SLOVENSKI STANDARD
SIST-TS CEN/TS 15280:2006

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Vrednotenje verjetnosti nastanka korozije vkopanih cevovodov – Uporaba pri katodno zaščitenih cevovodih

Evaluation of a.c. corrosion likelihood of buried pipelines - Application to cathodically protected pipelines

Beurteilung der Korrosionswahrscheinlichkeit durch Wechselstrom an erdverlegten Rohrleitungen - Anwendung für kathodisch geschützte Rohrleitungen

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Evaluation du risque de corrosion des canalisations enterrées occasionné par les courants alternatifs - Application aux canalisations protégées cathodiquement

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Ta slovenski standard je istoveten z: **CEN/TS 15280:2006**

ICS:

23.040.01	Deli cevovodov in cevovodi na splošno	Pipeline components and pipelines in general
77.060	Korozija kovin	Corrosion of metals

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2003-01.Slovenski inštitut za standardizacijo. Razmnoževanje celote ali delov tega standarda ni dovoljeno.

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TECHNICAL SPECIFICATION

SPÉCIFICATION TECHNIQUE

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CEN/TS 15280

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ICS 23.040.99; 77.060

English Version

Evaluation of a.c. corrosion likelihood of buried pipelines - Application to cathodically protected pipelines

Evaluation du risque de corrosion des canalisations enterrées occasionné par les courants alternatifs - Application pour les canalisations protégées cathodiquement

Beurteilung der Korrosionswahrscheinlichkeit durch Wechselstrom an erdverlegten Rohrleitungen - Anwendung für kathodisch geschützte Rohrleitungen

This Technical Specification (CEN/TS) was approved by CEN on 8 November 2005 for provisional application.

The period of validity of this CEN/TS is limited initially to three years. After two years the members of CEN will be requested to submit their comments, particularly on the question whether the CEN/TS can be converted into a European Standard.

CEN members are required to announce the existence of this CEN/TS in the same way as for an EN and to make the CEN/TS available promptly at national level in an appropriate form. It is permissible to keep conflicting national standards in force (in parallel to the CEN/TS) until the final decision about the possible conversion of the CEN/TS into an EN is reached.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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Foreword

This Technical Specification (CEN/TS 15280:2006) has been prepared by Technical Committee CEN/TC 219 “Cathodic Protection”, the secretariat of which is held by BSI.

Long term a.c. interference on buried metallic pipelines may cause corrosion due to an exchange of alternating current between the soil and the bare metal at unavoidable coating faults in the structure.

a.c. corrosion is more likely on pipelines which are not cathodically protected. To reduce it, it is advisable to consider the application of cathodic protection and to follow the present Technical Specification.

Danger to people in contact with the pipeline or connected equipment, malfunction of connected equipment and other damages to the pipeline or connected equipment are dealt with in relevant CENELEC standards.

This Technical Specification refers to EN 12954 and may be used in place of its Annex A.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to announce this CEN Technical Specification: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

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1 Scope

This Technical Specification is applicable to buried cathodically protected metallic structures and influenced by a.c. traction systems and/or a.c. power lines.

In this document, a buried pipeline (or structure) is intended as buried or immersed pipeline (or structure), as defined in the Standard EN 12954.

In the presence of a.c. interference, the criteria given in EN 12954, Table 1, are not sufficient to demonstrate that the steel is being protected against corrosion.

This Technical Specification provides limits, measurements procedures and information to deal with long term a.c. interference and the evaluation of a.c. corrosion likelihood.

Even though short term interference can cause damages to buried pipelines (e.g. arc fusion), this standard does not deal with short term interference.

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 13509:2003, *Cathodic protection measurement techniques*

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

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3 Terms and definitions

For the purposes of this Technical Specification, the following terms and definitions apply

3.1
a.c. traction system
an a.c. electrical system of a railway, i.e. the electric train units and their feeding and return systems

NOTE The lines used to feed the railway substations (three-phase lines or, sometimes, two-phase lines in case of 16,7 Hz systems) are a.c. power supply systems, and it is suggested to take them into consideration together with the a.c. traction system.

3.2
cathodic protection system
the entire installation, including active and passive elements, that provides cathodic protection

(See EN 12954:2001 clause 3.2.9)

NOTE It includes for example the following: cathodic protection stations and relevant accessories as remote control systems, drainages, insulating joints, resistors, diodes, test points, groundings, a.c. discharge / d.c. decoupling devices etc.

3.3
incubation time
period of time before the leakage resistance of exposed metal, at coating faults or coupons, stabilizes due to electrochemical reactions

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3.4
instantaneous measurement
reading of electrical parameters by an operator

3.5
leakage resistance
local resistance to earth of metal exposed to the environment

3.6
long term a.c. interference
interference on a pipeline during normal operating conditions of a.c. power systems (e.g. traction systems or electricity power lines)

3.7
long term measurements
measurements of electrical parameters taken by an operator having a duration of more than 1 hour using equipment to store the data

3.8
reference electrical status
electrical status to be used as a reference in subsequent cathodic protection measurements and checks which conform to protection requirements

NOTE The “electrical status” refers to a well defined cathodic protection system and its electrical configuration

3.9
remote monitoring
supervision of the state of operational equipment by means of telecommunication techniques

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3.10
selected test point
test point which allows comparison of present and past parameters to be recorded in the reference electric status where a cathodic protection system still maintains its efficiency and effectiveness

3.11
short term a.c. interference
interference on a pipeline during a fault condition of a.c. traction systems or electricity power lines

3.12
short measurements
measurements of electrical parameters taken by an operator having a duration of about 5 min using equipment to store the data

4 A. c. interference sources

Main long term a. c. interfering sources on buried metallic pipelines are:

- a.c. overhead or underground power lines;
- a.c. traction systems (usually fed by a parallel high voltage feeding line which may be 50 Hz or 16,7Hz).

Long term a.c. interference on a buried pipeline may cause corrosion due to an exchange of a.c. current between the exposed metal of the pipeline and the surrounding electrolyte.

This exchange of current depends on a.c. voltage whose amplitude is related to various parameters such as:

- the configuration of a.c. power line phase conductors and shield wires;

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- the distance between the a.c. power line / traction system and the pipeline;
- the current flowing in the a.c. power line / traction system phase conductors;
- the average coating resistance of the pipeline (Ω.m²);
- the thickness of the coating;
- the soil resistivity.

5 Simplified description of a.c. corrosion process

The cathodic protection of pipelines forces current to enter the pipeline through the metal surface in contact with soil where the coating is damaged. This current prevents corrosion from taking place.

The corrosion reaction is associated with a current leaving the metal surface.

When an a.c. voltage is present on the cathodically protected pipeline, current will flow through the metal surface at defects in the coating. This current depends on the impedance of the system. During the positive half wave of the a.c. voltage, the current will leave the metal surface if the a.c. voltage is sufficiently large.

The current leaving the metal surface can cause charging of the double layer capacitance, oxidation of hydrogen and reduced corrosion products due to the cathodic protection, and oxidation of the pipeline. Since the current leaving the metal surface is consumed by several non-corrosive processes, generally higher voltages than between 4V and 10 V are required to result in a significant corrosion attack on the pipeline. Various additional parameters influence this process, such as leakage resistance of the defect, soil composition, cathodic protection level etc.

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The processes taking place are schematically illustrated in Figure 1. During the positive half wave the bare metal surface is oxidized resulting in the formation of a passive film. This is due to the current that leaves the metal surface. During the negative half wave, when the current enters the metal surface this passive film is reduced to iron hydroxide. In the following anodic cycle a new passive film grows. Upon reduction of the passive film the amount of iron hydroxide is increased. Hence every a.c. cycle results in some oxidation of the metal. In the long term this can result in a significant metal loss.

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For comparison, the situation without a.c. interference is shown in Figure 2 In this case no metal loss is observed, since the current always enters the metal surface.

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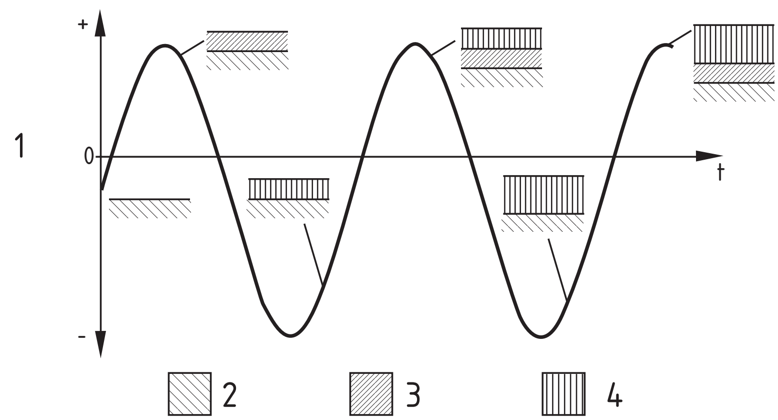

key

1 Current
2 Metal
3 Passive film (eg. $Fe_3 O_4$)
4 Iron hydroxide (eg. $Fe(OH)_2$)
t Time

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Figure 1 - Graph of cathodic protection current with a.c. influence - Schematic description of the a.c. corrosion process with cathodic protection

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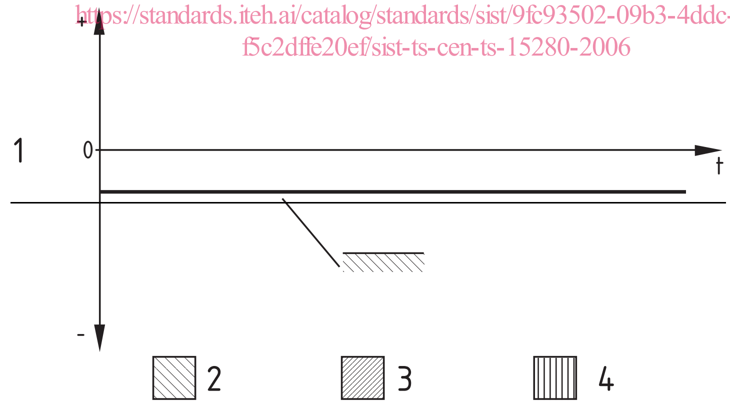

Key

1 Current
2 Metal
3 Passive film (eg. $Fe_3 O_4$)
4 Iron hydroxide (eg. $Fe(OH)_2$)
t Time

Figure 2 – Graph of cathodic protection current without a.c. influence

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6 Evaluation of a.c. corrosion likelihood

6.1 Prerequisite

The a.c. voltage on a pipeline is considered as the most important parameter to be taken into account when evaluating the adversely influences by a.c. system.

Therefore, before beginning any evaluation of the a.c. corrosion likelihood, the a.c. voltage of the pipeline should be lowered if necessary, according to 6.4.4.

6.2 General

The factors which mainly influence the a.c. corrosion phenomena are:

- induced a.c. voltage;
- a.c. current density on the exposed metal;
- d.c. polarisation;
- size of coating faults;
- local soil resistivity;
- local soil chemical composition.

The corrosion likelihood due to a.c. voltage can be evaluated by taking into account different factors which are generally used in conjunction, such as:

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- a.c. voltage on the structure; (See 6.4)
- pipe to soil off potential; (See 6.5)
- a.c. current density; (See 6.6)
- On potential; (See 6.7)
- a.c./d.c. current ratio; (See 6.8)
- soil characteristics; (See 6.9)
- corrosion condition of coupons. (See 6.10)

Other techniques are available to evaluate corrosion. Some of these techniques are described in the annexes A and B.

In the following, the conditions for evaluating the likelihood of corrosion, either by measurements or by calculation, are clarified.

For existing pipelines, measuring procedures are also suggested.

Routine direct short measurements on pipelines rarely reflect worst case conditions while calculation gives more reliable information on the a.c. interference.

For this purpose, measurements shall be related to worst established conditions during normal operation of interfering systems.

As a first approach, the general evaluation of the likelihood of a.c. corrosion can be by measurement of the a.c. voltage of the structure (see 6.4).

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To evaluate the different factors influencing the a.c. corrosion, the use of coupons is necessary (see EN 13509:2003 Clause 4, and EN 12954). For coupons, an incubation time has to be considered when evaluating measurement results.

The evaluation of more than one factor is necessary to better assess the a.c. corrosion likelihood. The more factors considered, the better the assessment.

6.3 Installation / use of coupons

Due to the fact that many electrical and electrochemical parameters cannot be measured directly on the pipeline itself, the use of coupons is particularly recommended for evaluating the likelihood of a.c. corrosion.

A.c. corrosion coupons are usually made of a steel plate having a known bare surface area (preferably 1 cm^2 round), simulating a coating fault. They are buried close to the pipeline and connected to it through a test post.

These coupons can either be used for measuring and/or for verifying local protection conditions. In this last option, three coupons may be installed at the same place (it is recommended to keep at least one meter between each coupon). The coupons should be excavated at the same time for the purpose of statistical examination.

Coupons have to be used where the worst conditions have been found in accordance with the calculation or the measurement described in 7.2.

A reference electrode can either be used during the measurement or permanently installed.

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6.4 Influence of a.c. voltage on the structure

6.4.1 General

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The a.c. voltage on a structure subjected to interference by a.c. systems should be considered as the most important parameter to be taken into account when evaluating the likelihood of corrosion on buried pipelines.

The a.c. voltage on a structure subjected to interference by a.c. systems can either be calculated or directly measured on the structure itself. To evaluate if a calculation or measurements are needed, see 6.4.2.

6.4.2 Voltage calculation

People's safety and the malfunction of apparatus should be calculated in accordance with CIGRE Technical Brochure N°95 published in 1995 "Guide on the Influence of High Voltage A.C. Power Systems on Metallic Pipelines".

The same algorithms can be used to calculate the pipeline a.c. voltage by taking into account the worst case under normal operating conditions of the interfering systems.

The limits indicated in 6.4.4 apply.

6.4.3 A.c. voltage measurements

6.4.3.1 General

A.c. interference can be determined by measurement of the a.c. voltage on the pipeline.

While taking measurements on an existing pipeline, the following should be taken into account:

- high voltage power line; variations during time, according to the charge;