**SLOVENSKI STANDARD**
**oSIST prEN 50122-2:2021**

**01-januar-2021**

**Železniške naprave - Stabilne naprave električne vleke - Električna varnost, ozemljitev in povratni tokokrog - 2. del: Zaščitni ukrepi proti učinkom blodečih tokov, ki jih povzročajo enosmerni sistemi vleke**

Railway applications - Fixed installations - Electrical safety, earthing and the return circuit - Part 2: Provisions against the effects of stray currents caused by DC traction systems

Bahnanwendungen - Ortsfeste Anlagen - Elektrische Sicherheit, Erdung und Rückleitung - Teil 2: Schutzmaßnahmen gegen Streustromwirkungen durch Gleichstrombahnen



Applications ferroviaires - Installations fixes - Sécurité électrique, mise à la terre et circuit de retour - Partie 2: Mesures de protection contre les effets des courants vagabonds issus de la traction électrique à courant continu



**Ta slovenski standard je istoveten z:** **prEN 50122-2**

**ICS:**

| | | |
|---|---|---|
| 29.120.50 | Varovalke in druga nadtokovna zaščita | Fuses and other overcurrent protection devices |
| 29.280 | Električna vlečna oprema | Electric traction equipment |

**oSIST prEN 50122-2:2021** **en**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

**DRAFT**
**prEN 50122-2**

November 2020

ICS 29.120.50; 29.280

Will supersede EN 50122-2:2010 and all of its amendments and corrigenda (if any)

English Version

# Railway applications - Fixed installations - Electrical safety, earthing and the return circuit - Part 2: Provisions against the effects of stray currents caused by DC traction systems

Applications ferroviaires - Installations fixes - Sécurité électrique, mise à la terre et circuit de retour - Partie 2: Mesures de protection contre les effets des courants vagabonds issus de la traction électrique à courant continu

Bahnanwendungen - Ortsfeste Anlagen - Elektrische Sicherheit, Erdung und Rückleitung - Teil 2: Schutzmaßnahmen gegen Streustromwirkungen durch Gleichstrombahnen

This draft European Standard is submitted to CENELEC members for enquiry.
Deadline for CENELEC: 2021-02-19.



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.



This draft European Standard was established by CENELEC in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

Warning : This document is not a European Standard. It is distributed for review and comments. It is subject to change without notice and shall not be referred to as a European Standard.

CENELEC

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

**CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels**



Project: 68105

Ref. No. prEN 50122-2 E

## Contents

1 Scope ..... 5
2 Normative references ..... 5
3 Terms and definitions ..... 6
4 Identification of hazards and risks ..... 6
5 Criteria for stray current assessment and acceptance ..... 7
5.1 General ..... 7
5.2 Criteria for the protection of the tracks ..... 7
5.3 Criteria for systems with metal reinforced concrete or metallic structures ..... 8
5.4 Specific investigations and measures ..... 9
6 Design provisions ..... 9
6.1 General ..... 9
6.2 Return circuit ..... 9
6.2.1 General ..... 9
6.2.2 Resistance of running rails ..... 10
6.2.3 Track system ..... 10
6.2.4 Return conductors ..... 10
6.2.5 Return cables ..... 10
6.2.6 Electrical separation between the return circuit and system parts with earth-electrode effect ..... 11
6.2.7 Rail-to-rail and track-to-track cross bonds ..... 11
6.3 Non-traction related electrical equipment ..... 11
6.4 Tracks of other traction systems ..... 11
6.5 Return busbar in the substation ..... 11
6.6 Level crossings ..... 11
6.7 Common power supply for tram and trolleybus ..... 12
6.8 Changeover from the mainline to depot and workshop areas ..... 12
7 Provisions for influenced metallic structures ..... 12
7.1 General ..... 12
7.2 Conductive civil structures ..... 12
7.2.1 Basic proceeding ..... 12
7.2.2 Longitudinal interconnection ..... 12
7.2.3 Sectionalized reinforcement ..... 13
7.2.4 External conductive parts ..... 13
7.2.5 Cables, pipework and power supply from outside ..... 13
7.3 Adjacent pipes or cables ..... 13
7.4 Voltage limiting devices ..... 14
8 Protective provisions applied to metallic structures ..... 14
9 Depots and workshops ..... 14
10 Tests and measurements ..... 14
10.1 Principles ..... 14
10.2 Supervision of the rail insulation ..... 15
10.2.1 Continuous monitoring of the rail potential ..... 15
10.2.2 Repetitive monitoring ..... 15
Annex A (informative) Measurement of track characteristics ..... 16
Annex B (informative) Stray current assessment — Rail insulation assessment using rail potential ..... 23
Annex C (informative) Estimation of stray current and impact on metallic structures ..... 25
Annex D (informative) Laboratory testing of materials for the insulation of rails ..... 28

**Annex E (informative) Fastening systems** .......... 29
**Bibliography** .......... 30

# European foreword

This document (prEN 50122-2:2020) has been prepared by CLC/SC 9XC “Electric supply and earthing systems for public transport equipment and ancillary apparatus (Fixed installations)”.

This document is currently submitted to the Enquiry.

The following dates are proposed:

| | | |
|---|---|---|
| • latest date by which the existence of this document has to be announced at national level | (doa) | dor + 6 months |
| • latest date by which this document has to be implemented at national level by publication of an identical national standard or by endorsement | (dop) | dor + 12 months |
| • latest date by which the national standards conflicting with this document have to be withdrawn | (dow) | dor + 36 months<br>(to be confirmed or modified when voting) |

This document will supersede EN 50122-2:2010 and all of its amendments and corrigenda (if any).

prEN 50122-2:2020 includes the following significant technical changes with respect to EN 50122-2:2010:

— harmonization with prEN 50122-1:2020;

— references from EN 50162 moved to ISO/FDIS 21857:2020;

— improvement of measurement specification in Annex A;

— new Annex D “Laboratory testing of materials for the insulation of rails”.

# 1 Scope

This document specifies requirements for protective provisions against the effects of stray currents, which result from the operation of DC traction systems.

As several decades' experience has not shown evident corrosion effects from AC traction systems and actual investigations are not completed, this document only deals with stray currents flowing from a DC traction system.

This document applies to all metallic fixed installations which form part of the traction system, and also to any other metallic components located in any position in the earth, which can carry stray currents resulting from the operation of the railway system.

This document applies to all new DC lines and to all major revisions to existing DC lines. The principles can also be applied to existing electrified transportation systems where it is necessary to consider the effects of stray currents.

This document does not specify working rules for maintenance but provides design requirements to allow maintenance.

The range of application includes:

a) railways,

b) guided mass transport systems such as:

1) tramways,

2) elevated and underground railways,

3) mountain railways,

4) trolleybus systems, and

5) magnetically levitated systems, which use a contact line system,

c) material transportation systems.



This document does not apply to

d) mine traction systems in underground mines,

e) cranes, transportable platforms and similar transportation equipment on rails, temporary structures (e.g. exhibition structures) in so far as these are not supplied directly from the contact line system and are not endangered by the traction power supply system,

f) suspended cable cars,

g) funicular railways.

# 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 50122-1:2020, *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 AC and DC traction systems*

EN 50163, *Railway applications - Supply voltages of traction systems*

ISO/FDIS 21857:2020, *Petroleum, petrochemical and natural gas industries — Prevention of corrosion on pipeline systems influenced by stray currents*

# 3 Terms and definitions

For the purposes of this document, the terms and definitions given in prEN 50122-1:2020 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

# 4 Identification of hazards and risks

DC traction systems can cause stray currents which could adversely affect both the railway concerned and/or outside installations, when the return circuit is not sufficiently insulated versus earth.

NOTE When not sufficiently insulated versus earth, the feeding circuit could also generate stray currents but its insulation is normally designed, installed and maintained to be strong enough to mitigate electrical safety risks.

The major effects of stray currents can be corrosion and subsequent damage of metallic structures, where stray currents leave the metallic structures. There is also the risk of overheating, arcing and fire and subsequent danger to persons and equipment both inside and outside the DC electric traction power supply system.

The following systems, which can produce stray currents, shall be considered:

— DC railways using running rails carrying the traction return current including track sections of other traction systems bonded to the tracks of DC railways;



— DC trolleybus systems which share the same power supply with a system using the running rails carrying the traction return current;

— DC railways not using running rails carrying the traction return current, where DC currents can flow to earth or earthing installations.



All components and systems which can be affected by stray currents shall be considered such as

— running rails,

— metallic pipe work,

— cables with metal armour and/or metal shield,

— metallic tanks and vessels,

— earthing installations,

— reinforced concrete structures,

— buried metallic structures,

— signalling and telecommunication installations,

— non-traction AC and DC power supply systems,

— cathodic protection installations.

Any provisions employed to control the effects of stray currents shall be checked, verified and validated according to this document.

The system design shall be completed sufficiently early that the results can be taken into account in the essential system parameters, which influence the stray current effects, like the spacing of the traction substations and in the design of the civil structures, see also 5.4 and 6.

The entity responsible for the design and erection of the railway infrastructure shall make sure that electrical requirements for railway related civil structures are met.

In case of major revisions of existing lines, the effects on the stray current situation shall be assessed by calculation and/or by measurements.

If stray current provisions affect electrical safety, protective provisions against electric shock according to prEN 50122-1 shall take precedence over provisions against the effects of stray currents.

# 5 Criteria for stray current assessment and acceptance

## 5.1 General

The amount of stray currents and their effects depend on the overall system design of the traction power supply. Stray currents leaving the return circuit can affect the return circuit itself and neighbouring installations, see Clause 4.

Beside to the operating currents, the most important parameters for the magnitude of stray current are:

— the conductance per length of the tracks and the other parts of the return circuit,

— the distance between traction substations,

— the longitudinal resistance of the running rails,

— spacing of cross bonds.



If the railway system meets the requirements and measures of this document, the railway system is assumed to be acceptable from the stray current point of view.

NOTE Third party structures in proximity of the railway system could require additional measures.



The most important influencing variable for stray currents leaving the tracks is the combination of the conductance per unit length between track and earth and the rail potential. The corrosion rate is the main aspect for the assessment of risk.

Parameters influencing the rail potential are the traction currents, the longitudinal resistance of the running rails, the resistance to earth and the length of the feeding sections. The precondition for this proceeding is that there is no direct electrical connection either accidental or intended to earthing installations and earth.

## 5.2 Criteria for the protection of the tracks

Experience over more than three decades has proven that there is no damage in the tracks over this period, if the average stray current per unit length does not exceed the following value:

$$I'_{\mathrm{max}} = 2{,}5 \text{ mA/m}$$

(time averaged stray current leakage per length of a single track line).

For a double track line, the value for the maximum average stray current leakage is to be multiplied by two. For more than two tracks the value increases accordingly. For the averaging process, only the total positive parts of the stray current over 24 h or multiples are considered.

For stray current considerations the positive rail potential shift $\Delta U_{\mathrm{RE}}$ is relevant. This is the difference between the rail potential $U_{\mathrm{RE}}$ occurring during operation and no-operation.

NOTE 1 During no-operation a voltage $U_{\mathrm{RE}}$ can be present, which is e.g. caused by the electrochemical series of elements or by an already connected cathodic protection system.

If the following values for the time averaged conductance per length $G'_{RE}$ and average rail potential shift $\Delta U_{RE}$ are not exceeded during the system life-time, further investigations according to 5.4 do not need to be performed.

— $G'_{RE} \leq 0{,}5$ S/km per track and $\Delta U_{RE} \leq +5$ V for open formation (1)

— $G'_{RE} \leq 2{,}5$ S/km per track and $\Delta U_{RE} \leq +1$ V for closed formation (2)

For the averaging process, only the total positive parts of rail potential shift $\Delta U_{RE}$ over 24 h or multiples are to be considered. They are then divided by the total number of measurements over the recording time.

A guide value for the sampling rate is two per second.

If the requirements in Formulae (1) and (2) are not met, an alternative maximum value for $G'_{RE}$ shall be calculated and used for the design, applying Formula (3).

$$G'_{RE} = \frac{I'}{\Delta U_{RE}} \tag{3}$$

where

| | |
|---|---|
| $I'$ | 2,5 mA/m per track or the value coming from the investigation in 5.4. |
| $G'_{RE}$ | is the conductance per length between rails and earth, in siemens per kilometre (S/km, whereby 1 S/km = 1/Ωkm); |
| $\Delta U_{RE}$ | average rail potential shift, in volts (V); |



For tracks in closed formation a time averaged conductance per length of $G'_{RE} \leq 0{,}5$ S/km is not practical and recommended because of changing moisture. If this average conductance per length does not allow to fulfil the criteria of $I' = 2{,}5$ mA/m, the traction power supply system should be optimized.

For a double track line, the value for the maximum conductance per length is to be multiplied by two. For more than two tracks the factor increases accordingly.



As it is not easy to measure the stray currents directly, the measurement of the rail potential is a convenient method. According to Formula (3), the acceptable conductance per length can be calculated for a single track line.

NOTE 2 Simulation of the traction power supply for scheduled train operation can provide values for the stray current per length for design purposes. A method of calculating dead-end tracks is given in Clause C.1. This is a conservative method, because the actual values are lower.

When the construction phase has been completed, it shall be proven that the permissible conductance per length according to Formulae (1), (2) or (3) is fulfilled. Annex A indicates proven methods for the measurement.

During operation, compliance with the limits of conductance per length according to Formulae (1), (2) or (3) shall be maintained.

## 5.3 Criteria for systems with metal reinforced concrete or metallic structures

In systems with metal reinforced concrete or metallic structures, like

— reinforced track bed,

— tunnels or

— viaducts,

the impact on the structures shall be considered.

The voltage shift of the structure versus earth is the criterion for assessment.

According to ISO/FDIS 21857:2020, there is no cause for concern if the average value of the positive potential shift between the structure and earth does not exceed + 200 mV for steel in concrete structures. A margin may be added according to the expected possible traffic extension in the future. For buried metal constructions the values depend on soil resistivity and the material. For both requirements refer to ISO/FDIS 21857:2020.

NOTE Experience has shown that in case the requirements given in this document are fulfilled, impacts on non-railway installations caused by stray currents are acceptable.

In order to avoid inadmissible stray current effects on metal reinforced concrete or metallic structures, the longitudinal voltage between any two points of these interconnected structures should be calculated. The maximum longitudinal voltage shall be smaller than the permissible positive potential shift. As an example for calculation see Clause C.2. This is a conservative procedure which ensures that the actual values for the structure potential with respect to earth will be lower.

### 5.4 Specific investigations and measures

If the requirements stated in 5.2 and 5.3 are not achieved, or if other methods of construction are planned, a study shall be carried out at an early planning stage. The study becomes also necessary in case of major revisions of existing lines, when the stray current situation is likely to become worse.

The possible impact of stray current corrosion shall be investigated, where the following aspects are included, such as

— insulation from earth of the rails and connected metallic structures,

— humidity of the track bed,

— longitudinal resistance of the running rails,

— number of and distance between the substations,

— effects of inequalities in the no load voltages of substations,

— substation no-load voltage and source impedance,

— timetable and vehicles,

— neighbouring metallic structures.



Clause 6 and Clause 7 show suitable corrective provisions.

## 6 Design provisions

### 6.1 General

Any provisions employed to control the effects of stray currents shall be checked and confirmed according to this document.

The system design shall be completed so that the results can be taken into account in the essential system parameters which influence the stray current effects, like the spacing of the traction substations and the design of the civil structures.

### 6.2 Return circuit

#### 6.2.1 General

In order to minimize stray current caused by a DC electric traction power supply system, the traction return current shall be confined to the intended return circuit as far as possible.

As the return circuit in case of DC electric traction power supply systems usually is not connected to earth, safety requirements for the rail potential according to prEN 50122-1:2020, 6.2.2 and Clause 9, shall be fulfilled.

### 6.2.2 Resistance of running rails

The longitudinal resistance of the running rails shall be low. Therefore, rail joints shall be welded or connected by rail joint bonds of low resistance such that the longitudinal resistance of the rails is not increased by more than 5 %. This does not include the insulated rail joints of signalling system.

In case of impedance bonds at insulated rail joints, the total resistance may be increased by more than 5 %.

The longitudinal resistance can be reduced by the use of rails with greater cross section or cross bonding of the running rails where signalling considerations allow.

### 6.2.3 Track system

A high level of insulation from earth of the running rails and of the whole return circuit is required, when the running rails are used as part of the return circuit.

The track formation shall be designed in a way that the insulation quality of the rails with respect to earth will not be diminished substantially by water. In order to fulfil the values given in Formulae (1), (2) and (3) of 5.2 the water drainage of the substructure of the running rails is essential.

The values of conductance per length, specified in 5.2, apply to a track consisting of two running rails with tie bars as well as the attached system parts under dry conditions.

NOTE 1 Dry conditions in this context mean at least 24 h without e.g.

— rain or

— washing water.

NOTE 2 After concreting, wait until the concrete has set, this lasts usually at least one month. The setting of concrete is strongly dependent on the environmental conditions.



EXAMPLE 1 The following provisions can be made to achieve the required values of the conductance $G'_{RE}$ for rails laid in an open formation:



— clean ballast;

— wooden sleepers or reinforced-concrete sleepers with insulating fastening;

— distance between running rails and ballast.

EXAMPLE 2 The following provisions can be made to achieve the required values of the conductance $G'_{RE}$ for rails laid in a closed formation:

— fitting of the running rails in an insulating resin bed; Appendix D and Appendix E provide guidelines to test encapsulation and fastening systems respectively

— provision of insulating intermediate layers between the tracks and the bearing systems;

— effective drainage.

### 6.2.4 Return conductors

Return conductors, if required, are laid in parallel to the running rails and shall be connected to them at regular intervals so that the rail potentials and stray current criteria are met. The return conductors shall be insulated from earth.

### 6.2.5 Return cables

Return cables connect the running rails with the substation. They shall have an insulating outer sheath, so that no stray currents can leave or enter.

Where mechanical damage is likely, return cables should have an additional protection.

Requirements of prEN 50122-1:2020, 10.3 remain.