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Železniške naprave - Stabilne naprave električne vleke - Načela zaščite za sisteme izmeničnih ali enosmernih električnih vlek

Railway applications - Fixed installations - Protection principles for AC and DC electric traction systems

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Foreword

83 This document (prEN 50633:2014) has been prepared by SC 9XC "Electric supply and earthing
84 systems for public transport equipment and ancillary apparatus (Fixed installations)" of CLC/TC 9X
85 "Electrical and electronic applications for railways".

86 This document is currently submitted to the Enquiry.

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87 1 Scope

88 This standard

- 89 – defines protection principles,
- 90 – describes the railway specific protection functions,
- 91 – defines minimum functional requirements and informative examples of their application,
- 92 – describe technical limits,
- 93 – identify residual risks,
- 94 – describes principles for conformity assessment,

95 for AC and DC electric traction systems.

96

97 It applies to

- 98 – railways,
- 99 – guided mass transport systems, such as tramways, elevated and underground railways,
- 100 mountain railways, trolleybus systems, and magnetically levitated systems which use a
- 101 contact line system.

102 This standard may also be applied to electrified road traffic with contact line, such as truck-trolley
103 systems.

104 This standard applies to new electric traction systems and to all significant changes of existing
105 systems.

106 <https://standards.iteh.ai/catalog/standards/sist/75033e6f-fd3d-447f-80f2-11097f64830b/sist->
107 [en-50633-2016](https://standards.iteh.ai/catalog/standards/sist/75033e6f-fd3d-447f-80f2-11097f64830b/sist-en-50633-2016)

- 108 – underground mine traction systems,
- 109 – cranes, transportable platforms and similar transportation equipment on rails, temporary
- 110 structures (e.g. exhibition structures) in so far as these are not supplied directly or via
- 111 transformers from the contact line system and are not endangered by the traction power
- 112 supply system,
- 113 – suspended cable cars,
- 114 – funicular railways,
- 115 – magnetic levitated systems (without contact line system),
- 116 – railways with inductive power supply without contact system,
- 117 – railways with buried contact system that is required to be energized only below the train to
- 118 ensure safety.
- 119

120 This standard does not cover

- 121 – technical requirements for products,
- 122 – rules for maintenance of protection systems.

123

124 2 Normative references

125 The following documents, in whole or in part, are normatively referenced in this document and are
126 indispensable for its application. For dated references, only the edition cited applies. For undated
127 references, the latest edition of the referenced document (including any amendments) applies.

128 EN 50122-1, Railway applications – Fixed installations – Electrical safety, earthing and the return
129 circuit – Part 1: Protective provisions against electric shock

130 EN 50122-3, Railway applications – Fixed installations – Electrical safety, earthing and the return
131 circuit – Part 3: Mutual Interaction of a.c. and d.c. traction systems

132 EN 50123 (all parts), Railway applications – Fixed installations – D.C. switchgear

133 EN 50152 (all parts), Railway applications – Fixed installations – Particular requirements for AC
134 switchgear

135 EN 50153, Railway applications - Rolling stock - Protective provisions relating to electrical hazards

136 EN 50388, Railway applications – Power supply and rolling stock – Technical criteria for the
137 coordination between power supply (substation) and rolling stock to achieve interoperability

138 EN 60255 (all parts), Measuring relays and protection equipment (IEC 60255 (all parts))

139 EN 50327, Railway applications - Fixed installations - Harmonisation of the rated values for converter
140 groups and tests on converter groups

141

142 3 Terms and definitions (standards.iteh.ai)

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

144 NOTE When possible, the following definitions have been taken from the relevant chapters of the International Electrotechnical
145 Vocabulary (IEV), IEC 60050. In such cases, the appropriate IEV reference is given.

146 3.1

147 contact line system

148 support network for supplying electrical energy from substations to electrically powered traction units,
149 which covers overhead contact line systems and conductor rail systems; the electrical limits of the
150 system are the feeding point and the contact point to the current collector

151 Note 1 to entry: The mechanical system may comprise

- 152 – the contact line,
- 153 – structures and foundations,
- 154 – supports and any components supporting or registering the conductors,
- 155 – head and cross spans,
- 156 – tensioning devices,
- 157 – along-track feeders, reinforcing feeders, and other lines like earth wires and return conductors as far as they are supported
158 from contact line system structures,
- 159 – any other equipment necessary for operating the contact line,
- 160 – conductors connected permanently to the contact line for supply of other electrical equipment such as lights, signal
161 operation, point control and point heating.

162 [EN 50119:2009, 3.1.1]

163

- 164 **3.2**
 165 **electric traction system**
 166 railway electrical distribution network used to provide energy for rolling stock
 167 Note 1 to entry: The system may comprise
 168 – contact line systems,
 169 – return circuit of electric traction systems,
 170 – electrical installations in substations, which are utilized solely for distribution of power directly to the contact line,
 171 – electrical installations of switching stations.
 172 [EN 50122-1:2011, 3.4.1, modified: running rails of non-electrified lines in the vicinity of, and
 173 conductively connected to the running rails of an electric traction system, and electrical installations
 174 which are supplied from contact lines either directly or via a transformer have been excluded from
 175 Note 1 to entry.
- 176 **3.3**
 177 **(traction) substation**
 178 a substation the main function of which is to supply a traction system
 179 [IEV811-36-03]
- 180 **3.4**
 181 **(traction) switching station**
 182 installation from which electrical energy can be distributed to different feeding sections or from which
 183 different feeding sections can be switched on and off or can be interconnected
- 184 **3.5**
 185 **feeding section**
 186 electrical section of the route fed by individual track feeder circuit-breakers within the area supplied by
 187 the substation
 188 [EN 50119:2009, 3.3.2]
- 189 **3.6**
 190 **electrical safety**
 191 freedom from unacceptable risk of harm caused by electrical hazards
 192 [EN 50122-1:2011, 3.1.1]
- 193 **3.7**
 194 **electric shock**
 195 pathophysiological effect resulting from an electric current passing through a human or animal body
 196 [IEC 60050-826-12-01]
- 197 **3.8**
 198 **return circuit**
 199 all conductors which form the intended path for the traction return current
 200 EXAMPLE The conductors may be
 201 – running rails,
 202 – return conductor rails,
 203 – return conductors,
 204 – return cables.
 205 [EN 50122-1:2011, 3.3.1]
- 206 **3.9**
 207 **switchgear and controlgear**
 208 a general term covering switching devices and their combination with associated control, measuring,
 209 protective and regulating equipment, also assemblies of such devices and equipment with associated
 210 interconnections, accessories, enclosures and supporting structures
 211 [IEC 60050-441-11-01]

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212 **3.10**
 213 **opening time** (of a mechanical switching device)
 214 the interval of time between the specified instant of initiation of the opening operation and the instant
 215 when the arcing contacts have separated in all poles

216 Note 1 to entry: The instant of initiation of the opening operation, i.e. the application of the opening command (e.g. energizing
 217 the release, etc.) is given in the relevant specifications.

218 [IEC 60050-441-17-36]

219 **3.11**
 220 **(effective) touch voltage**

221 U_{te}
 222 voltage between conductive parts when touched simultaneously by a person or an animal

223 Note 1 to entry: The value of the effective touch voltage can be appreciably influenced by the impedance of the
 224 person or the animal in electric contact with these conductive parts.

225 [IEC 60050-195-05-11]

226 **3.12**
 227 **earth**

228 conductive mass of the earth, whose electric potential at any point is conventionally taken as equal to
 229 zero

230 [IEC 60050-826-04-01]

231 **3.13**
 232 **earthing**

233 connection of conductive parts to an appropriate earth electrode

234 **3.14**
 235 **fault condition**

236 non intended condition caused by short-circuit. The time duration is terminated by the correct function
 237 of the protection devices and circuit breakers

238 Note 1 to entry: For the relevant fault duration the correct operation of protection devices and circuit breakers is taken into
 239 account.

240 [EN 50122-1]

241 **3.15**
 242 **low resistance fault**

243 short circuit fault condition where the resistance of the fault is sufficiently low that the fault current is of
 244 a similar magnitude to that which would flow if the fault resistance were zero

245 Note 1 to entry: The resistance of the fault is typically dominated by the resistance of the power arc.

246 Note 2 to entry: In this definition, resistance is to understood as also being impedance for AC fault currents.

247 **3.16**
 248 **high resistance fault**

249 short circuit fault condition where the resistance of the fault is sufficiently high that the fault current is
 250 of a substantially different magnitude to that which would flow if the fault resistance were zero

251 Note 1 to entry: In this definition, resistance is to understood as also being impedance for AC fault currents.

252 **3.17**
 253 **abnormal operating condition**

254 condition where the system is operated beyond its intended capabilities such that damage or reduced
 255 life expectancy can be anticipated

256 **3.18**
 257 **short-circuit**

258 accidental or intentional conductive path between two or more conductive parts forcing the electric
 259 potential differences between these conductive parts to be equal to or close to zero

260 [IEC 60050-195-04-11]

- 261 **3.19**
 262 **current collector**
 263 equipment fitted to the vehicle and intended to collect current from a contact wire or conductor rail
 264 [IEC 60050-811-32-01]
- 265 **3.20**
 266 **protection**
 267 provisions for detecting faults or other abnormal conditions in a power system, for enabling fault
 268 clearance, for terminating abnormal conditions, and for initiating signals or indications
- 269 Note 1 to entry: The term "protection" is a generic term for protection equipment or protection systems.
- 270 Note 2 to entry: The term "protection" may be used to describe the protection of a complete power system or the protection of
 271 individual plant items in a power system e.g. transformer protection, line protection, generator protection.
- 272 Note 3 to entry: Protection does not include items of power system plant provided, for example, to limit overvoltages on the
 273 power system. However, it includes items provided to control the power system voltage or frequency deviations such as
 274 automatic reactor switching, load-shedding, etc..
- 275 [IEC 60050- 448-11-01]
- 276 **3.21**
 277 **protection system**
 278 arrangement of one or more protection equipments, and other devices intended to perform one or
 279 more specified protection functions
- 280 Note 1 to entry: A protection system includes one or more protection equipment, IEDs, instrument transformer(s), wiring, tripping
 281 circuit(s), auxiliary supply(s) and, where provided, communication system(s). Depending upon the principle(s) of the protection
 282 system, it may include one end or all ends of the protected section and, possibly, automatic reclosing equipment.
- 283 Note 2 to entry: The circuit-breaker(s) are excluded.
- 284 Note 3 to entry: The circuit-breaker protection functions are included, e.g. direct overcurrent release of dc-circuit-breakers(s) .
- 285 [IEC 60050- 448-11-04, modified – Note 3 to entry has been added.]
- 286 **3.22**
 287 **protection equipment** equipment incorporating one or more protection relays and, if necessary, logic
 288 elements intended to perform one or more specified protection functions
- 289 Note 1 to entry: A protection equipment is part of a protection system.
- 290 [IEC 60050- 448-11-03]
- 291 **3.23**
 292 **protection relay**
 293 measuring relay which, either solely or in combination with other relays, is a constituent of a protection
 294 equipment
- 295 [IEC 60050-448-11-02]
- 296 **3.24**
 297 **protected section**
 298 that part of a power system network, or circuit within a network, to which specified protection has been
 299 applied
- 300 [IEC 60050-448-11-05]
- 301 **3.25**
 302 **selectivity of protection**
 303 ability of a protection to identify the faulty section and/or phase(s) of a power system
- 304 [IEC 60050-448-11-06]

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- 305 **3.26**
306 **reliability of protection**
307 probability that a protection can perform a required function under given conditions for a given time
308 interval
309 [IEC 60050-448-12-05]
- 310 **3.27**
311 **redundancy**
312 in an item, existence of more than one means for performing a required function
313 [IEC 60050-448-12-08]
- 314 **3.28**
315 **sensitivity of protection**
316 ability to identify smallest process values outside the normal range
317 EXAMPLE: Sensitivity of a protection system might be expressed by minimum fault current or maximum fault impedance
318 coverage.
- 319 **3.29**
320 **main protection**
321 protection expected to have priority in initiating fault clearance or an action to terminate an abnormal
322 condition in a power system
323 [IEC 60050-448-11-13]
- 324 **3.30**
325 **backup protection**
326 protection which is intended to operate when a system fault is not cleared, or abnormal condition not
327 detected, in the required time because of failure or inability of other protection to operate or failure of
328 the appropriate circuit-breaker(s) to trip
329 [IEC 60050-448-11-14]
- 330 **3.31**
331 **circuit local backup protection**
332 backup protection which is energised either from those instrument transformers which energize the
333 main protection or from instrument transformers associated with the same primary circuit as the main
334 protection
335 [IEC 60050-448-11-15]
- 336 **3.32**
337 **substation local backup protection**
338 backup protection which is energized from instrument transformers located within the same substation
339 as the corresponding main protection and not associated with the same primary circuit
340 [IEC 60050-448-11-16]
- 341 **3.33**
342 **remote backup protection**
343 backup protection located in a substation remote from that substation in which the corresponding main
344 protection is located
345 [IEC 60050-448-11-17]
- 346 **3.34**
347 **circuit-breaker failure protection**
348 protection which is designed to clear a system fault by initiating tripping of other circuit-breaker(s) in
349 the case of failure to trip of the appropriate circuit-breaker
350 [IEC 60050-448-11-18]

351 **3.35**
 352 **tripping**
 353 opening of a circuit-breaker by either manual or automatic control or by protective devices
 354 [IEC 60050-448-11-31]

355 **3.36**
 356 **direct over-current release**
 357 over-current release directly energized by the current in the main circuit of a mechanical switching
 358 device
 359 [IEC 60050-441-16-36]

360 **3.37**
 361 **indirect over-current release**
 362 over-current release energized by the current in the main circuit of a mechanical switching device
 363 through a current transformer or a shunt
 364 [IEC 60050-441-16-36]
 365

366 **4 System to be protected**

367 **4.1 Description**

368 The system to be protected within the scope of this standard is the electrical traction system, with the
 369 limits shown in Figure 1.

370 The electric traction system comprises

- 371 – Infeed to power conversion,
- 372 – Power conversion,
- 373 – Infeed to secondary distribution busbar,
- 374 – Line feeder, distribution to contact line system,
- 375 – Contact line, return circuit.

376 NOTE The operational responsibility of the above mentioned components can be split among different operators (owners).
 377 However, the protection principles described hereafter are valid for all installations. Not every electric traction system has
 378 necessarily all above mentioned parts.

379 The electrical traction system has interfaces to other parts the railway system. These interfaces can
 380 include

- 381 – Infeed to the primary distribution busbar,
- 382 – Rolling stock,
- 383 – Electrical installations fed by the contact line system or busbar (e.g. auxiliary transformers,
 384 capacitor banks, etc.),
- 385 – Electrical installations supplying the contact line system or busbar (e.g. solar or wind power
 386 generation).

387 Other subsystems or equipment, e.g. signaling and communication may be influenced by the electric
 388 traction system but their protection is not within the scope of this standard.
 389