a period when there is a high voltage fault and first fault in the low-voltage installation. (see figure 44E)

I_d the fault current that flows through the earthing arrangement of the exposed-conductive parts of the low-voltage installation during the first fault in a low-voltage system. (see figure 44F and G)

Z is the impedance of the earthing arrangement of the low-voltage system neutral, for low voltage systems in which the earthing arrangements of the transformer sub-station and the low-voltage system neutral are electrically independent.

Note: An earthing arrangement may be considered electrically independent of another earthing arrangement if a rise of potential with respect to earth in one earthing arrangement does not cause an unacceptable rise of potential with respect to earth in the other earthing arrangement. See prEN50179 Clause 9 for requirements for electrically independent earthing arrangements.

442.2 Earthing arrangements in transformer sub-stations

There shall be an earthing arrangement at the transformer sub-station which complies with prEN50179, Clause 9.

Note: prEN50179 Clause 9 contains the requirements for the dimensions, construction and measurement of the earthing arrangement and for the connection, when necessary of the exposed- and extraneous- conductive parts in the transformer substation.

442.3 Earthing arrangements with regard to type of earthing systems in low-voltage system

442.3.1 TN-systems

(a) The neutral conductor of the low-voltage system may be connected to the earthing arrangement of the transformer sub-station when the voltage U_f, ($R_E x I_E$), is disconnected within a time given by figure 44A (see Figure 44B TN-a).

Note 1: This condition is based on the simple worst-case where the low-voltage system neutral conductor (PEN conductor in TN-C systems) is earthed only at the transformer sub-station earthing arrangement. Where the neutral or PEN is earthed at several points or the earthing is part of a global earthing system the relevant requirements of prEN50179 may be applied.

Note 2: In general, for the system TN-a (see figure 44B), inside the building where the main equipotential bonding is applied, no touch voltage appears.

(b) If the neutral conductor low-voltage system is not connected to the earthing arrangement of the transformer sub-station in accordance with condition (a), the neutral conductor of the low-voltage system shall be earthed via an electrically independent earthing arrangement (see TN-b in figure 44B). In this case, the conditions of 442.4.1 apply.

Note: Where the transformer sub-station is within a building it may not be possible to make the earthing arrangement of the transformer sub-station electrically independent of the earthing arrangement of the low-voltage system neutral conductor.

442.3.2 TT-systems

(a) The neutral conductor of the low-voltage system may be connected to the earthing arrangement of the transformer sub-station when the relation between the stress-voltage U_2, ($R_E x I_E + U_o$), and the disconnecting time given in table 44A is complied with for the low-voltage equipment of the installation (see figure 44C TT-a).

Note: If the transformer-substation is part of a global earthing system the relevant requirements of prEN50179 may be applied.

(b) If the condition under (a) is not fulfilled, the neutral conductor of the low-voltage system shall be earthed via an electrically independent earthing arrangement (see TT-b in figure 44C). In this case, the conditions of 442.4.1 apply.

442.3.3 IT-systems

(a) The exposed-conductive-parts of the equipment of the low-voltage installation may only be connected to the earthing arrangement of the transformer sub-station when the voltage U_f, ($R_E x I_E$), is disconnected within a time given in figure 44A (see figures 44D and 44H).

If this condition is not fulfilled:

- the exposed-conductive-parts of the equipment of the low-voltage installation shall be connected to an earthing arrangement electrically independent of the earthing system of the transformer sub-station (see figures 44E to 44G), and
- for the system IT b (see figure 44E) the earthing resistance of the earthing arrangement of the exposed-conductive-parts of the equipment of the low-voltage installation shall be sufficiently low that the voltage U_f, (R_A x I_h in this case) is disconnected within a time compatible with figure 44A.

(b) The neutral impedance of the low-voltage system, if any, may be connected to the earthing arrangement of the transformer sub-station when the exposed-conductive-parts of the equipment in the low-voltage installation are earthed via an earthing arrangement electrically independent of the earthing arrangement of the transformer sub-station (see figure 44E), if the relation between the stress-voltage ($R_E x I_E + \sqrt{3}U_o$) and the disconnecting time given in table 44A is complied with for the equipment of the low-voltage installation.

If this condition is not fulfilled, the neutral impedance shall be earthed via an electrically independent earthing arrangement (see figures 44F and 44G). In this case, the conditions of 442.4.2 apply.

442.4 Power-frequency stress-voltages in low-voltage equipment of transformer sub-stations

442.4.1 TN- and TT-systems

When in TN- and TT-systems the neutral conductor is earthed via an earthing arrangement electrically independent of the earthing arrangement of the transformer sub-station (see figures TN -b in figure 44B and TT - b in figure 44C), the insulation level of the low-voltage equipment of the transformer sub-station shall be compatible with the power-frequency stress-voltage ($R_E x I_E + U_o$).

442.4.2 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 an earthing arrangement electrically independent of the earthing arrangement of the transformer sub-station (see figures 44F and 44G), the insulation level of the low-voltage equipment of the transformer sub-station shall be compatible with the power-frequency stress-voltage ($R_E x I_E + \sqrt{3}U_o$).

Note: The Public Electricity Supply Company may provide general guidance in respect of the stress-voltage to be expected.

442.5 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 $U = \sqrt{3}U_o$.

442.6 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 $U = \sqrt{3}U_o$.

442.7 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 voltage can reach the value of $1.45U_o$ for a time up to 5 s.