SLOVENSKI STANDARD

SIST EN 50162:2005

december 2005

Železniške naprave – Zaščita proti koroziji zaradi učinkovanja blodečih tokov pri enosmernih tokovnih sistemih

Protection against corrosion by stray current from direct current systems

ICS 29.020; 77.060

Referenčna številka
SIST EN 50162:2005(en)

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 50162

August 2004

ICS 29.020; 77.060

English version

Protection against corrosion by stray current from direct current systems

Protection contre la corrosion due aux courants vagabonds des systèmes à courant continu

Schutz gegen Korrosion durch Streuströme aus Gleichstromanlagen

This European Standard was approved by CENELEC on 2004-05-01. 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.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists 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 Central Secretariat has the same status as the official versions.

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

CENELEC

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

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

Ref. No. EN 50162:2004 E

Foreword

This European Standard has been prepared by CENELEC BTTF 114-1, Protection against corrosion by stray current from direct current systems.

The text of the draft was submitted to the Unique Acceptance Procedure and was approved by CENELEC as EN 50162 on 2004-05-01.

The following dates were fixed:

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2005-05-01
- latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2007-05-01

Contents

Figures

Tables

Introduction

Stray currents originating from direct current systems may cause severe material damage by corrosion, stray current corrosion, on buried or immersed metal structures (see Annex A). Particularly, long buried horizontal structures, e.g. pipelines and metal sheathed cables, may be in danger of this type of corrosion. Since corrosion damage can appear after only a short time of exposure to stray current it is important to make provisions for protective measures at an early stage and also to check the effect of these measures regularly.

This standard describes appropriate measures that can be applied to interfering d.c. systems and, if necessary, to structures which are, or which can be, exposed to stray current corrosion. The standard also gives measurement criteria for determining when these measures must be applied. Measurement techniques used on d.c. interfered structures are described in EN 13509.

The measures described in this standard are aimed for protection against stray current corrosion. For effective protection against other types of corrosion other measures have to be applied.

1 Scope

This standard establishes the general principles to be adopted to minimize the effects of stray current corrosion caused by direct-current (d.c.) on buried or immersed metal structures.

The standard is intended to offer guidance for:

– the design of direct current systems which may produce stray currents;

– the design of metal structures, which are to be buried or immersed and

– which may be subject to stray current corrosion;

– the selection of appropriate protection measures.

The standard mainly deals with external stray current corrosion on buried or immersed structures.

However stray current corrosion may also occur internally in systems containing an electrolyte e.g. near insulating joints or high resistance pipe joints in a water pipeline.

These situations are not dealt with in detail in this standard but principles and measures described here are generally applicable for minimizing the interference effects.

Stray currents may also cause other effects such as overheating. These are not covered in this standard.

D.C. systems that can cause currents to flow in the earth or any other electrolyte, whether intentional or unintentional, include:

– d.c. traction systems;

– trolley bus systems;

– d.c. power systems;

– d.c. equipment at industrial sites;

– d.c. communication systems ;

– cathodic protection systems;

– high voltage d.c. (HVDC) transmission systems;

– d.c. track circuit signalling systems. For stray currents from traction systems EN 50122-2 gives requirements for minimizing their production and for the effects within the railroad.

Systems which may be affected by stray currents include buried or immersed metal structures such as:

a) pipelines;

b) metal sheathed cables;

c) tanks and vessels;

d) earthing systems;

e) steel reinforcement in concrete;

f) steel piling.

An affected structure carrying stray currents, e.g. a pipeline or cable may itself affect other nearby structures (see Clause 8).

This standard does not address the effect of a.c. stray current. Where a.c. stray current is suspected, care should be taken when taking measurements on any components due to risk of large induced voltages. If a.c. stray current interference is present the criteria described in this standard will not apply.

2 Normative references

The following referenced documents are indispensable for the application 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 50122-2:1998, *Railway applications - Fixed installations - Part 2: Protective provisions against the effects of stray currents caused by d.c. traction systems*

EN 12954:2001, *Cathodic protection of buried or immersed metallic structures – General principles and application for pipelines*

EN 13509:2003, *Cathodic protection measurement techniques*

3 Definitions

For the purposes of this European Standard, the terms and definitions given in EN 12954, EN 50122-2 and the following apply.

3.1
coating
electrically insulating covering bonded to a metal surface for protection against corrosion by preventing contact between the electrolyte and the metal surface

3.2
drainage (electrical drainage)
transfer of stray current from an affected structure to the current source by means of a deliberate bond

NOTE For drainage devices see direct drainage bond, unidirectional drainage bond and forced drainage bond

3.3
direct drainage bond
device that provides electrical drainage by means of a direct bond between an affected structure and the stray current source. The bond may include a series resistor to limit current

3.4
forced drainage bond
device that provides electrical drainage by means of a bond between an affected structure and the stray current source. The bond includes a separate source of d.c. power to augment the transfer of current

3.5
unidirectional drainage bond
device that provides electrical drainage by means of a unidirectional bond between the affected structure and the stray current source. The bond includes a device such as a diode to ensure that current can only flow in one direction

4 Information exchange and co-operation

During the design stage of buried or immersed metallic structures the possibility of both causing and suffering from stray current interference shall be taken into consideration in order to meet the criteria mentioned in Clause 6.

Electrical interference problems on buried or immersed metallic structures shall be considered with the following points in mind:

– the owner of the metallic structure may protect a structure against corrosion with the method that he considers to be the most suitable. However, electrical interference to neighbouring structures shall be maintained within the defined limits;

– stray currents, especially from d.c. traction systems are directly related to the design of the return circuits. This means that it is possible to limit the stray current but not to remove it entirely;

– where other structures that may be affected are present, the requirement to maintain interference within the defined limits applies to all affected structures.

This goal is best achieved by agreement, co-operation and information exchange between the parties involved. Information exchange and co-operation are important and shall be carried out both at the design stage and during operation of the systems. In this way possible effects, suitable precautions and remedies can be assessed.

The following information shall be exchanged:

1) details of new buried metallic structures;

2) cathodic protection installations or significant modifications;

3) d.c. traction system installations or significant modifications;

4) HVDC transmission line installation or modification.

Agreement and co-operation may be more effectively achieved and maintained by periodic meetings between interested parties, committees or other associations who can establish information exchange procedures and protocols.

5 Identification and measurement of stray current interference

5.1 Identification

In cases where there is a possible corrosion risk due to d.c. interference analysis of the situation shall consider electrical properties and the location of the possible source of interference as well as anomalies recorded during routine cathodic protection measurements.

There are four principal ways to identify stray-current interference. These are to measure one or more of the following:

– structure to electrolyte potential fluctuations;

– deviations from normal structure to electrolyte potentials;

– voltage gradients in the electrolyte;

– line currents in pipelines coupons or metallic cable sheaths.

NOTE The measurement of current fluctuations and current polarity changes is particularly useful for identifying interference in complex networks.

After stray current interference has been identified further measurements must be carried out to assess the risk of corrosion.

5.2 Measurement

5.2.1 General

In order to assess the risk of corrosion to which any metal structure is exposed as a result of stray current, the positive potential shift of the affected structure shall be considered (see 6.1). If cathodic corrosion (see Annex A and EN 12954) of the metallic structure is likely to occur corrosion risks shall also be assessed by reference to the negative shift of the potential of the structure (see 6.2).The structure to soil potential should be measured with respect to a reference electrode, which is placed directly above the interfered structure.

In order to identify stray current polarity and/or magnitude potential gradient measurements using two reference electrodes may be carried out. One of the two electrodes shall be placed immediately above the structure exposed to the interference and the other one at a distance of, ideally, not less than 10 m.

Measuring the magnitude and direction of current flow and/or the potential shift at coupons or test probes will help to assess a possible corrosion risk.

Measurement techniques, sample periods and the number of readings shall be selected to provide representative data. In order to ensure accurate measurements care should be taken to select suitable voltage recording equipment and due consideration given to input impedance, sample period (or chart speed) and signal conditioning and filtering.

Measurement techniques are described in EN 13509.

5.2.2 Non fluctuating interference

In case of non fluctuating interference structure-to-electrolyte potentials or voltage gradients in the electrolyte shall be measured while the stray current source is in and out of operation. The measured values during these two conditions shall be compared with each other. If the stray current source cannot be temporarily switched off, the interference should be extrapolated from tests made under different stray current source operation conditions.

5.2.3 Fluctuating interference

Where the potentials or voltage drops measured fluctuate, e.g. as a result of interference from a d.c. traction system, measurements should be made using a continuous chart recorder or digital data logger. The recording shall include the period of time when maximum interference is expected as well as a period of no interference if possible. Many sources of interference exhibit the maximum and minimum levels over a 24 h period.

It is advisable to record the measured values of the affected system and an operating parameter of the stray current source simultaneously to allow a clear association of the stray current to the source.

Values recorded during the non operational period of the interfering system shall be considered as the normal or unaffected potentials.

NOTE A judgment should be made where the interfering system is not de-energised during non operational periods.

6 Criteria for stray-current interference

6.1 Anodic interference

A positive shift in potential on the structure constitutes anodic interference (see Annex A).

6.1.1 Structures without cathodic protection

Anodic interference (see Annex B) on structures without cathodic protection is acceptable if the positive potential shift ΔU is lower than the criterion given in Table 1.

NOTE 1 The acceptable positive potential shift ΔU (ohmic voltage drop, i.e. IR-drop, included) is related to the electrolyte resistivity since the IR-drop part of the measured potential shift increases with increasing resistivity (see Annex C).

NOTE 2 It is difficult to assess whether anodic interference meets the acceptance criterion of Table 1 where the potentials are rapidly fluctuating. A judgement should be made regarding the duration and extent of the potential excursions beyond the criterion as to whether or not the excursions are acceptable. This judgement may be based on the duration and frequency of the excursions or upon the average potential shift. If the results of the judgement are inconclusive then IR free potential measurements should be made and the criterion of Table 1 column three should be applied (ΔU/mV excluding IR drop)

Table 1 – Acceptable positive potential shifts ΔU for buried or immersed metal structures which are not cathodically protected

Structure metal	Resistivity of the electrolyte ρ (Ωm)	Maximum positive potential shift ΔU (mV) (including IR-drop)	Maximum positive potential shift ΔU (mV) (excluding IR-drop)
Steel, cast iron	≥ 200	300	20
	15 to 200	1,5 x ρ*	20
	< 15	20	20
Lead		1 x ρ*	
Steel in buried concrete structures		200	
*ρ in Ωm			

6.1.2 Structures with cathodic protection

Structures protected against corrosion by cathodic protection shall be deemed to be exposed to unacceptable stray current interference if the IR free potential is outside the protective potential range (see EN 12954).

To evaluate the acceptability of stray current interference the installation of test probes and coupons should be considered.

In situations with fluctuating interference current probe measurements as described in Annex D can also be used to evaluate the acceptability of interference.

If in special situations (e.g. under d.c. traction influence) there are reasons to doubt the accuracy of the measurement method used other measurement techniques (e.g. weight loss coupons) can be used to establish that the structure is cathodically protected.

Measurements should be carried out during a period of normal operation of the interfering system.

6.2 Cathodic interference

Cathodic interference (see Annex B) by stray currents shall be deemed to be unacceptably high if the interference causes the IR free potential to be more negative than the limiting IR-free potential (see EN 12954).