ISO/FDIS 15589-2

ISO/TC 67/SC 2

~~ISO/FDIS 15589-2:2023(E)~~

~~2023/07/28~~

Secretariat: UNI~~/UNSIDER~~

Date: 2023-10-05

Oil and gas industries including lower carbon energy — Cathodic protection of pipeline transportation systems —

Part 2: Offshore pipelines

~~*Industries du pétrole et du gaz y compris les énergies à faible teneur en carbone — Protection cathodique des systèmes de transport par conduites — Partie 2: Conduites en mer*~~

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~~This~~FDIS stage

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO ~~documents~~document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 67, ~~*Materials, equipment*~~*Oil* and ~~*offshore structures for petroleum, petrochemical and natural*~~ *gas industries* *including lower carbon energy*, Subcommittee SC 2, *Pipeline transportation systems,* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 219, *Cathodic protection,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 15589-2:2012), which has been ~~extensively~~technically revised.

The main changes are as follows:

— in Clause 6~~ — In Clause 6,~~ recommendations for isolating joints have been expanded;

— in Clause 7~~ — Clause 7 Notes on Table 1~~, NOTEs to Table 1 and text in 7.4~~Clause 7.4~~ have been updated to avoid discrepancies with Figure 2~~Figure 2. Coating~~; coating breakdown factors have been revised for errors left in the previous edition and less conservative values for some coating systems have been selected based on feedback from the industry;

— in Clause 8~~ — In Clause 8 Notes~~, NOTEs and guidance on the design of the system have been updated including recommendations for buried pipelines~~. Anode~~; anode utilization factors have been expanded to cover additional anodes types~~.~~;

— in Clause 9— In Clause 9, Table 6, Table 6 has been updated to reflect anode compositions in line with current industry practices and other standards.;

— in Clause 10— In Clause 10,, additional references have been provided for guidance on core dimensions and position as well as testing for quality control of anode electrochemical properties.;

— in Annex A— In Annex A,, additional anode resistance equationsformulae have been provided to cover different anode types.

— Annex B— Annex B has been modified to present the NORSOK method as normative, while thea requirement, with an alternative method been made informativegiven for information.

— Annex C— Annex C has been updated as informative and the test method replaced with references to current test methods in line with current industry practice.

— —The previous Annex E has been removed and replaced by additional guidance on quality control testing of anodes in 10.10Clause 10.10. .

— —In the updated Annex EAnnex E (Interferance) (Interference), additional references for alternating current interference have been added.

A list of all parts in the ISO 15589 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

~~The technical revision of this part of ISO 15589 has been carried out in order to accommodate the needs of industry and to move this International Standard to a higher level of service within the petroleum, petrochemical and natural gas industry.~~

Pipeline cathodic protection is achieved by the supply of sufficient direct current to the external pipe surface, so that the steel-to-electrolyte potential is lowered on all the surface to values at which external corrosion is reduced to an insignificant rate.

Cathodic protection is normally used in combination with a suitable protective coating system to protect the external surfaces of steel pipelines from corrosion.

~~Users of this document should be aware that further or differing requirements may be needed for individual applications. This document is not intended to prevent alternative equipment or engineering solutions from being used for individual applications. This may be particularly applicable where there is innovative or developing technology. Where an alternative is offered, it is intended that any variations from this document be identified and documented.~~

This document can also be used for offshore pipelines outside the petroleum, petrochemical and natural gas industries.

Oil and gas industries including lower carbon energy — Cathodic protection of pipeline transportation systems — ~~Part 2: Offshore pipelines~~

Part 2: Offshore pipelines

1 Scope

This document specifies requirements and gives recommendations for the pre-installation surveys, design, materials, equipment, fabrication, installation, commissioning, operation, inspection and maintenance of cathodic protection (CP) systems for offshore pipelines for the petroleum, petrochemical and natural gas industries as defined in ISO 13623. Flexible pipelines, in-field flowlines, spools and risers are included in this document. Subsea production and injection equipment and structures are not included in this document.

This document is applicable to carbon steel, stainless steel and flexible metallic pipelines in offshore service.

This document is applicable to retrofits, modifications and repairs made to existing pipeline systems.

This document is applicable to all types of seawater and seabed environments encountered in submerged conditions and on risers up to mean water level.

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.

ISO 630, *Structural steels*

ISO 1461, *Hot dip galvanized coatings on fabricated iron and steel articles — Specifications and test methods*

ISO 8044, *Corrosion of metals and alloys — Vocabulary*

ISO 8501-1, *Preparation of steel substrates before application of paints and related products — Visual assessment of surface cleanliness — Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings*

ISO 9606-1, *Qualification testing of welders — Fusion welding — Part 1: Steels*

~~ISO 15257, *Cathodic protection — Competence levels of cathodic protection persons — Basis for a certification scheme*~~

ISO 15589-1, *Petroleum, petrochemical and natural gas industries — Cathodic protection of pipeline systems — Part 1: On-land pipelines*

ISO 15607, *Specification and qualification of welding procedures for metallic materials — General rules*

~~ISO 18086, *Corrosion of metals and alloys — Determination of AC corrosion — Protection criteria*~~

~~ISO 21857, *Petroleum, petrochemical and natural gas industries - Prevention of corrosion on pipeline systems influenced by stray currents*~~

AWS D1.1/D1.1M, *Structural Welding Code — Steel*

EN 10025 (all parts), *Hot rolled products of structural steels*

EN 10204:2004, *Metallic products — Types of inspection documents*

ASTM D1141, *Standard Practice for Preparation of Substitute Ocean Water*

DNV-RP-B401, *Cathodic Protection Design*

NACE TM0190, *Standard Test Method — Impressed Current Test Method for Laboratory Testing of Aluminium Anodes*

3 Terms and definitions

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

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

— ~~—~~ISO Online browsing platform: available at https://www.iso.org/obp

— ~~—~~IEC Electropedia: available at https://www.electropedia.org/

3.1
~~**anode potential**~~
~~anode-to-electrolyte potential~~

~~**3.2**~~
anode sled
anodes installed on a structure and connected to the pipeline by a cable

3.3~~2~~
closed-circuit ~~anode~~ potential
anode potential while electrically linked to the pipeline to be protected

3.4~~3~~
coating breakdown factor
f_c
time-dependent factor to address increasing current requirements due to coating breakdown based on the ratio of current density required to polarize a coated steel surface as compared to a bare steel surface

3.5~~4~~
cold shut
horizontal surface discontinuity caused by solidification of the meniscus of the partially cast anodes as a result of interrupted flow of the casting stream

3.6~~5~~
driving voltage
difference between the pipeline/electrolyte potential and the anode/electrolyte potential when the cathodic protection is operating

3.~~7~~6
electric field gradient
change in electrical potential per unit distance through a conductive medium, arising from the flow of electric current

3.~~8~~7
electrochemical capacity
ε
total amount of electric charge that is produced when a fixed mass (usually 1 kg) of anode material is consumed electrochemically

Note 1 to entry: Electrochemical capacity is expressed in ampere hours.

3.~~9~~8
final current density
~~Current~~current density required to repolarise pipeline at the end of the CP design life

Note 1 to entry: Final current density is expressed in amperes per square metre.

3.~~10~~9
hydrogen-induced stress cracking
HISC
cracking due to a combination of load and hydrogen embrittlement caused by the ingress of hydrogen formed at the steel surface due to the cathodic polarization

3.~~11~~10
IR drop
voltage due to any current, measured between two points of the metal of the pipe or two points of the electrolyte, such as seawater or seabed, in accordance with Ohm's law

Note 1 to entry: IR drop and *electric field gradient* (3.6) are related terms.

~~3.12~~11
~~jumper~~
~~rigid or flexible piping utilized to transport the pipe contents between manifolds, pipeline end terminations/ manifolds and trees~~

~~3.13~~
master reference electrode
reference electrode, calibrated with the *primary calibration reference electrode* (3.15~~,~~), used for verification of reference electrodes that are used for field or laboratory measurements

3.~~14~~12
mean current density
estimated average cathodic current density for the entire lifetime of the pipeline

Note 1 to entry: Mean current density is expressed in amperes per square metre.

3.~~15~~13
protection potential
structure-to-electrolyte potential for which the metal corrosion rate is considered as insignificant

3.~~16~~14
pitting resistance equivalent number
PREN
number, developed to reflect and predict the pitting resistance of a stainless steel, based on the proportions of Cr, Mo, W and N in the chemical composition of the alloy

3.~~17~~15
primary calibration reference electrode
reference electrode used for calibration of *master reference electrodes* (3.11)

3.~~18~~16
remotely-operated vehicle
ROV
underwater vehicle operated remotely from a surface vessel or installation

[SOURCE~~:~~: ISO 14723:2009, 4.32]

3.~~19~~17
riser
part of an offshore pipeline, including any subsea spool pieces, that extends from the seabed to the pipeline termination point on an offshore installation

[SOURCE: ISO 13623:2017, 3.1.20, modified — "including any subsea spool pieces" ~~was~~has been added.]

3.~~20~~18
utilization factor
μ
fraction of the anodic material weight of a galvanic anode that can be consumed before the anode ceases to provide the minimum required current output

3.~~21~~19
~~Pipeline~~pipeline lifetime
~~The~~ period that includes pipeline service life, and any prior or subsequent period planned by the operator~~.~~

4 Symbols and abbreviated terms

4.1 Symbols

ΔE_A	electrolytic potential drop
ΔE_{Me}	metallic potential drop
μ	utilization factor
A	anode exposed surface area
Ac	total surface area
A_w	cross-sectional area of the pipe wall
C	anode cross-sectional perimeter
D	pipeline outer diameter
d	pipeline wall thickness
~~AE~~ΔE	driving voltage
D_i	pipeline internal diameter

