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

To be completed

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This draft European Standard is submitted to CENELEC members for enquiry.
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It has been drawn up by CLC/SC 9XC.

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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European Committee for Electrotechnical Standardization
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Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

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Foreword

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

This document is currently submitted to the Enquiry.

1 Scope

This standard

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

for AC and DC electric traction systems.

It applies to

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

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

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

It does not apply to

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

This standard does not cover

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

2 Normative references

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

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

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

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

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

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

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

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

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

3 Terms and definitions

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

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

3.1
contact line system
support network for supplying electrical energy from substations to electrically powered traction units, which covers overhead contact line systems and conductor rail systems; the electrical limits of the system are the feeding point and the contact point to the current collector

Note 1 to entry: The mechanical system may comprise

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

[EN 50119:2009, 3.1.1]

3.2
electric traction system
railway electrical distribution network used to provide energy for rolling stock

Note 1 to entry: The system may comprise

– contact line systems,

– return circuit of electric traction systems,

– electrical installations in substations, which are utilized solely for distribution of power directly to the contact line,

– electrical installations of switching stations.

[EN 50122-1:2011, 3.4.1, modified: running rails of non-electrified lines in the vicinity of, and conductively connected to the running rails of an electric traction system, and electrical installations which are supplied from contact lines either directly or via a transformer have been excluded from Note 1 to entry.

3.3
(traction) substation
a substation the main function of which is to supply a traction system

[IEV811-36-03]

3.4
(traction) switching station
installation from which electrical energy can be distributed to different feeding sections or from which different feeding sections can be switched on and off or can be interconnected

3.5
feeding section
electrical section of the route fed by individual track feeder circuit-breakers within the area supplied by the substation

[EN 50119:2009, 3.3.2]

3.6
electrical safety
freedom from unacceptable risk of harm caused by electrical hazards

[EN 50122-1:2011, 3.1.1]

3.7
electric shock
pathophysiological effect resulting from an electric current passing through a human or animal body

[IEC 60050-826-12-01]

3.8
return circuit
all conductors which form the intended path for the traction return current

EXAMPLE The conductors may be

– running rails,

– return conductor rails,

– return conductors,

– return cables.

[EN 50122-1:2011, 3.3.1]

3.9
switchgear and controlgear
a general term covering switching devices and their combination with associated control, measuring, protective and regulating equipment, also assemblies of such devices and equipment with associated interconnections, accessories, enclosures and supporting structures

[IEC 60050-441-11-01]

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

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

[IEC 60050-441-17-36]

3.11
(effective) touch voltage
U_{te}
voltage between conductive parts when touched simultaneously by a person or an animal

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

[IEC 60050-195-05-11]

3.12
earth
conductive mass of the earth, whose electric potential at any point is conventionally taken as equal to zero

[IEC 60050-826-04-01]

3.13
earthing
connection of conductive parts to an appropriate earth electrode

3.14
fault condition
non intended condition caused by short-circuit. The time duration is terminated by the correct function of the protection devices and circuit breakers

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

[EN 50122-1]

3.15
low resistance fault
short circuit fault condition where the resistance of the fault is sufficiently low that the fault current is of a similar magnitude to that which would flow if the fault resistance were zero

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

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

3.16
high resistance fault
short circuit fault condition where the resistance of the fault is sufficiently high that the fault current is of a substantially different magnitude to that which would flow if the fault resistance were zero

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

3.17
abnormal operating condition
condition where the system is operated beyond its intended capabilities such that damage or reduced life expectance can be anticipated

3.18
short-circuit
accidental or intentional conductive path between two or more conductive parts forcing the electric potential differences between these conductive parts to be equal to or close to zero

[IEC 60050-195-04-11]

3.19
current collector
equipment fitted to the vehicle and intended to collect current from a contact wire or conductor rail

[IEC 60050-811-32-01]

3.20
protection
provisions for detecting faults or other abnormal conditions in a power system, for enabling fault clearance, for terminating abnormal conditions, and for initiating signals or indications

Note 1 to entry: The term "protection" is a generic term for protection equipment or protection systems.

Note 2 to entry: The term "protection" may be used to describe the protection of a complete power system or the protection of individual plant items in a power system e.g. transformer protection, line protection, generator protection.

Note 3 to entry: Protection does not include items of power system plant provided, for example, to limit overvoltages on the power system. However, it includes items provided to control the power system voltage or frequency deviations such as automatic reactor switching, load-shedding, etc..

[IEC 60050- 448-11-01]

3.21
protection system
arrangement of one or more protection equipments, and other devices intended to perform one or more specified protection functions

Note 1 to entry: A protection system includes one or more protection equipment, IEDs, instrument transformer(s), wiring, tripping circuit(s), auxiliary supply(s) and, where provided, communication system(s). Depending upon the principle(s) of the protection system, it may include one end or all ends of the protected section and, possibly, automatic reclosing equipment.

Note 2 to entry: The circuit-breaker(s) are excluded.

Note 3 to entry: The circuit-breaker protection functions are included, e.g. direct overcurrent release of dc-circuit-breakers(s). ,

[IEC 60050- 448-11-04, modified – Note 3 to entry has been added.]

3.22
protection equipmentequipment incorporating one or more protection relays and, if necessary, logic elements intended to perform one or more specified protection functions

Note 1 to entry: A protection equipment is part of a protection system.

[IEC 60050- 448-11-03]

3.23
protection relay
measuring relay which, either solely or in combination with other relays, is a constituent of a protection equipment

[IEC 60050-448-11-02]

3.24
protected section
that part of a power system network, or circuit within a network, to which specified protection has been applied

[IEC 60050-448-11-05]

3.25
selectivity of protection
ability of a protection to identify the faulty section and/or phase(s) of a power system

[IEC 60050-448-11-06]

3.26
reliability of protection
probability that a protection can perform a required function under given conditions for a given time interval

[IEC 60050-448-12-05]

3.27
redundancy
in an item, existence of more than one means for performing a required function

[IEC 60050-448-12-08]

3.28
sensitivity of protection
ability to identify smallest process values outside the normal range

EXAMPLE: Sensitivity of a protection system might be expressed by minimum fault current or maximum fault impedance coverage.

3.29
main protection
protection expected to have priority in initiating fault clearance or an action to terminate an abnormal condition in a power system

[IEC 60050-448-11-13]

3.30
backup protection
protection which is intended to operate when a system fault is not cleared, or abnormal condition not detected, in the required time because of failure or inability of other protection to operate or failure of the appropriate circuit-breaker(s) to trip

[IEC 60050-448-11-14]

3.31
circuit local backup protection
backup protection which is energised either from those instrument transformers which energize the main protection or from instrument transformers associated with the same primary circuit as the main protection

[IEC 60050-448-11-15]

3.32
substation local backup protection
backup protection which is energized from instrument transformers located within the same substation as the corresponding main protection and not associated with the same primary circuit

[IEC 60050-448-11-16]

3.33
remote backup protection
backup protection located in a substation remote from that substation in which the corresponding main protection is located

[IEC 60050-448-11-17]

3.34
circuit-breaker failure protection
protection which is designed to clear a system fault by initiating tripping of other circuit-breaker(s) in the case of failure to trip of the appropriate circuit-breaker

[IEC 60050-448-11-18]

3.35
tripping
opening of a circuit-breaker by either manual or automatic control or by protective devices

[IEC 60050-448-11-31]

3.36
direct over-current release
over-current release directly energized by the current in the main circuit of a mechanical switching device

[IEC 60050-441-16-36]

3.37
indirect over-current release
over-current release energized by the current in the main circuit of a mechanical switching device through a current transformer or a shunt

[IEC 60050-441-16-36]

4 System to be protected

4.1 Description

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

The electric traction system comprises

- Infeed to power conversion,
- Power conversion,
- Infeed to secondary distribution busbar,
- Line feeder, distribution to contact line system,
- Contact line, return circuit.

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

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

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

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