DRAFT INTERNATIONAL STANDARD ISO/DIS 12495

Attributed to ISO/TC **156** by the Central Secretariat (see page iii)

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2005-09-05

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

FAST-TRACK PROCEDURE

Cathodic protection for fixed steel offshore structures

Protection cathodique des structures en acier fixes en mer

ICS 47.020.99; 77.060

THIS DOCUMENT IS A DRAFT CIRCULATED FOR COMMENT AND APPROVAL. IT IS THEREFORE SUBJECT TO CHANGE AND MAY NOT BE REFERRED TO AS AN INTERNATIONAL STANDARD UNTIL PUBLISHED AS SUCH.

IN ADDITION TO THEIR EVALUATION AS BEING ACCEPTABLE FOR INDUSTRIAL, TECHNOLOGICAL, COMMERCIAL AND USER PURPOSES, DRAFT INTERNATIONAL STANDARDS MAY ON OCCASION HAVE TO BE CONSIDERED IN THE LIGHT OF THEIR POTENTIAL TO BECOME STANDARDS TO WHICH REFERENCE MAY BE MADE IN NATIONAL REGULATIONS.

NOTE FROM THE ISO CENTRAL SECRETARIAT

This draft International Standard is submitted for voting to ISO member bodies under the fast-track procedure.

Technical Committee ISO/TC 156, *Corrosion of metals and alloys*, at its meeting held in May 2004, decided to approve the submission of the standard EN 12495:2000, *Cathodic protection for fixed steel offshore structures*, for processing under the “Fast-track procedure”, in accordance with the provisions of Clause F.2, Annex F, of the ISO/IEC Directives, Part 1 (fourth edition, 2001).

F.2 “Fast-track procedure”

F.2.1 Proposals to apply the fast-track procedure may be made as follows.

F.2.1.1 Any P-member or category A liaison organization of a concerned technical committee may propose that an **existing standard from any source** be submitted for vote as an enquiry draft. The proposer shall obtain the agreement of the originating organization before making a proposal. The criteria for proposing an existing standard for the fast-track procedure are a matter for each proposer to decide.

F.2.1.2 An international standardizing body recognized by the ISO or IEC council board may propose that a **standard developed by that body** be submitted for vote as a final draft International Standard.

F.2.1.3 An organization having entered into a formal technical agreement with ISO or IEC may propose, in agreement with the appropriate technical committee or subcommittee, that a **draft standard developed by that organization** be submitted for vote as an enquiry draft within that technical committee or subcommittee.

F.2.2 The proposal shall be received by the Chief Executive Officer, who shall take the following actions:

a) settle the copyright and/or trademark situation with the organization having originated the proposed document, so that it can be freely copied and distributed to national bodies without restriction;

b) for cases F.2.1.1 and F.2.1.3, assess in consultation with the relevant secretariats which technical committee/subcommittee is competent for the subject covered by the proposed document; where no technical committee exists competent to deal with the subject of the document in question, the Chief Executive Officer shall refer the proposal to the technical management board, which may request the Chief Executive Officer to submit the document to the enquiry stage and to establish an ad hoc group to deal with matters subsequently arising;

c) ascertain that there is no evident contradiction with other International Standards;

d) distribute the proposed document as an enquiry draft (F.2.1.1 and F.2.1.3) in accordance with 2.6.1, or as a final draft International Standard (case F.2.1.2) in accordance with 2.7.1, indicating (in cases F.2.1.1 and F.2.1.3) the technical committee/subcommittee to the domain of which the proposed document belongs.

F.2.3 The period for voting and the conditions for approval shall be as specified in 2.6 for an enquiry draft and 2.7 for a final draft International Standard. In the case where no technical committee is involved, the condition for approval of a final draft International Standard is that not more than one-quarter of the total number of votes cast are negative.

F.2.4 If, for an enquiry draft, the conditions of approval are met, the draft standard shall progress to the approval stage (2.7). If not, the proposal has failed and any further action shall be decided upon by the technical committee/subcommittee to which the document was attributed in accordance with F.2.2 b).

If, for a final draft International Standard, the conditions of approval are met, the document shall progress to the publication stage (2.8). If not, the proposal has failed and any further action shall be decided upon by the technical committee/subcommittee to which the FDIS was attributed in accordance with F.2.2 b), or by discussion between the originating organization and the office of the CEO if no technical committee was involved.

If the standard is published, its maintenance shall be handled by the technical committee/subcommittee to which the document was attributed in accordance with F.2.2 b), or, if no technical committee was involved, the approval procedure set out above shall be repeated if the originating organization decides that changes to the standard are required.

Contents

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 July 2000, and conflicting national standards shall be withdrawn at the latest by July 2000.

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.

The Annexes A,B,C,D, and E of this European Standard are informative.

Introduction

Cathodic protection, possibly together with protective coating or paint, is usually applied to protect the external surfaces of fixed steel offshore structures and appurtenance from corrosion due to sea water or marine sediments.

The general principles of cathodic protection are detailed in prEN 12473:1999.

The cathodic reaction ensures the protection from corrosion of the submerged areas of the structure and associated appurtenances which are exposed to the marine environment.

Cathodic protection involves the supply of sufficient direct current to the external surface of the structure in order to reduce the steel to electrolyte potential down to values where corrosion is insignificant.

1 Scope

This European Standard defines the means to be used to cathodically protect the submerged areas of fixed steel offshore structures and appurtenances.

1.1 Structural parts

This European Standard defines the requirements for the cathodic protection of fixed structures, including sub sea production and related protective structures whether connected or not to each other by pipelines and/or walkways.

It also covers the submerged areas of appurtenances attached to the structure, when these are electrically connected to the structure.

It does not cover the cathodic protection of floating structures such as ships, semi-submersible units, or elongated structures such as pipelines or cables.

This European Standard concerns only the cathodic protection of external surfaces, in contact with the sea water or with the sea bed. It covers the immersed or buried external surfaces of the jacket, conductor pipes, well casings, piles, J-tubes, production or utility risers, etc.

It does not cover the corrosion protection of the sections of the structure above the sea level : i.e. the splash zone and atmospheric zone.

This standard does not include the internal protection of any components such as jacket members, legs, conductor pipes; the protection of these is often performed using chemicals.

1.2 Materials

This European Standard covers the cathodic protection of bare or coated steels with a specified minimum yield strength (S.M.Y.S.) not exceeding 500 N/mm^2.

1.2.1 Overpolarisation & high strength steels

If the potential of the structure becomes too negative the structure will become overpolarised and this can induce a penetration of hydrogen into the steel wall, resulting in embrittlement of the metal, and subsequently a possible detrimental effect, including propagation of cracks.

As a general indication the higher the tensile properties, the greater is the risk of hydrogen induced damage. However, material hardness and microstructure are also important.

These phenomena can occur on conventional steels used for offshore fixed structures (grade S355 as per EN 10025) at potentials more negative than -1,10 V vs. Ag/AgCl/sea water. Relevant tests should be performed for the use of cathodic protection outside these limits.

1.2.2 Galvanic coupling

Some parts of the structure can be made of metallic materials other than carbon manganese steel. The cathodic protection system should be designed to ensure that there is complete control over any galvanic corrosion arising from this coupling.

1.3 Environment

This European Standard is applicable for the whole submerged zone in any kind of sea water or sea bed.

For surfaces which are alternately immersed and exposed to the atmosphere, the cathodic protection is only effective when the immersion time is sufficiently long for the steel to become polarised. This is the case on about the lowest third part of the tidal zone. A different method of corrosion protection shall be therefore used for the protection of the wetted surface located above this level, i.e. by using a protective coating, cladding, sheathing or increasing the thickness of the structural material.

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 amendement or revision. For undated references the latest edition of the publication referred to applies.

prEN 12473:1999, *General principles of cathodic protection in sea water*.

prEN 12496:1997, S*acrificial anodes for cathodic protection in sea water*

EN 10025, *Hot rolled products of non-alloy structural steels - Technical delivery conditions.*

3 Terms and definitions

For the purpose of this European Standard the terms and definitions in prEN 12473 :1999 and the following apply :

3.1
atmospheric zone
zone located above the splash zone, i.e. above the level reached by the normal swell

3.2
buried zone
zone located under the mud line

3.3
conductor pipe
first installed casing of an offshore well

3.4
doubler plate
plate welded onto a member to locally reinforce it or to isolate it from further welding work

3.5
extended tidal zone
zone including the tidal zone, the splash zone and the transition zone

3.6
H.A.T.
level of the highest astronomical tide

3.7
immersed zone
zone located below the extended tidal zone and above the mud line

3.8
J.tube
curved tubular conduit designed and installed on a structure to support and guide one or more pipeline risers or cables.

3.9
L.A.T.
level of the lowest astronomical tide

3.10
marine sediments
top layer of the sea bed composed of water saturated solid materials of various densities

3.11
M.T.L.
mean tide level (also known as M.S.L. or M.W.L.)

3.12
pile
deep foundation element supporting a fixed offshore structure

3.13
riser
vertical or near vertical portion of an offshore pipeline between the platform piping and the pipeline at or below the seabed, including a length of pipe of at least five pipe diameters beyond the bottom elbow, bend or fitting

3.14
salinity
amount of inorganic salts dissolved in the sea water. The standardised measurement is based on the determination of the electrical conductivity of the sea water. Salinity is expressed in grammes per kilogramme or in ppt

3.15
splash zone
height of the structure which is intermittently wet and dry due to the wave action just above the H.A.T

3.16
submerged zone
zone including the buried zone, the immersed zone and the transition zone

3.17
tidal zone
zone located between the L.A.T. and the H.A.T.

3.18
transition zone
zone located below the L.A.T. and including the possible level inaccuracy of the platform installation and a depth with a usually higher oxygen content due to the normal swell

3.19
well casing
string of steel pipes lowered into oil, gas or water producing wells to shut off water or to prevent the caving in of loose ground

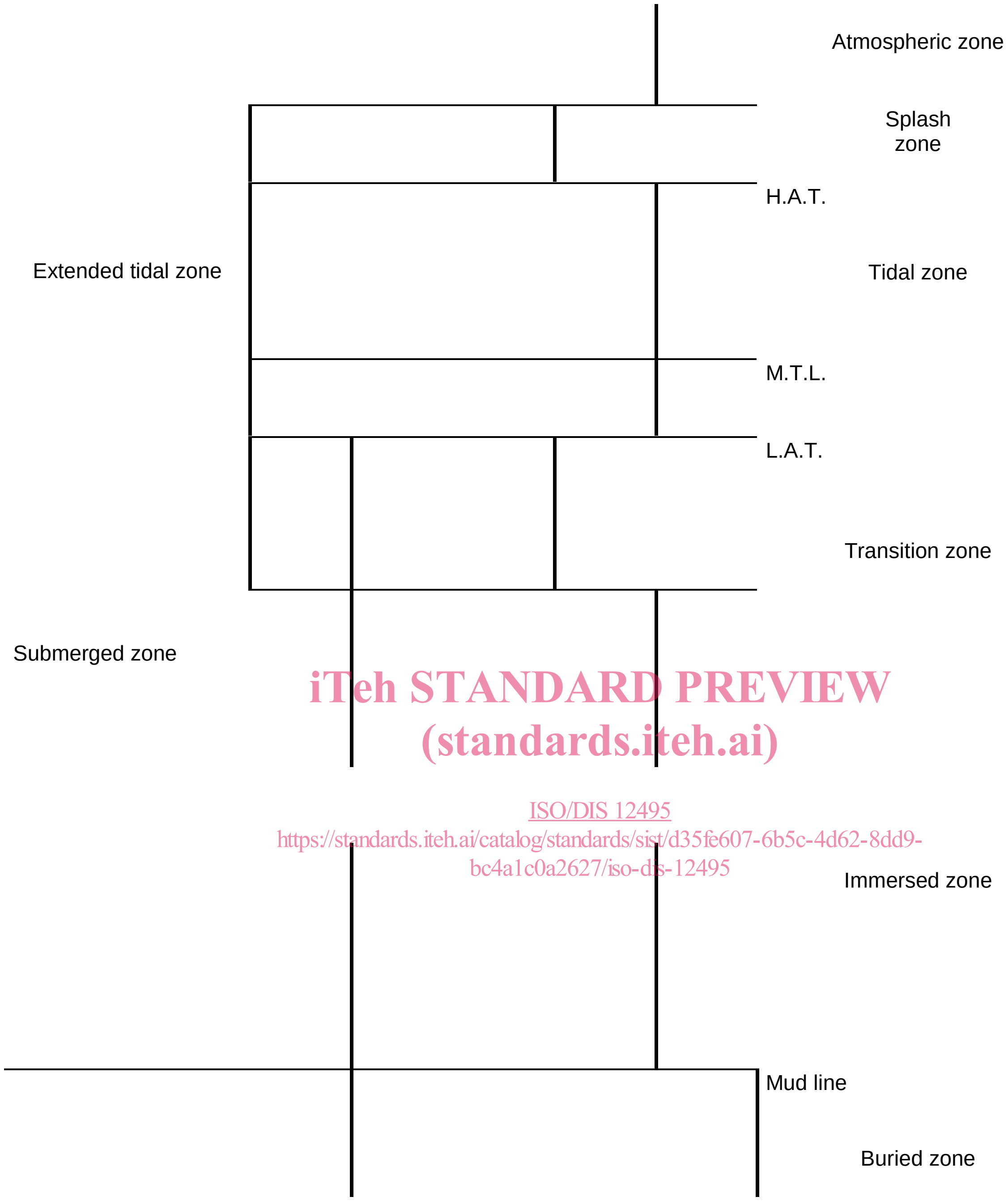

Figure 1 - Schematic representation of levels and zones in sea water environment

4 Design basis

4.1 Objectives

The major objective of a cathodic protection system is to deliver sufficient current to protect each part of the structure and appurtenances and distribute this current so that the steel to sea water potential of each part of the structure is within the limits given by the potential criteria (refer to 4.2).

Potentials should be as homogeneous as possible over the whole structure. This aim may only be approached by an adequate distribution of the anodes over the structure. This is difficult to achieve in some areas such as complex nodes or frames of conductor guides where little room can be allocated for the installation of anodes though large surfaces are to be protected. Therefore consideration should be given at the structure design stage :

- by avoiding complex configurations : i.e. tubular elements are preferred rather than T or H profiles ;
- by reducing the number of ancillary surfaces ;
- by limiting the ratio of steel surfaces over electrolyte volume in congested areas.

A protective coating may be used near anodes where their current output and proximity to the structure may lead to overpolarisation (see 1.2.1).

The cathodic protection system should normally be designed for the life time of the structure.

In order to achieve an appropriate design of the cathodic protection system it should be carried out by a cathodic protection specialist.

4.2 Cathodic protection criteria

The cathodic protection criteria are detailed in prEN 12473:1999.

To achieve an adequate cathodic protection level, steel structures should have protective potentials as indicated in the following table.

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
Carbon / low alloy steels		
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 higher potentials can be considered.

NOTE 2 Depending on metallurgical structure these alloys can be susceptible to cracking and high negative potentials must be avoided (see prEN 12473:1999).

4.3 Electrical current demand

In order to achieve the cathodic protection criteria on the whole structure it is necessary to consider the electrical current demand on each part of the structure.

The electrical current demand of each part of the structure is the product of its steel surface area multiplied by the electrical current density required.

The current density required is not the same for all parts of the structure as the environmental conditions are variable. Therefore, the following areas and parts should be considered, referring to zones as defined in clause 3 :

- areas located in the tidal and transition zones (usually coated or cladded) ;
- areas located in the immersed zone ;
- areas located in the buried zone ;

- wells to be drilled ; a current allowance per well shall be considered, depending on projected sizes, depth and cementing of the wells (see A.4 in annex A) ;

- neighbouring structures and pipelines in electrical contact with the fixed steel offshore structure to be protected.

The selection of design current densities may be based on experiences from similar structures in the same environment or from specific tests and measurements (typical values are given in annex A).

The electrical current density required for cathodic protection depends upon the kinetics of the electrochemical reactions and varies with parameters such as the electrode potential of the steel, the dissolved oxygen content of the sea water, the water flow rate, the temperature, and, possibly, the water depth. Furthermore, the build up of calcareous deposits and the settlement of marine growth modify the surface conditions for the cathodic reactions.

For each particular set of environmental condition and surface condition of the steel (such as rusted, blast cleaned, coated with organic or metallic coating), the following electrical current densities shall be evaluated :

- initial electrical current density required to achieve the initial polarisation of the structure, i.e. to achieve the lowering of the steel potential down to value within the range recommended in table 1;

- maintenance electrical current density required to maintain this polarisation level on the structure ;

- final or repolarisation electrical current density required for a possible repolarisation (i.e. for re-establishing the potential to the initial polarisation level) of the structure after severe storms or cleaning operations.

As the initial polarisation period preceding steady state or maintenance conditions is normally short compared to the design life, the time weighted electrical current density becomes very close to maintenance electrical current density.

A proper evaluation of the current densities required shall be carried out to optimise the cathodic protection system.

Interactions

A platform may be permanently or temporarily connected to other neighbouring structures. These structures should be fitted with their own cathodic protection system which shall be checked before electrically connecting them to the platform considered.

If temporary structures are not fitted with a cathodic protection system or if this is ineffective, the cathodic protection of the platform should be checked to ensure its efficiency during the connection period and the influence of this foreign structure should be evaluated.

4.4 Coatings

The cathodic protection system may be combined with suitable coating systems. The coating reduces the electrical current demand and improves the electrical current distribution on the structure due to its insulating properties.

This reduction of the electrical current demand may be in a ratio of 100 to 1 or even more. However, the current demand of coated steel will increase with time as the coating deteriorates.

An initial coating breakdown factor related mainly to mechanical damage occurring during the installation of the structure should be considered and a coating deterioration rate shall be thereafter evaluated in order to take into account the coating ageing and possible small mechanical damage occurring to the coating during the structure life.

These values are closely dependent on the actual installation conditions and operation conditions.

Guidelines for the values of coating breakdown factors are given in annex A.

The resultant electrical current density needed for the protection of coated steel is therefore equal to the product of the electrical current density for bare steel and the coating breakdown factor.