

# SLOVENSKI STANDARD oSIST prEN 50522:2008

01-december-2008

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Earthing of power installations exceeding 1 kV a.c.

Erdung von Starkstromanlagen mit Nennwechselspannungen über 1 kV

Prises de terre des installations électriques en courant alternatif de puissance supérieure à 1 kV

Ta slovenski standard je istoveten z: prEN 50522:2008

<u>ICS:</u>

29.240.01 U{ \^0bæÁæá, \^}[•Á3, Power transmission and åædæič&ãų Á\/\dã}^Á\}\\*æ distribution networks in }æÁ][[z][ general

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en,fr,de



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# EUROPEAN STANDARD NORME EUROPÉENNE EUROPÄISCHE NORM

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English version

## Earthing of power installations exceeding 1 kV a.c.

Prises de terre des installations électriques en courant alternatif de puissance supérieure à 1 kV Erdung von Starkstromanlagen mit Nennwechselspannungen über 1 kV

This draft European Standard is submitted to CENELEC members for CENELEC enquiry. Deadline for CENELEC: 2009-03-13.

It has been drawn up by CLC/TC 99X.

If this draft becomes a European Standard, CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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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 1 2 3 This draft European Standard was prepared by the Technical Committee CENELEC TC 99X, 4 Power installations exceeding 1 kV a.c. (1,5 kV d.c.). It is submitted to the CENELEC enquiry. 5 CLC/TC 99X note: This draft European Standard is circulated simultaneously with the parallel vote on future IEC 61936-1 (99/81/CDV). The text identical with IEC 61936-1 / MT 4 is written in italics. 6 7 8 9

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#### 110 **1 Scope**

- 111 This European Standard contains the requirements for the design and erection of earthing
- systems of electrical installations, in systems with nominal voltage above 1 kV a.c., so as to
- 113 provide safety and proper functioning for the use intended.
- For the purpose of interpreting this standard, an electrical power installation is considered to be one of the following.
- 116 a) Substation.
- 117 b) Electrical installations on mast, pole and tower.
- 118 Switchgear and/or transformers located outside a closed electrical operating area.
- 119 c) One (or more) power station(s) located on a single site.
- 120 The installation includes generators and transformers with all associated switchgear and all 121 electrical auxiliary systems. Connections between generating stations located on different 122 sites are excluded.
- 123 d) The electrical system of a factory, industrial plant or other industrial, agricultural, 124 commercial or public premises.
- 125 The electrical power installation includes, among others, the following equipment:
- 126 rotating electrical machines; /
- 127 switchgear;
- 128 transformers and reactors; **1200**
- 129 converters;
- 130 cables;
- 131 wiring systems; and ards.iteh.ai/catalog/standards/sist/93892b89-6105-4c0c-89bf-
- 132 batteries;
- 133 capacitors;
- 134 earthing systems;
- 135 buildings and fences which are part of a closed electrical operating area;
- 136 associated protection, control and auxiliary systems;
- 137 large air core reactor.
- 138 NOTE In general, a standard for an item of equipment takes precedence over this standard.
- This European Standard does not apply to the design and erection of earthing systems of anyof the following:
- 141 overhead and underground lines between separate installations;
- 142 electric railways (but not the substation feeding a railway system);
- 143 mining equipment and installations;
- 144 fluorescent lamp installations;
- 145 installations on ships and off-shore installations;
- 146 electrostatic equipment (e.g. electrostatic precipitators, spray-painting units);
- 147 test sites;
- 148 medical equipment, e.g. medical X-ray equipment.
- 149 This European Standard does not apply to the requirements for carrying out live working on 150 electrical installations.

#### 151 2 Normative references

152 The following referenced documents are indispensable for the application of this document. For 153 dated references, only the edition cited applies. For undated references, the latest edition of

- the referenced document (including any amendments) applies.
- 155 EN 60529, Degrees of protection provided by enclosures (IP Code) (IEC 60529)
- 156 EN 60909, Short-circuit currents in three-phase a.c. systems (IEC 60909)
- HD 60364-1, Low-voltage electrical installations Part 1: Fundamental principles, assessment
   of general characteristics, definitions (IEC 60364-1, modified)
- HD 60364-4-41, Low-voltage electrical installations Part 4-41: Protection for safety –
   Protection against electric shock (IEC 60364-4-41, modified)
- 161 IEC 60050(151):2001, International Electrotechnical Vocabulary (IEV) Part 151: Electrical 162 and magnetic devices
- 163 IEC 60050(195):1998, International Electrotechnical Vocabulary (IEV) Part 195: Earthing and 164 protection against electric shock
- 165 IEC 60050(601):1985, International Electrotechnical Vocabulary (IEV) Part 601: Generation, 166 transmission and distribution of electricity – General
- 167 IEC 60050(602):1983, International Electrotechnical Vocabulary (IEV) –Part 602: Generation,
   168 transmission and distribution of electricity Generation
- 169 IEC 60050(604):1987, International Electrotechnical Vocabulary (IEV) Part 604: Generation,
   170 transmission and distribution of electricity Operation
- 171 IEC 60050(605):1983, International Electrotechnical Vocabulary (IEV) Part 605: Generation,
   172 transmission and distribution of electricity Substations
- 173 IEC 60050(826):2004, International Electrotechnical Vocabulary (IEV) Part 826: Electrical 174 installations
- 175 IEC 60287-3-1, Electric cables Calculation of the current rating Part 3-1: Sections on 176 operating conditions – Reference operating conditions and selection of cable type
- 177 IEC/TS 60479-1:2005, Effects of current on human beings and livestock Part 1: General 178 aspects
- 179 IEC 60949:1988, Calculation of thermally permissible short-circuit currents, taking into account180 non-adiabatic heating effects
- 181 IEC 61000-5-2, *Electromagnetic compatibility (EMC) Part 5: Installation and mitigation* 182 guidelines – Section 2: Earthing and cabling

## 183 **3 Definitions**

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

#### 185 3.1 General

186 **3.1.1** 

#### 187 electrical equipment

- any item used for such purposes as generation, conversion, transmission, distribution and
   utilization of electrical energy, such as machines, transformers, apparatus, measuring
   instruments, protective devices, equipment for wiring systems, appliances
- 191 [IEV 826-07-01]
- 192 **3.1.2**
- 193 rated value
- 194 value of a quantity used for specification purposes, established for a specified set of operating
- 195 conditions of a component, device, equipment, or system
- 196 *[IEV 151-16-08]*
- 197 **3.1.3**
- 198 high voltage
- 199 voltage exceeding 1 000 V a.c.
- 200 **3.1.4**

## 201 *low voltage*

202 voltage not exceeding 1 000 V a.c.

## 203 **3.1.5**

204 operation

## <u>5151 EN 56522.2011</u>

- all activities, including both electrical and non-electrical work activities, necessary to permit the
   power installation to function. These activities include switching, controlling, monitoring and
   maintenance
- 208 3.2 Installations

## 209 **3.2.1**

#### 210 closed electrical operating area

room or location for operation of electrical installations and equipment to which access is intended to be restricted to skilled or instructed persons or to lay personnel under the supervision of skilled or instructed persons, e.g. by opening of a door or removal of protective barrier only by the use of a key or tool, and which is clearly marked by appropriate warning signs

216 **3.2.2** 

## 217 substation

218 part of a power system, concentrated in a given place, including mainly the terminations of 219 transmission or distribution lines, switchgear and housing and which may also include 220 transformers. It generally includes facilities necessary for system security and control (e.g. the 221 protective devices)

- 222 EXAMPLES: transmission substation (of a transmission system), distribution substation, 400 kV substation, 20 kV 223 substation.
- 224 [IEV 605-01-01]

225 NOTE / According to the nature of the system within which the substation is included, a prefix may qualify it.

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#### 226 **3.2.3**

- 227 power station
- installation whose purpose is to generate electricity and which includes civil engineering works, energy conversion equipment and all the necessary ancillary equipment
- 230 [IEV 602-01-01]

#### 231 **3.2.4**

- 232 installations of open design
- 233 installations where the equipment does not have protection against direct contact
- 234 **3.2.5**

#### 235 installations of enclosed design

- 236 installations where the equipment has protection against direct contact
- 237 NOTE For degrees of enclosure protection see EN 60529.
- 238
- 239 **3.3 Safety measures against electric shock**
- 240 **3.3.1**

#### 241 protection against direct contact

- 242 measures which prevent persons coming into hazardous proximity to live parts or those parts 243 which could carry a hazardous voltage, with parts of their bodies or objects (reaching the
- 244 *danger zone*)
- 245 3.3.2
- 246 protection in case of indirect contact
- 247 protection of persons from hazards which could arise, in event of fault, from contact with 248 exposed conductive parts of electrical equipment or extraneous conductive parts
- 249 3.3.3 https://standards.iteb.ai/catalog/stradards/sist/03802b/
- 250 enclosure
- part providing protection of equipment against certain external influences and, in any direction,
   protection against direct contact
- 253 [IEV 826-03-12]
- 254

## 255 **3.4 Earthing**

- 256 **3.4.1**
- 257 (local) earth
- 258 part of the Earth which is in electric contact with an earth electrode and the electric potential of 259 which is not necessarily equal to zero
- 260 NOTE The conductive mass of the earth, whose electric potential at any point is conventionally taken as equal to 261 zero.
- 262 [IEV 195-01-03]
- 263 **3.4.2**
- 264 reference earth
- 265 (remote earth)
- part of the Earth considered as conductive, the electric potential of which is conventionally
   taken as zero, being outside the zone of influence of the relevant earthing arrangement
- 268 NOTE The concept "Earth" means the planet and all its physical matter.
- 269 [IEV 195-01-01, modified]

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#### 270 343

#### earth electrode 271

- conductive part, which is in electric contact with the earth and which may be embedded in a 272 specific conductive medium, e.g. in concrete 273
- 274 [IEV 195-02-01]

#### 275 3.4.4

#### 276 earthing conductor

- 277 conductor which provides a conductive path, or part of the conductive path, between a given 278 point in a system or in an installation or in equipment and an earth electrode
- 279 [IEV 195-02-03]
- 280 NOTE Where the connection between part of the installation and the earth electrode is made via a disconnecting 281 link, disconnecting switch, surge arrester counter, surge arrester control gap etc., then only that part of the 282 connection permanently attached to the earth electrode is an earthing conductor.

#### 283 3.4.5

#### 284 protective bonding conductor

- 285 protective conductor for ensuring equipotential bonding
- 286 [IEV 826-04-10, modified]
- 287 3.4.6

#### 288 earthing system

- arrangement of connections and devices necessary to earth equipment or a system separately 289 290 or jointly
- [IEV 604-04-02] 291

#### 292 347

- 293 earth rod
- 294 earth electrode consisting of a metal rod driven into the ground
- 295 [IEV 604-04-09]/standards.iteh.ai/catalog/stradards/sist/93892b89-6105-4c0c-89bf-
- 296 3.4.8

#### 297 structural earth electrode

- 298 metal part, which is in conductive contact with the earth or with water directly or via concrete, 299 whose original purpose is not earthing, but which fulfils all requirements of an earth electrode 300 without impairment of the original purpose
- 301 NOTE Examples of structural earth electrodes are pipelines, sheet piling, concrete reinforcement bars in 302 foundations and the steel structure of buildings, etc.

#### 303 3.4.9

- 304 electric resistivity of soil,  $\rho_s$
- 305 resistivity of a typical sample of soil

#### 306 3 4 10

- 307 resistance to earth,  $R_{\rm E}$
- 308 real part of the impedance to earth
- 309 3.4.11
- 310 impedance to earth,  $Z_{E}$
- 311 impedance at a given frequency between a specified point in a system or in an installation or in 312 equipment and reference earth
- 313 NOTE The impedance to earth is determined by the directly connected earth electrodes and also by connected
- 314 overhead earth wires and wires buried in earth of overhead lines, by connected cables with earth electrode effect 315 316 and by other earthing systems which are conductively connected to the relevant earthing system by conductive
- cable sheaths, shields, PEN conductors or in another way.

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## 317 **3.4.12**

## 318 earth potential rise, EPR

319 voltage between an earthing system and reference earth

- 320 **3.4.13**
- 321 *potential*
- 321 polenilai 322 voltago botw
- 322 voltage between an observation point and reference earth
- 323 **3.4.14**
- 324 (effective) touch voltage, U<sub>T</sub>
- 325 voltage between conductive parts when touched simultaneously
- 326 NOTE The value of the effective touch voltage may be appreciably influenced by the impedance of the person in electric contact with these conductive parts.
- 328 [IEV 195-05-11, modified]

## 329 **3.4.15**

#### 330 prospective touch voltage (source voltage for touching)

- 331 voltage between simultaneously accessible conductive parts when those conductive parts are 332 not being touched
- 333 *[IEV 195-05-09, modified]*

#### 334 **3.4.16**

- 335 step voltage, Us r
- voltage between two points on the earth's surface that are 1 m distant from each other, which
   is considered to be the stride length of a person
- 338 *[IEV 195-05-12]*

## 339 **3.4.17**

#### 340 transferred potential

- potential rise of an earthing system caused by a current to earth transferred by means of a connected conductor (for example a metallic cable sheath, PEN conductor, pipeline, rail) into areas with low or no potential rise relative to reference earth resulting in a potential difference occurring between the conductor and its surroundings (Figure 1).
- 345 NOTE The definition also applies where a conductor, which is connected to reference earth, leads into the area 346 of the potential rise.

#### 347 **3.4.18**

#### 348 stress voltage

349 voltage appearing during earth fault conditions between an earthed part or enclosure of 350 equipment or device and any other of its parts and which could affect its normal operation or 351 safety

352 **3.4.19** 

#### 353 global earthing system

- equivalent earthing system created by the interconnection of local earthing systems that
  ensures, by the proximity of the earthing systems, that there are no dangerous touch voltages.
  Such systems permit the division of the earth fault current in a way that results in a reduction of
  the earth potential rise at the local earthing system. Such a system could be said to form a
  guasi equipotential surface
- 359 NOTE The existence of a global earthing system may be determined by sample measurements or calculation for 360 typical systems. Typical examples of global earthing systems are in city centres; urban or industrial areas with 361 distributed low- and high-voltage earthing (see Annex O).

## 362 **3.4.20**

## 363 multi-earthed HV neutral conductor

364 neutral conductor of a distribution line connected to the earthing system of the source 365 transformer and regularly earthed

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#### 366 3.4.21

#### 367 exposed conductive part

- conductive part of equipment which can be touched and which is not normally live, but which 368 can become live when basic insulation fails 369
- [IEV 826-03-02, modified] 370

#### 371 3.4.22

#### 372 extraneous conductive part

- conductive part not forming part of the electrical installation and liable to introduce an electric 373
- potential, generally the electric potential of a local earth 374
- 375 [IEV 826-03-03, modified]

#### 376 3.4.23

- 377 **PEN** conductor
- 378 conductor combining the functions of both protective earthing conductor and neutral conductor
- 379 [IEV 826-04-06, modified]

#### 380 3.4.24

- 381 earth fault
- fault caused by a conductor being connected to earth or by the insulation resistance to earth 382 383 becoming less than a specified value
- 384 [IEV 151-03-40:1978]
- 385 NOTE Earth faults of two or several phase conductors of the same system at different locations are designated 386 as double or multiple earth faults.

#### 387 3.4.25

#### 388 system with isolated neutral

- 389 system in which the neutrals of transformers and generators are not intentionally connected to 390 earth, except for high impedance connections for signalling, measuring or protection purposes
- 391 [IEV 601-02-24, modified]

#### 392 3.4.26

397

401

402

403

404

#### 393 system with resonant earthing

- 394 system in which at least one neutral of a transformer or earthing transformer is earthed via an 395 arc suppression coil and the combined inductance of all arc suppression coils is essentially 396 tuned to the earth capacitance of the system for the operating frequency
- 398 NOTE In case of no self-extinguishing arc fault there are two different operation methods used:
- 399 - immediate automatic disconnection; 400
  - continuous operation during fault localisation process.
  - In order to facilitate the fault localisation and operation there are different supporting procedures:
  - short term earthing for detection;
  - short term earthing for tripping;
  - phase earthing.
- 405 3.4.27

#### 406 system with low-impedance neutral earthing

- 407 system in which at least one neutral of a transformer, earthing transformer or generator is 408 earthed directly or via an impedance designed such that due to an earth fault at any location 409 the magnitude of the fault current leads to a reliable automatic tripping due to the magnitude of
- 410 the fault current
- 411 [IEV 601-02-25, 601-02-26]

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#### 412 **3.4.28**

- 413 earth fault current, I<sub>F</sub>
- 414 current which flows from the main circuit to earth or earthed parts at the fault location (earth
- 415 *fault location)* (Figure 2 and Figure 3).
- 416 For single earth faults, this is,
- 417 in systems with isolated neutral, the capacitive earth fault current;
- 418 in systems with high resistive earthing, the RC composed earth fault current;
- 419 in systems with resonant earthing, the earth fault residual current;
- 420 in systems with solid or low impedance neutral earthing, the line-to-earth short-circuit current

#### 421 3.4.29

## 422 current to earth, $I_{\rm E}$

423 current flowing to earth via the impedance to earth (see Figure 2)

424 425 NOTE The current to earth is the part of the earth fault current  $I_F$ , which causes the potential rise of the earthing 426 system. For the determination of  $I_E$  see also Annex L.

#### 427 **3.4.30**

- 428 reduction factor, r
- factor r of a three phase line is the ratio of the current to earth over the sum of the zero sequence currents in the phase conductors of the main circuit ( $r = I_E / 3I_o$ ) at a point remote from the short-circuit location and the earthing system of an installation
- 432 **3.4.31**
- 433 circulating transformer neutral current
- 434 portion of fault current which flows back to the transformer neutral point via the metallic parts 435 and/or the earthing system without ever discharging into soil

#### 436 3.4.32

#### <u>ST EN 50522:201</u>

- 430 **5.4.32** 437 horizontal earth electrode
- 437 **IIOTZOIItal earth electroue**
- electrode which is generally buried at a depth of up to approximately 1 m. It can consist of
  strip, round bar or stranded conductor and can be laid out to form a radial, ring or mesh earth
  electrode or a combination of these

#### 441 **3.4.33**

- 442 cable with earth electrode effect
- 443 cable whose sheaths, screens or armourings have the same effect as a strip earth electrode

#### 444 **3.4.34**

## 445 foundation earth electrode

- 446 conductive structural embedded in concrete which is in conductive contact with the earth via a
- 447 large surface
- 448 [IEV 826-13-08, modified]
- 449 3.4.35
- 450 potential grading earth electrode
- 451 conductor which due to shape and arrangement is principally used for potential grading rather 452 than for establishing a certain resistance to earth