

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.

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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

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prEN 50122-2:2020 (E)

53 **European foreword**

54 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)”.

56 This document is currently submitted to the Enquiry.

57 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- latest date by which the national standards conflicting with this document have to be withdrawn (dow) dor + 36 months (to be confirmed or modified when voting)

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

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

- 60 — harmonization with prEN 50122-1:2020;
- 61 — references from EN 50162 moved to ISO/FDIS 21857:2020;
- 62 — improvement of measurement specification in Annex A;
- 63 — new Annex D “Laboratory testing of materials for the insulation of rails”.

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64 1 Scope

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

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

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

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

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

78 The range of application includes:

79 a) railways,

80 b) guided mass transport systems such as:

81 1) tramways,

82 2) elevated and underground railways,

83 3) mountain railways,

84 4) trolleybus systems, and

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

86 c) material transportation systems.

87 This document does not apply to

88 d) mine traction systems in underground mines,

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

92 f) suspended cable cars,

93 g) funicular railways.

94 2 Normative references

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

98 EN 50122-1:2020, *Railway applications - Fixed installations - Electrical safety, earthing and the return circuit -*
99 *Part 1: Protective provisions against electric shock*

100 EN 50122-3, *Railway applications - Fixed installations - Electrical safety, earthing and the return circuit - Part*
101 *3: Mutual Interaction of AC and DC traction systems*

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

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

105 3 Terms and definitions

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

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

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

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

110 4 Identification of hazards and risks

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

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

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

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

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

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

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

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

126 — running rails,

127 — metallic pipe work, <https://www.iso.org/standards/catalog/standards/sist/323e7383-6f97-438e-9637-dab7e265df67/sist-en-50122-2-2022>

128 — cables with metal armour and/or metal shield,

129 — metallic tanks and vessels,

130 — earthing installations,

131 — reinforced concrete structures,

132 — buried metallic structures,

133 — signalling and telecommunication installations,

134 — non-traction AC and DC power supply systems,

135 — cathodic protection installations.

136 Any provisions employed to control the effects of stray currents shall be checked, verified and validated ac-
 137 cording to this document.

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

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

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

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

147 **5 Criteria for stray current assessment and acceptance**

148 **5.1 General**

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

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

- 153 — the conductance per length of the tracks and the other parts of the return circuit,
- 154 — the distance between traction substations,
- 155 — the longitudinal resistance of the running rails,
- 156 — spacing of cross bonds.

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

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

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

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

166 **5.2 Criteria for the protection of the tracks**

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

169
$$I'_{\max} = 2,5 \text{ mA/m}$$

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

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

174 For stray current considerations the positive rail potential shift ΔU_{RE} is relevant. This is the difference between
175 the rail potential U_{RE} occurring during operation and no-operation.

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

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178 If the following values for the time averaged conductance per length G'_{RE} and average rail potential shift ΔU_{RE}
 179 are not exceeded during the system life-time, further investigations according to 5.4 do not need to be per-
 180 formed.

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

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

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

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

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

$$188 \quad G'_{RE} = \frac{I'}{\Delta U_{RE}} \quad (3)$$

189 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);

ΔU_{RE} average rail potential shift, in volts (V);

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

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

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

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

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

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

205 5.3 Criteria for systems with metal reinforced concrete or metallic structures

206 In systems with metal reinforced concrete or metallic structures, like

207 — reinforced track bed,

208 — tunnels or

209 — viaducts,

210 the impact on the structures shall be considered.

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

212 According to ISO/FDIS 21857:2020, there is no cause for concern if the average value of the positive potential
 213 shift between the structure and earth does not exceed + 200 mV for steel in concrete structures. A margin may

214 be added according to the expected possible traffic extension in the future. For buried metal constructions the
215 values depend on soil resistivity and the material. For both requirements refer to ISO/FDIS 21857:2020.

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

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

223 5.4 Specific investigations and measures

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

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

- 229 — insulation from earth of the rails and connected metallic structures,
- 230 — humidity of the track bed,
- 231 — longitudinal resistance of the running rails,
- 232 — number of and distance between the substations,
- 233 — effects of inequalities in the no load voltages of substations,
- 234 — substation no-load voltage and source impedance,
- 235 — timetable and vehicles,
- 236 — neighbouring metallic structures.

237 Clause 6 and Clause 7 show suitable corrective provisions.

238 6 Design provisions

239 6.1 General

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

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

245 6.2 Return circuit

246 6.2.1 General

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

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