SLOVENSKI STANDARD
SIST EN 12954:2020

01-januar-2020

Nadomešča:
SIST EN 12954:2003

Splošna načela katodne zaščite vkopanih ali potopljenih kovinskih konstrukcij

General principles of cathodic protection of buried or immersed onshore metallic structures

Grundlagen des kathodischen Korrosionsschutzes von metallenen Anlagen in Böden und Wässern

Principes généraux de la protection cathodique des structures métalliques à terre enterrées ou immergées

Ta slovenski standard je istoveten z: **EN 12954:2019**

ICS:

25.220.40	Kovinske prevleke	Metallic coatings
91.080.10	Kovinske konstrukcije	Metal structures

SIST EN 12954:2020 **en**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 12954

August 2019

ICS 23.040.99; 77.060

Supersedes EN 12954:2001

English Version

General principles of cathodic protection of buried or immersed onshore metallic structures

Principes généraux de la protection cathodique des structures métalliques à terre enterrées ou immergées

Grundlagen des kathodischen Korrosionsschutzes von metallenen Anlagen in Böden und Wässern

This European Standard was approved by CEN on 28 July 2019.

CEN 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 CEN-CENELEC Management Centre or to any CEN 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 CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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

Ref. No. EN 12954:2019 E

Contents

Page

European foreword ... 4
Introduction ... 5
1 Scope ... 6
2 Normative references ... 6
3 Terms and definitions ... 7
4 Abbreviations and symbols ... 13
5 Cathodic protection personnel competence ... 13
6 Principles and criteria of cathodic protection ... 14
6.1 Principles of cathodic protection ... 14
6.2 Cathodic protection criteria ... 14
Table 1 — Free corrosion potentials, protection potentials and limiting critical potentials of common metallic materials in soils and waters (except seawater and brackish water) measured against CSE ... 15
6.3 Alternative method ... 16
6.3.1 100 mV cathodic potential shift ... 16
6.3.2 Other methods ... 17
6.4 Criteria in presence of a.c ... 17
7 Prerequisites for application of cathodic protection ... 17
7.1 General ... 17
7.2 Electrical continuity ... 17
7.3 Electrical isolation ... 17
7.4 External coating ... 18
8 Useful data and design considerations ... 18
8.1 General ... 18
8.2 Structure details ... 19
8.3 Service conditions ... 19
9 Design ... 20
9.1 General ... 20
9.2 Design lifetime ... 20
9.3 Adjacent structures and external electrical sources ... 20
9.4 Electrical continuity/discontinuity ... 20
9.5 Protective coatings ... 21
9.6 Current demand ... 21
9.7 Galvanic anode systems ... 22
9.7.1 General considerations ... 22
9.7.2 Utilization of galvanic anode systems ... 22
9.7.3 Design of a galvanic anode system ... 22
9.7.4 Technical considerations and data for the design of a galvanic protection system ... 23
Table 2 — Typical chemical compositions of the alloys used for zinc anodes ... 24
Table 3 — Typical electrochemical parameters for zinc anodes used in soils ... 25
Table 4 — Typical chemical compositions of the alloys used for magnesium anodes ... 25

Table 5 — Typical electrochemical parameters for magnesium anodes used in soils 26
Figure 1 — Current capacity of magnesium alloy versus current density [9] 27
9.8 A.C. and/or d.c. decoupling devices 28
9.9 Impressed current cathodic protection (ICCP) system 28
9.10 Monitoring 29
9.11 Cable 29
9.12 Impressed current groundbeds 30
10 Installation of cathodic protection systems 31
11 Commissioning 31
11.1 General 31
11.2 Preliminary checking 31
11.3 Start-up 32
11.4 Assessment of the cathodic protection effectiveness 32
11.5 Documentations 33
12 Monitoring, inspection and maintenance 33
12.1 General 33
12.2 Monitoring 34
12.3 Inspection 35
12.4 Maintenance 35
Annex A (informative) Corrosion likelihood in soils 36
Annex B (informative) Reduction of the corrosion rate by using a 100 mV cathodic polarization — 100 mV cathodic potential shift 38
B.1 Measurement method during polarization 38
Figure B.1 — Polarization formation method 38
B.2 Measurement method during depolarization 39
Figure B.2 — Polarization decay method 39
Bibliography 40

European foreword

This document (EN 12954:2019) has been prepared by Technical Committee CEN/TC 219 “Cathodic protection”, the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by February 2020, and conflicting national standards shall be withdrawn at the latest by February 2020.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 12954:2001.

This document describes general principles for applying external cathodic protection on onshore metallic structures in contact with soils, fresh surface waters or underground waters, except those which are embedded in concrete and those which are in sea-waters or brackish waters.

This edition of EN 12954 does not cover specific applications for on-land pipelines.

NOTE On-land pipeline applications is now completely covered by EN ISO 15589-1 [1].

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

Cathodic protection is a technique based on the application of electrochemical principles. It is achieved by the supply of sufficient direct current to the external surface, such that the metallic structure-to-electrolyte potential is shifted to more negative values where external corrosion becomes insignificant. Cathodic protection covers a wide range of materials and equipment and requires a variety of measurement techniques.

This document is applicable to the protection of external surfaces of all types of buried or immersed metallic structures. However, in order to allow for structures having specific features with regards to shape, use, detailed configuration, construction, commissioning or operation, provision has been made for complementary standards to be used in conjunction with this one to deal with the peculiarities of such structures.

To achieve effective cathodic protection design installation, commissioning, inspection and maintenance it is essential that the works are performed by competent personnel.

This document specifies conditions necessary to consider cathodic protection as an efficient method which can be applied to mitigate corrosion. It is normally used in combination with a coating.

Alternative solutions to those provided in this standard may be applied if it is demonstrated that they give equivalent effectiveness and they are well documented.

1 Scope

This document describes the general principles for the implementation and management of a system of cathodic protection against corrosive attacks on structures which are buried or in contact with soils, surface fresh waters or underground waters, with and without the interference of external electrical sources. It specifies the protection criteria to be achieved to demonstrate the cathodic protection effectiveness.

For structures that cannot be electrically isolated from neighbouring influencing structures, it may be impossible to use the criteria defined in the present document. In this case, EN 14505 will be applied (see 9.4 “Electrical continuity/discontinuity”).

NOTE To assist in forming a decision whether or not to apply cathodic protection the corrosion likelihood can be evaluated using informative Annex A which summarizes the requirements of EN 12501-1 [2] and EN 12501-2 [3].

Cathodic protection of structures immersed in seawater or brackish waters is covered by EN 12473 and a series of standards more specific for various applications.

Cathodic protection for reinforced concrete structures is covered by EN ISO 12696.

This document is applicable in conjunction with:

— EN ISO 15589-1 for application for buried or immersed cathodically protected pipelines,

— EN 50162 to manage d.c. stray currents,

— EN ISO 18086 to manage corrosion due to a.c. interference from high voltage power sources and a.c. traction systems,

— EN 13509 for cathodic protection measurement techniques

— EN 50443 to manage protection for touch and step voltage.

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 12496, *Galvanic anodes for cathodic protection in seawater and saline mud*

EN 13509, *Cathodic protection measurement techniques*

EN 14505, *Cathodic protection of complex structures*

EN 50162, *Protection against corrosion by stray current from direct current systems*

EN 60079-10-1, *Explosive atmospheres – Part 10-1: Classification of areas - Explosive gas atmospheres (IEC 60079-10-1)*

EN ISO 8044, *Corrosion of metals and alloys - Basic terms and definitions (ISO 8044)*

EN ISO 15257, *Cathodic protection - Competence levels of cathodic protection persons - Basis for certification scheme (ISO 15257)*

EN ISO 18086, *Corrosion of metals and alloys - Determination of AC corrosion - Protection criteria (ISO 18086)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN ISO 8044 and the following apply.

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

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
anaerobic conditions
lack of free oxygen in the electrolyte adjacent to a metallic structure

3.2
anode backfill
added material immediately surrounding a buried anode

3.3
electrical bond
metal conductor, usually copper, connecting two points on the same structure or on different structures

3.4
cathodic protection system
all active and passive components associated with the provision of active external corrosion protection and its monitoring

Note 1 to entry: Cathodic protection is provided either by impressed current or by galvanic anodes using one or more stations.

Note 2 to entry: Impressed current and galvanic anode systems consist of all the equipment necessary for the application of cathodic protection, such as impressed current stations, galvanic anodes, electrical bonds and isolating joints.

3.5
coating breakdown factor
fc
ratio of current density required to polarize a coated steel surface as compared to a bare steel surface

3.6
average coating resistance
average structure to soil resistance
r_{co}
value derived from the ratio of the difference between the ON and OFF potentials to the protection current and the surface area of the structure in question

Note 1 to entry: It is usually expressed in $\Omega.m^2$.

Note 2 to entry: It is mainly determined by the size and number of coating defects, coating porosity and the electrolyte resistivity.

3.7
complex structure
structure composed of the structure to be protected and of one or more foreign electrodes, which, for safety or technical reason, are not electrically separated from it

3.8
copper/saturated copper sulphate reference electrode
CSE
reference electrode consisting of piece of copper in a saturated solution of copper sulphate

3.9
coupon
representative metal sample with known bare surface area dimensions

Note 1 to entry: A coupon can be electrically connected to the structure.

3.10
d.c. decoupling device
equipment that provides a low-impedance path for a.c. and high resistance for d.c

Note 1 to entry: Polarization cells, capacitors or diodes assemblies are examples.

3.11
depolarization
anodic change of potential of a cathodically polarized electrode after disconnection or loss of the cathodic protection source

3.12
design current
maximum current necessary to protect a structure for the lifetime of a cathodic protection system

Note 1 to entry: This current can be the result of calculation or test (on existing structure). It can be affected by a design allowance (according to laying conditions, ageing of coating, environmental conditions, operating conditions…).

3.13
drainage
electrical drainage
transfer of stray current from the affected structure to its source by mean of a deliberate electrical bond

Note 1 to entry: For drainage devices (direct drainage bond, resistance drainage bond, unidirectional drainage bond and forced drainage bond) see EN 50162.

3.14
drainage station
equipment and materials required to provide drainage of stray currents from affected systems

3.15
driving voltage
difference between the structure/electrolyte potential and the anode/electrolyte potential when the cathodic protection is operating

3.16
earthing system
arrangement of connections and devices necessary to earth equipment or a system separately or jointly

3.17
electrical continuity
physical state of a structure such that a current circulating within it does not produce a significant voltage drop

3.18
electrical isolation
lack of electrical continuity between structures or components

3.19
foreign structure
foreign electrode
metallic structure or electrode (anode or cathode), in contact with the structure under consideration

Note 1 to entry: A foreign anode is a foreign electrode, which has a more negative potential than the structure, a foreign cathode is a foreign electrode, which has a more positive potential than the structure.

3.20
galvanic anode
electrode that provides current for cathodic protection by means of galvanic action

3.21
groundbed
system of buried or immersed galvanic or impressed current anodes

3.22
holiday
defect in a protective coating at which metal is exposed to the environment

3.23
immersed structure
metal construction, or part of a construction laid in a liquid environment such as fresh water (rivers, lakes)

3.24
impressed current anode
electrode that supplies current for cathodic protection by means of an impressed current source

3.25
impressed current station
station which comprises the equipment and materials required to provide cathodic protection by impressed current

Note 1 to entry: Such materials and equipment include impressed current anodes, cables, one or several d.c. sources (e.g. transformer rectifier) and tests facilities.

3.26
insulated flanges
flanged joint between adjacent lengths of pipe in which the nuts and bolts are electrically insulated from the flange(s) and the gasket is non-conducting, so that there is an electrical discontinuity in the structure (e.g. pipeline, piping system) at that point

3.27
interference
phenomenon resulting from conductive, capacitive, or inductive coupling between a structure and a foreign d.c. or a.c. electrical source or between two structures, and which can cause malfunction, dangerous voltage, damage, etc

Note 1 to entry: Capacitive and inductive coupling are related to a.c. interference.

3.28
interference test
test to determine the electrical interaction between two structures

3.29
IR drop
voltage, due to any current, developed in any part of the circuit, such as the electrolyte (typically soil), in accordance with Ohm's Law

Note 1 to entry: In this standard, when IR Drop is discussed, it is mainly the one present in the electrolyte (typically soil), between the reference electrode and the metal of the structure.

Note 2 to entry: IR drops in the electrolyte can affect the accuracy of the structure-to-electrolyte potential.

3.30
IR free potential
$E_{\text{IR free}}$
structure-to-electrolyte potential measured without the voltage error caused by the IR drop due to the protection current or any other current

3.31
isolating joint
electrically-insulating component between two parts of a structure, in order to provide electrical discontinuity between them

EXAMPLE Monobloc/monolithic isolating joint, insulated flange, isolating coupling.

3.32
limiting critical potential
IR free potential below which there is a risk of detrimental effect on the protected material

3.33
OFF-potential
***E*$_{OFF}$**
structure-to-electrolyte potential measured immediately after synchronous interruption of all sources of applied cathodic protection current and before significant depolarization of the structure

Note 1 to entry: E_{OFF} can be misleading in presence of d.c. or a.c. interference.

3.34
ON-potential
***E*$_{ON}$**
structure-to-electrolyte potential measured with the cathodic protection current and/or any other current flowing

3.35
polarization
electrode polarization
change in the structure-to-electrolyte potential as the result of current flow to or from that structure

3.36
protected structure
structure to which cathodic protection is applied

3.37
protection current
current made to flow onto a metallic structure from its electrolytic environment in order to effect cathodic protection of the structure

3.38
protection potential
structure-to-electrolyte potential at which the metal corrosion rate is acceptable for the structure

3.39
remote earth
part of the electrolyte in which no noticeable voltage, caused by current flow, occur between any two points

Note 1 to entry: This situation generally prevails outside the zone of influence of an earth electrode, an earthing system, an impressed current groundbed or a protected structure.

3.40
remote monitoring
measurement made using telecommunication systems for transmission of data

Note 1 to entry: It can include an automatic reporting system when pre-set upper and lower limits are exceeded.

3.41
standard hydrogen electrode
reference electrode, used as a standard in laboratories, consisting of an inert metal, such as platinum, in an electrolyte containing hydrogen ions at unit activity and saturated with hydrogen gas at one standard atmosphere