

Cathodic protection of submarine pipelines

The European Standard EN 12474:2001 has the status of a
British Standard

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National foreword

This British Standard is the official English language version of EN 12474:2001.

Attention is drawn to the fact that BS 7361-1:1991, *Cathodic protection — Part 1: Code of practice for land and marine applications*, provides general information on cathodic protection. Note that BS 7361-1:1991 will eventually be withdrawn when all the CEN standards relating to cathodic protection currently being prepared are published.

The UK participation in its preparation was entrusted to Technical Committee GEL/603, Cathodic protection which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled “International Standards Correspondence Index”, or by using the “Find” facility of the BSI Standards Electronic Catalogue.

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This British Standard, having been prepared under the direction of the Electrotechnical Sector Policy and Strategy Committee, was published under the authority of the Standards Policy and Strategy Committee on 25 October 2001

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Cathodic protection of submarine pipelines

Protection cathodique des canalisations sous marines

Katodischer Korrosionsschutz für unterseeische
Rohrleitungen

This European Standard was approved by CEN on 7 March 2001.

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 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 Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.



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Foreword

This European Standard 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 October 2001, and conflicting national standards shall be withdrawn at the latest by October 2001.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

Cathodic protection, together with a corrosion protection coating, is usually applied to protect the external surface of submarine pipelines from corrosion due to sea water or saline mud.

The corrosion protection coating is applied on the external surface of the pipeline to insulate the steel surface from the aggressive environment into which the pipeline is surrounded.

The cathodic protection ensures the protection of the areas of the pipeline which are directly exposed to the aggressive marine environment due to damage or defects in the coating.

The cathodic protection supplies sufficient direct current to the external surfaces of the pipeline to reduce the pipe to electrolyte potential to values where there is insignificant corrosion.

The general principles of cathodic protection are detailed in EN 12473.

1 Scope

This European Standard establishes the general criteria and recommendations for the design, installation, monitoring and commissioning of the cathodic protection systems for submarine pipelines.

This standard is applicable to all grades of carbon manganese steel and to stainless steel pipelines; it covers all types of sea water and seabed environments encountered in submerged conditions.

The cathodic protection of short lengths of submarine pipelines and their branches, which are directly connected to cathodically protected onshore pipelines, are outside of the scope of this standard (see EN 12954:2001).

The cathodic protection of risers is included in this standard only if they are insulated from the supporting structure. The cathodic protection of the risers in direct electrical contact with the supporting structure is included in EN 12495.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 12473:2000, *General principles of cathodic protection in sea water*.

EN 12495, *Cathodic protection for fixed steel offshore structures*.

prEN 12496:1996, *Sacrificial anodes for cathodic protection in sea water*.

EN 12954:2001, *Cathodic protection of buried or immersed metallic structures - General principles*.

EN ISO 8044, *Corrosion of metals and alloys – Basic terms and definitions (ISO 8044:1999)*.

3 Terms and definitions

For the purposes of this European Standard the terms and definitions in EN ISO 8044 and the following apply:

3.1

weight coating

coating usually made of steel wire reinforced concrete, applied to the pipes to provide anti-buoyancy and/or mechanical protection of the pipeline

3.2

remotely operated vehicle (R.O.V.)

unmanned submarine vehicle operated by a surface vessel and used for inspection and survey of the pipeline

3.3

"J" tube

curved tubular conduit designed and installed on a structure to support and guide one or more pipeline risers or cables

3.4

riser

vertical or near vertical portion of an offshore pipeline which connects the platform piping to the pipeline at or below the sea bed

4 Criteria and principles for cathodic protection design

4.1 Protective criteria

4.1.1 Protective potentials

To achieve adequate cathodic protection a submarine pipeline should have the protective potentials indicated in the following table. These potentials apply to saline mud and normal sea water compositions (salinity 32 ‰ to 38 ‰).

Table 1 — Summary of potential versus silver/silver chloride/sea water reference electrode recommended for the cathodic protection of steel materials in sea water

Material	Minimum negative potential volt	Maximum negative potential volt
Iron and steel		
aerobic environment	-0,80	-1,10
anaerobic environment	-0,90	-1,10
Stainless steel		
Austenitic steel		
- (PREN ≥ 40)	-0,30	no limit
- (PREN < 40)	-0,60 (see note 1)	no limit
Duplex	-0,60 (see note 1)	(see note 2)
NOTE 1 For most applications these potentials are adequate for the protection of crevices although more negative potentials may be considered.		
NOTE 2 Depending on metallurgical structure these alloys may be susceptible to cracking and more negative potentials should be avoided (in accordance with 8.3.2.2 of EN 12473:2000).		

4.1.2 Reference electrodes

The following types of reference electrodes may be used to measure the potential between the pipeline surface and sea water:

- silver-silver chloride/seawater (Ag/AgCl/sea water);

- high purity zinc (99,9 % min. of zinc with iron content not exceeding 0,0014 %)/sea water;
- anode zinc alloy/seawater;
- saturated KCl calomel ($\text{Hg}/\text{HgCl}_2/\text{KCl}$ saturated) for reference electrode calibration purposes only.

4.2 Corrosion protection coating

A corrosion protection coating is normally applied to a submarine pipeline in conjunction with cathodic protection to control external corrosion. The coating reduces the current required to achieve effective cathodic protection and enhances the distribution of the cathodic protection current over the pipeline surface (see table A.3).

4.3 Basic parameters

The following should be taken into consideration when designing a cathodic protection system:

- characteristics of the submarine pipeline to be protected, such as diameter, wall thickness, length, route, laying conditions on the sea bottom, temperature profile along its whole length, type and thickness of corrosion protection coating(s) for pipes and fittings, presence, type and thickness of thermal insulation, mechanical protection, and/or weight coating;
- existing or proposed installations (pipelines, platforms etc.) in close proximity to or crossing of the pipeline route;
- the requirement for electrical isolation from adjoining steel structures, platform, onshore pipelines etc.;
- presence of "J" tubes, risers and clamps;
- environmental conditions;
- design life of the pipeline;
- pipeline lay method;
- protection criteria;
- offshore site i.e. accessibility for repair and replacement;
- performance data of cathodic protection systems in the same environment site;
- availability of electric power;
- safety requirements;
- applicable codes;
- risk assessment.

4.4 Environmental parameters

The following environmental parameters should be evaluated through field measurements if experience from the area is limited.

- temperature;
- sea water and mud resistivity;
- sea water velocity;
- pH;
- water pressure (depth) along the route;

- presence and quantity of H₂S producing bacteria (e.g. SRB);
- water composition with particular reference to the oxygen content;
- presence of stray and/or telluric currents in the area (see 10.2).

4.5 Protective current density

One of the main parameters to be defined in the design of the cathodic protection system for a submarine pipeline is the current density required to protect the steel surface of the pipeline throughout all its design life.

Three values of current density are significant. The initial, maintenance and repolarization values which refer respectively to the current density required to polarize the pipeline within a reasonable time period (i.e. 1 to 2 months) the current density necessary to maintain the polarization and the current density necessary for an eventual repolarization which may occur for example after an heavy storm.

The selection of the design current densities may be based on experience from similar pipelines in the same environment or on field measurements carried out in the same area.

Due consideration should be given to the following:

- the current density demand is normally not constant with time; for bare steel areas of pipelines in seawater or the seabed the current density requirements may decrease due to the formation of calcareous deposits caused by the cathodic current;
- for coated areas of pipelines the current requirements may increase with time as the coating deteriorates.

Guidelines on the design current densities are given in annex A.

4.6 Selection of the cathodic protection system

Either sacrificial anode and/or impressed current cathodic protection system may be used to protect a submarine pipeline.

The selection between the two systems should be based on the following considerations:

- the impressed current system may only protect a finite length of pipeline, determined by the following:
 - practical limitations on the locations for impressed current system installations, e.g. the ends of the pipeline and intermediate platforms or landfalls,
 - the value of the insulation resistance of the coated pipeline versus the surrounding electrolyte at the end of its design service life (see annex C),
 - the longitudinal resistance of the pipeline (see annex C);
- the lack of a source of external power may preclude the use of impressed current systems;
- sacrificial anode systems do not require any operation control or maintenance during the service life of the pipeline;
- sacrificial anode systems seldom cause serious interaction problems on foreign neighbouring structures, whereas impressed current system may have a significant effect.

4.7 Electrical isolation

Electrical isolation between a submarine pipeline and other steel structures to which the pipeline is mechanically connected may be used in order to improve or verify the effectiveness of the relevant cathodic protection system.

Cases where insulating devices may be used are as follows:

- between the offshore and the onshore sections of the same pipeline;