



SLOVENSKI STANDARD
oSIST prEN ISO 15589-2:2022
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**Petrokemična industrija ter industrija za predelavo nafte in zemeljskega plina -
Katodna zaščita cevovodov - 2. del: Cevovodi na morju (ISO/DIS 15589-2:2021)**

Petroleum, petrochemical and natural gas industries - Cathodic protection of pipeline transportation systems - Part 2: Offshore pipelines (ISO/DIS 15589-2:2021)

Erdöl- und Erdgasindustrie - Kathodischer Schutz für Transportleitungssysteme - Teil 2: Offshore-Pipelines (ISO/DIS 15589-2:2021)

Industries du pétrole, de la pétrochimie et du gaz naturel - Protection cathodique des systèmes de transport par conduites - Partie 2: Conduites en mer (ISO/DIS 15589-2:2021)

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ICS:

75.200	Oprema za skladiščenje nafte, naftnih proizvodov in zemeljskega plina	Petroleum products and natural gas handling equipment
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Petroleum, petrochemical and natural gas industries — Cathodic protection of pipeline transportation systems — Part 2: Offshore pipelines

Industries du pétrole, de la pétrochimie et du gaz naturel — Protection cathodique des systèmes de transport par conduites —

Partie 2: Conduites en mer

ICS: 75.200

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CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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Contents

Page

Foreword	v
Introduction	vii
1 Scope	1
2 Normative references	1
3 Terms and definitions	2
4 Symbols and abbreviated terms	4
4.1 Symbols.....	4
4.2 Abbreviated terms.....	4
5 General	5
5.1 Competence assurance.....	5
5.2 Compliance.....	5
6 Cathodic protection system requirements	5
6.1 General.....	5
6.2 Selection of CP systems.....	6
6.2.1 General.....	6
6.2.2 System selection considerations.....	6
6.3 Isolating joints.....	7
7 Design parameters	7
7.1 General.....	7
7.2 Protection potentials.....	9
7.2.1 Potential criteria.....	9
7.2.2 HISC evaluation for martensitic and duplex stainless steel materials.....	10
7.2.3 Thermally sprayed aluminium.....	11
7.3 Design life.....	11
7.4 Design current densities for bare steel.....	11
7.4.1 General.....	11
7.4.2 Splash zone.....	13
7.4.3 Buried pipelines.....	13
7.4.4 Thermally Sprayed Aluminum Coated Pipelines.....	13
7.4.5 Elevated temperatures.....	13
7.4.6 Current drains.....	13
7.5 Coating breakdown factors.....	14
8 Galvanic anodes	16
8.1 Design of system.....	16
8.2 Selection of anode material.....	17
8.3 Electrochemical properties.....	17
8.4 Anode shape and utilization factor.....	18
8.5 Mechanical and electrical considerations.....	19
9 Galvanic anode manufacturing	20
9.1 Pre-production test.....	20
9.2 Coating.....	20
9.3 Anode core materials.....	20
9.4 Aluminium anode materials.....	21
9.5 Zinc anode materials.....	21
10 Galvanic anode quality control	22
10.1 General.....	22
10.2 Steel anode cores.....	22
10.3 Chemical analysis of anode alloy.....	22
10.4 Anode mass.....	22
10.5 Anode dimensions and straightness.....	22

ISO/DIS 15589-2:2021(E)

10.5.1	Slender anodes	22
10.5.2	Bracelet anodes	22
10.6	Anode core dimensions and position	23
10.7	Anode surface irregularities	23
10.7.1	Slender anodes	23
10.7.2	Bracelet anodes	23
10.8	Cracks	24
10.8.1	General	24
10.8.2	Aluminium slender anodes	24
10.8.3	Aluminium bracelet anodes	24
10.9	Internal defects, destructive testing	25
10.10	Electrochemical quality control testing	25
11	Galvanic anode installation	26
12	Impressed-current CP systems	27
12.1	Current sources and control	27
12.2	Impressed-current anode materials	27
12.3	System design	28
12.4	Manufacturing and installation considerations	29
12.5	Mechanical and electrical considerations	29
13	Documentation	30
13.1	Design, manufacturing and installation documentation	30
13.2	Commissioning procedures	30
13.3	Operating and maintenance manual	31
14	Operation, monitoring and maintenance of CP systems	31
14.1	General	31
14.2	Monitoring plans	31
14.3	Repair	32
Annex A (normative)	Galvanic anode CP design procedures	33
Annex B (normative)	Attenuation of protection	40
Annex C (informative)	Qualification testing of galvanic anode materials	44
Annex D (normative)	CP monitoring and surveys	45
Annex E (informative)	Interference	52
Annex F (informative)	Pipeline design for CP	54
Bibliography		60

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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

ISO 15589-2 was prepared by Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries*, Subcommittee SC 2, *Pipeline transportation systems*.

This third edition cancels and replaces the second edition (ISO 15589-2:2012), which has been extensively revised, with the main changes as follows:

- In [Clause 6](#) recommendations for isolating joints have been expanded.
- In [Clause 7](#) Notes on [Table 1](#) and text in [Clause 7.4](#) have been updated to avoid discrepancies with [Figure 2](#). 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](#) Notes and guidance on the design of the system have been updated including recommendations for buried pipelines. Anode utilization factors have been expanded to cover additional anodes types.
- In [Clause 9](#), [Table 6](#) has been updated to reflect anode compositions in line with current industry practices and other standards.
- 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](#), additional anode resistance equations have been provided to cover different anode types. for the
- [Annex B](#) has been modified to present the NORSOK method as normative, while the alternative method been made informative.
- [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 [Clause 10.10](#). .
- In the updated [Annex E](#) (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.

ISO/DIS 15589-2:2021(E)

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.

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Introduction

The technical revision of this document 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.

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Petroleum, petrochemical and natural gas industries — Cathodic protection of pipeline transportation systems —

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. Hardware Subsea infrastructure used to aid in the gathering of hydrocarbons, excluding pipelines, flowlines, risers and jumpers are not included in ISO 15589 as they covered by different industry standards.

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 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 13623, *Petroleum and natural gas industries — Pipeline transportation systems*

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*

ASTM D1141,¹⁾ *Standard Practice for the Preparation of Substitute Ocean Water*

1) ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, USA.

ISO/DIS 15589-2:2021(E)

AWS D1.1/D1.1M,²⁾ *Structural Welding Code — Steel*

EN 10025-(all parts),³⁾ *Hot rolled products of structural steels*

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

NACE Publication 35110, *AC Corrosion State-of-the-Art: Corrosion Rate, Mechanism, and Mitigation Requirements*

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 terminological 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**closed-circuit anode potential**

anode potential while electrically linked to the pipeline to be protected

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3.4**coating breakdown factor**

f_c

ratio of current density required to polarize a coated steel surface as compared to a bare steel surface

3.5**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**driving voltage**

difference between the pipeline/electrolyte potential and the anode/electrolyte potential when the cathodic protection is operating

3.7**electric field gradient**

change in electrical potential per unit distance through a conductive medium, arising from the flow of electric current

3.8**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.

2) American Welding Society, 550 NW Le Jeune Road, Miami, FL 33126, USA.

3) European Committee for Standardization, Rue de la Science 23, B-1040, Brussels, Belgium.

3.9**final current density**

estimated current density at the end of the lifetime of the pipeline

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

3.10**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**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 are related terms.

3.12**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, used for verification of reference electrodes that are used for field or laboratory measurements

3.14**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**protection potential**

structure-to-electrolyte potential for which the metal corrosion rate is considered as insignificant

3.16**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**primary calibration reference electrode**

reference electrode used for calibration of master reference electrodes

3.18**remotely operated vehicle****ROV**

underwater vehicle operated remotely from a surface vessel or installation

[SOURCE: ISO 14723:2009]

3.19**riser**

part of an offshore pipeline, including any subsea spool pieces, which extends from the seabed to the pipeline termination point on an offshore installation

[SOURCE: ISO 13623:2017]

ISO/DIS 15589-2:2021(E)

3.20 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

4 Symbols and abbreviated terms

4.1 Symbols

ε	electrochemical capacity
f_c	coating breakdown factor
μ	utilization factor

4.2 Abbreviated terms

CAT	cold-applied tape
CE	carbon equivalent
CP	cathodic protection
CRA	corrosion-resistant alloy
EPDM	ethylene propylene diene monomer
FBE	fusion-bonded epoxy
HISC	hydrogen-induced stress cracking
HSS	heat-shrinkable sleeve
PE	polyethylene
PP	polypropylene
PREN	pitting resistance equivalent number
PU	polyurethane
ROV	remotely operated vehicle
SCE	saturated calomel electrode
SMYS	specified minimum yield strength
SRB	sulphate reducing bacteria
3LPE	three-layer polyethylene
3LPP	three-layer polypropylene

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5 General

5.1 Competence assurance

Personnel who undertake the design, supervision of installation, commissioning, supervision of operation, measurements, monitoring and supervision of maintenance of cathodic protection systems shall have the appropriate level of competence for the tasks undertaken.

NOTE 1 EN 15257 or the NACE Cathodic Protection Training and Certification Programme constitute suitable methods that can be used to assess competence of cathodic protection personnel.

NOTE 2 Competence of cathodic protection personnel to the appropriate level for tasks undertaken can be demonstrated by certification in accordance with prequalification procedures such as EN 15257, the NACE Cathodic Protection Training and Certification Programme or any other equivalent scheme.

5.2 Compliance

A quality system and an environmental management system should be applied to assist compliance with the requirements of this part of ISO 15589.

NOTE ISO/TS 29001 gives sector-specific guidance on quality management systems and ISO 14001 gives guidance on the selection and use of an environmental management system.

6 Cathodic protection system requirements

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6.1 General

The CP system shall be designed to prevent external corrosion over the design life of the pipeline and to:

- provide sufficient current to the pipeline to be protected and distribute this current so that the selected criteria for CP are effectively attained on the entire surface;
- provide a design life of the anode system commensurate with the required life of the protected pipeline, or to provide for periodic rehabilitation of the anode system;
- provide adequate allowance for anticipated changes in current requirements with time;
- ensure that anodes are installed where the possibility of disturbance or damage is minimal;
- provide adequate monitoring facilities to test and evaluate the system's performance.

The CP system shall be designed with due regard to environmental conditions and neighbouring structures.

Electrical isolation of offshore pipelines protected by galvanic anodes from other pipelines, structures, subsea facility or floaters that are protected by impressed-current systems shall be evaluated for adverse interaction between the two systems. An assessment shall be performed to identify the cathodic protection system of these facilities and review the electrical connectivity with the proposed pipeline to ensure no detrimental effects on each side related to inadequate or excessive polarization. Offshore pipelines shall be isolated from other unprotected or less protected structures, which could drain current from the pipeline's CP system. If isolation is not practical or stray current problems are suspected, electrical continuity should be ensured.

Care shall be taken to ensure that different CP systems of adjacent pipelines or structures are compatible and that no excessive current drains from one system into an adjacent system.

The pipeline CP design shall take into account the pipeline installation method, the types of pipeline and riser, and the burial and stabilization methods proposed. Further guidance is given in [Annex F](#).