

DIN EN ISO 15589-2



ICS 75.200

Entwurf

Einsprüche bis 2022-01-26
Vorgesehen als Ersatz für
DIN EN ISO 15589-2:2014-07

**Erdöl- und Erdgasindustrie –
Kathodischer Schutz für Transportleitungssysteme –
Teil 2: Offshore-Pipelines (ISO/DIS 15589-2:2021);
Englische Fassung prEN ISO 15589-2:2021**

Petroleum, petrochemical and natural gas industries –
Cathodic protection of pipeline transportation systems –
Part 2: Offshore pipelines (ISO/DIS 15589-2:2021);
English version prEN ISO 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);
Version anglaise prEN ISO 15589-2:2021

Anwendungswarnvermerk

Dieser Norm-Entwurf mit Erscheinungsdatum 2021-11-26 wird der Öffentlichkeit zur Prüfung und Stellungnahme vorgelegt.

Weil die beabsichtigte Norm von der vorliegenden Fassung abweichen kann, ist die Anwendung dieses Entwurfs besonders zu vereinbaren.

Stellungnahmen werden erbeten

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- oder als Datei per E-Mail an noeg@din.de möglichst in Form einer Tabelle. Die Vorlage dieser Tabelle kann im Internet unter www.din.de/go/stellungnahmen-norm-entwuerfe oder für Stellungnahmen zu Norm-Entwürfen der DKE unter www.dke.de/stellungnahme abgerufen werden;
- oder in Papierform an den DIN-Normenausschuss Erdöl- und Erdgasgewinnung (NÖG), 10772 Berlin oder Am DIN-Platz, Burggrafenstr. 6, 10787 Berlin.

Die Empfänger dieses Norm-Entwurfs werden gebeten, mit ihren Kommentaren jegliche relevanten Patentrechte, die sie kennen, mitzuteilen und unterstützende Dokumentationen zur Verfügung zu stellen.

Gesamtumfang 77 Seiten

DIN-Normenausschuss Erdöl- und Erdgasgewinnung (NÖG)
DIN-Normenausschuss Materialprüfung (NMP)

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Nationales Vorwort

Dieses Dokument (prEN ISO 21809-2:2021) wurde vom Technischen Komitee ISO/TC 67 „Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries“ in Zusammenarbeit mit dem Technischen Komitee CEN/TC 219 „Kathodischer Korrosionsschutz“ (Sekretariat BSI, Belgien) erarbeitet.

Für Deutschland hat hieran der Arbeitsausschuss NA 109-00-02 AA „Fernleitungssysteme - Spiegelausschuss zu ISO/TC 67/SC 2“ im DIN-Normenausschuss Erdöl- und Erdgasgewinnung (NÖG) mitgearbeitet.

Dieses Dokument enthält unter Berücksichtigung des DIN-Präsidialbeschlusses 1/2004 nur die Englische Fassung von [prEN ISO 21809-2:2021].

Der Bedarf für eine Deutsche Fassung wird derzeit beraten.

Für die in diesem Dokument zitierten Dokumente wird im Folgenden auf die entsprechenden deutschen Dokumente hingewiesen:

ISO 1461	siehe	DIN EN ISO 1461
ISO 8044	siehe	DIN EN ISO 8044
ISO 8501-1	siehe	DIN EN ISO 8501-1
ISO 9606-1	siehe	DIN EN ISO 9606-1
ISO 14001	siehe	DIN EN ISO 14001
ISO 14723	siehe	DIN EN ISO 14723
ISO 15589-1	siehe	DIN EN ISO 15589-1
ISO 15607	siehe	DIN EN ISO 15607
ISO 18086	siehe	DIN EN ISO 18086
ISO 21809 (all parts)	siehe	DIN EN ISO 21809 (alle Teile)

Aktuelle Informationen zu diesem Dokument können über die Internetseiten von DIN (www.din.de) durch eine Suche nach der Dokumentennummer aufgerufen werden.

Änderungen

Gegenüber DIN EN ISO 15589-2:2014-07 wurden folgende Änderungen vorgenommen:

- a) In Abschnitt 6 wurden die Empfehlungen für isolierende Verbindungen erweitert;
- b) in Abschnitt 7 wurden die Anmerkungen zu Tabelle 1 und der Text in 7.4 aktualisiert, um Diskrepanzen mit Bild 2 zu vermeiden. Die Durchschlagsfaktoren für Beschichtungen wurden überarbeitet, um Fehler aus der vorherigen Ausgabe zu korrigieren und für einige Beschichtungssysteme wurden aufgrund von Rückmeldungen aus der Industrie weniger konservative Werte gewählt;
- c) in Abschnitt 8 wurden Hinweise und Anleitungen für die Auslegung des Systems aktualisiert, einschließlich Empfehlungen für erdverlegte Rohrleitungen. Die Anodennutzungsfaktoren wurden erweitert, um zusätzliche Anodentypen abzudecken;
- d) in Abschnitt 9 wurde Tabelle 6 aktualisiert, um die Anodenzusammensetzung in Übereinstimmung mit der aktuellen Industriepraxis und anderen Normen wiederzugeben;
- e) in Abschnitt 10 wurden zusätzliche Verweise auf Leitlinien zu Kernabmessungen und -position sowie auf Prüfungen zur Qualitätskontrolle der elektrochemischen Eigenschaften von Anoden aufgenommen;

- f) in Anhang A wurden zusätzliche Gleichungen für den Anodenwiderstand aufgenommen, um verschiedene Anodentypen abzudecken;
- g) Anhang B wurde geändert, um die NORSOK-Methode als normativ darzustellen, während die alternative Methode als informativ eingestuft wurde;
- h) Anhang C wurde als informativ aktualisiert und die Prüfmethode durch Verweise auf aktuelle Prüfmethoden in Übereinstimmung mit der aktuellen Industriepraxis ersetzt;
- i) der frühere Anhang E wurde gestrichen und durch eine zusätzliche Anleitung für die Qualitätskontrolle von Anoden in 10.10. ersetzt;
- j) im aktualisierten Anhang E (Interferenzen) wurden zusätzliche Hinweise auf Wechselstrominterferenzen hinzugefügt;
- k) die Literaturhinweise wurden aktualisiert;
- l) die Norm wurde redaktionell überarbeitet.

Nationaler Anhang NA (informativ)

Begriffe und Abkürzungen

Reihenfolge und Inhalt der folgenden Begriffe sind identisch mit denen im Abschnitt Begriffe der Englischen Fassung.

3 Begriffe

Für die Anwendung dieses Dokuments gelten die Begriffe nach ISO 8044 und die folgenden Begriffe.

ISO und IEC stellen terminologische Datenbanken für die Verwendung in der Normung unter den folgenden Adressen bereit:

- ISO Online Browsing Platform: verfügbar unter <https://www.iso.org/obp>
- IEC Electropedia: verfügbar unter <https://www.electropedia.org/>

3.1

Anodenpotential

Anodenpotential im Elektrolyten

3.2

Anodenschlitten

auf einer Anlage befestigte Anoden, die über ein Kabel mit der Rohrleitung verbunden sind

3.3

Anodenpotential des geschlossenen Stromkreises

Anodenpotential bei elektrischer Verbindung zu der zu schützenden Rohrleitung

3.4

Beschichtungs-Reduktionsfaktor

f_c

Verhältnis der Stromdichte, die erforderlich ist, um eine beschichtete Stahloberfläche im Vergleich zu einer unbeschichteten Stahloberfläche zu polarisieren

3.5

Kaltschweißstelle

horizontale Unstetigkeit in der Oberfläche, verursacht durch das Erstarren des Gusspiegels der teilgegossenen Anoden infolge des unterbrochenen Flusses des Gussstroms

3.6

Steuerspannung

Differenz zwischen dem Rohrleitungspotential im Elektrolyten und dem Anodenpotential im Elektrolyten, wenn der kathodische Schutz wirkt

3.7

elektrischer Feldgradient

Änderung des elektrischen Potentials je Längeneinheit durch ein leitendes Medium, hervorgehend aus dem elektrischen Stromfluss

3.8 elektrochemische Kapazität

ϵ

Gesamtmenge der elektrischen Ladung, die erzeugt wird, wenn eine feste Masse (gewöhnlich 1 kg) des Anodenwerkstoffs elektrochemisch verbraucht wird

Anmerkung 1 zum Begriff: Die elektrochemische Kapazität wird in Amperestunden angegeben.

3.9 Endstromdichte

abgeschätzte Stromdichte am Ende der Lebensdauer einer Rohrleitung

Anmerkung 1 zum Begriff: Die Endstromdichte wird in Ampere je Quadratmeter angegeben.

3.10 wasserstoffinduzierte Spannungsrissbildung

HISC, en:hydrogen-induced stress cracking

Rissbildung durch eine Kombination aus Last und Wasserstoffversprödung, verursacht durch das Eindringen von Wasserstoff, der sich durch die kathodische Polarisation auf der Stahloberfläche gebildet hat

3.11 ohmscher Spannungsabfall

Spannung infolge eines Stroms, gemessen zwischen zwei Punkten auf dem Metall der Rohrleitung oder zwischen zwei Punkten des Elektrolyten, wie Meerwasser oder Meeresboden, entsprechend dem Ohmschen Gesetz

Anmerkung 1 zum Begriff: Der ohmsche Spannungsabfall und der elektrische Feldgradient sind zusammengehörige Begriffe.

3.12 Überbrückungsleitung

starre oder flexible Rohrleitung, die zum Transport des Rohrinhalts zwischen Verteilerstücken, Pipeline-Endabschlussstücken/Endverteilerstücken und E-Kreuzen verwendet wird

3.13 Hauptbezugselektrode

Bezugselektrode, kalibriert mit der primären Kalibrier-Bezugselektrode, die für die Verifizierung von Bezugselektroden verwendet wird, die für Feld- oder Labormessungen eingesetzt werden

3.14 mittlere Stromdichte

abgeschätzter Mittelwert der kathodischen Stromdichte für die gesamte Lebensdauer der Rohrleitung

Anmerkung 1 zum Begriff: Die mittlere Stromdichte wird in Ampere je Quadratmeter angegeben.

3.15 Schutzpotential

Anlagenpotential im Elektrolyten, für das die Korrosionsgeschwindigkeit des Metalls als unbedeutend angesehen wird

3.16 Lochfraßindex

PREN, en: pitting resistance equivalent number

Index, der entwickelt wurde, um die Lochfraßbeständigkeit von nichtrostendem Stahl wiederzugeben und vorauszuberechnen, was auf der Grundlage der Anteile der Elemente Cr, Mo, W und N in der chemischen Zusammensetzung der Legierung geschieht

3.17

primäre Kalibrier-Bezugselektrode

Bezugselektrode, die zum Kalibrieren von Hauptbezugselektroden verwendet wird

3.18

ferngelenktes Fahrzeug

ROV, en: remotely operated vehicle

Unterwasserfahrzeug, das von einem Fahrzeug oder einer Anlage an der Wasseroberfläche aus gelenkt wird

[QUELLE: ISO 14723:2009]

3.19

Steigleitung

Teil einer Offshore-Rohrleitung, einschließlich jeglicher Unterwasser-Flanschstücke, der vom Meeresboden bis zum Rohrleitungsende einer Offshore-Anlage verläuft

[QUELLE: ISO 13623:2017]

3.20

Ausnutzungsfaktor

μ

Anteil der Masse des Anodenwerkstoffs einer galvanischen Anode, der verbraucht werden kann, bevor die Anode aufhört, die mindestens erforderliche Stromabgabe zu liefern

4 Symbole und Abkürzungen

4.1 Symbole

ε elektrochemische Kapazität

f_c Beschichtungs-Reduktionsfaktor

μ Ausnutzungsfaktor

4.2 Abkürzungen

CAT kaltverarbeitetes Band (en: cold-applied tape)

CE Kohlenstoffäquivalent (en: carbon equivalent)

CP kathodischer Korrosionsschutz (en: cathodic protection)

CRA korrosionsbeständige Legierung (en: corrosion-resistant alloy)

EPDM Ethylen-Propylen-Dien-Monomer (en: ethylene propylene diene monomer)

FBE Epoxidpulver (en: fusion-bonded epoxy)

HISC wasserstoffinduzierte Spannungsrissbildung (en: hydrogen-induced stress cracking)

HSS Schrumpfschlauch (en: heat-shrinkable sleeve)

PE Polyethylen (en: polyethylene)

PP Polypropylen (en: polypropylene)

PREN	Lochfraßindex (en: pitting resistance equivalent number)
PU	Polyurethan (en: polyurethane)
ROV	ferngelenktes Fahrzeug (en: remotely operated vehicle)
SCE	gesättigte Kalomelelektrode (en: saturated calomel electrode)
SMYS	festgelegte Mindeststreckgrenze (en: specified minimum yield strength)
SRB	sulfatreduzierende Bakterien (en: sulphate reducing bacteria)
3LPE	Dreischicht-Polyethylen (en: three-layer polyethylene)
3LPP	Dreischicht-Polypropylen (en: three-layer polypropylene)

Nationaler Anhang NB (informativ)

Literaturhinweise

DIN EN ISO 1461, *Durch Feuerverzinken auf Stahl aufgebrachte Zinküberzüge (Stückverzinken) — Anforderungen und Prüfungen*

DIN EN ISO 8044, *Korrosion von Metallen und Legierungen — Grundbegriffe*

DIN EN ISO 8501-1, *Vorbereitung von Stahloberflächen vor dem Auftragen von Beschichtungsstoffen — Visuelle Beurteilung der Oberflächenreinheit — Teil 1: Rostgrade und Oberflächenvorbereitungsgrade von unbeschichteten Stahloberflächen und Stahloberflächen nach ganzflächigem Entfernen vorhandener Beschichtungen*

DIN EN ISO 9606-1, *Prüfung von Schweißern — Schmelzschweißen — Teil 1: Stähle*

DIN EN ISO 14001, *Umweltmanagementsysteme — Anforderungen mit Anleitung zur Anwendung*

DIN EN ISO 14723, *Erdöl- und Erdgasindustrie — Rohrleitungstransportsysteme — Unterwasserarmaturen*

DIN EN ISO 15589-1, *Erdöl-, petrochemische und Erdgasindustrie — Kathodischer Korrosionsschutz für Rohrleitungssysteme — Teil 1: Rohrleitungen an Land*

DIN EN ISO 15607, *Anforderung und Qualifizierung von Schweißverfahren für metallische Werkstoffe — Allgemeine Regeln*

DIN EN ISO 18086, *Korrosion von Metallen und Legierungen — Bestimmung der Wechselstromkorrosion — Schutzkriterien*

DIN EN ISO 21809 (alle Teile), *Erdöl- und Erdgasindustrie — Umhüllungen für erd- und wasserverlegte Rohrleitungen in Transportsystemen*

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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.

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 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.

– *Entwurf* –

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.

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

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]

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

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

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.

The CP system based on galvanic anodes shall be designed for the lifetime of the pipeline system using the calculation procedure given in Annex A.

For areas with high water velocities and areas with erosion effects (e.g. from entrained sand, silt, ice particles), the design of the CP system needs special attention and additional design criteria shall be considered.

Installation of permanent test facilities should be considered, taking into account specific parameters such as pipeline length, water depth and underwater access related to the burial conditions.

ISO 15589-1 should be used for the cathodic protection of short lengths of offshore pipelines and their branches that are directly connected to cathodically protected onshore pipelines.

6.2 Selection of CP systems

6.2.1 General

CP shall be achieved using either galvanic anodes or an impressed-current system. Galvanic anodes shall be connected to the pipe, either individually or in groups

NOTE 1 Galvanic anodes are limited in current output by the anode-to-pipe driving voltage and the electrolyte resistivity. Generally, anodes are attached directly to the pipe as bracelets. Sleds of anodes can also be placed at regular intervals along the pipeline.

NOTE 2 Some pipelines can be protected by anodes located at each end. Typically, this type of installation is used on inter-platform pipelines. Anodes for the pipeline can be attached to the platform if the pipeline is electrically connected to the platform.

Items that shall be considered in selecting the system to be used are covered in 6.2.2.

6.2.2 System selection considerations

Selection of the CP system shall be based on the following considerations:

- magnitude of the protective current required;
- resistivity of the seawater;
- availability and location of suitable power sources for impressed-current systems;
- existence of any stray currents causing significant potential fluctuations between pipeline and earth that can preclude the use of galvanic anodes;
- effects of any CP interference currents on adjacent structures that might limit the use of impressed-current CP systems;
- limitations on the space available, due to the proximity of foreign structures, and related construction and maintenance concerns;
- future development of the area and any anticipated future extensions to the pipeline system;
- cost of installation, operation and maintenance;
- reliability of the overall system;
- integrity of other pipelines and/or structures existing in the same area that could be affected by impressed-current systems unless proper measures are taken to prevent these effects.

NOTE Impressed-current systems can be preferred on short pipelines which terminate at platforms that have impressed-current systems installed or where an impressed-current system is operated from the shore. Impressed-current systems can also be preferred as a retrofit system on pipelines with galvanic anode failures, excessive anode consumption, operation beyond original design life or excessive coating deterioration. Impressed current can also be the preferred method for high-resistivity water.

6.3 Isolating joints

Isolating joints should be considered at the following locations:

- at connections to onshore pipelines or onshore receiving facilities;
- at connections to pipelines that require different protection criteria;
- between cathodically protected pipelines and non-protected facilities or less protected facilities;
- between pipeline systems (or structures) protected by impressed current and galvanic anodes.
- at connections between pipelines and appurtenances constructed from dissimilar metals (e.g pumps and valves)

Electrical isolation of submarine pipelines from onshore electrical earthing systems is essential for effective cathodic protection offshore and onshore. This isolation shall be provided using electrically isolating joints.

Where offshore submarine pipeline CP is provided using galvanic anodes and onshore sections of the pipeline are protected using either impressed current or galvanic anodes, electrical isolation is necessary in order to enable the onshore section to be subject to the performance assessment as in ISO 15589-1 Clause 6 which requires the measurement of IR Free pipe/soil potentials on the pipeline. As current flowing to the onshore pipeline from offshore galvanic anodes cannot be interrupted, it is necessary to electrically isolate the onshore pipeline from the offshore pipeline, in order to permit the onshore pipeline CP system to be adequately performance assessed.

This isolation shall be provided using electrically isolating joints. These isolating joints are best located at the landfall or on the seaward side of any emergency shut down valves, on the seaward side of any electrical or control piping connections to the onshore pipeline, avoiding these short circuiting and negating the effectiveness of the isolation joints.

NOTE 1 If these requirements for isolation joints are not followed, there is a considerable threat that cathodic protection effectiveness will be severely impaired and that significantly costly remedial work will be necessary in order to maintain pipeline integrity.

If isolating joints are used they shall be designed and installed to ensure long-term integrity and shall be positioned to allow easy access for inspection and maintenance. Detailed design requirements are given in ISO 15589-1 Clause 7.3.

NOTE 2 ISO 15589-1 clause 7.3.3. requires that monolithic or monobloc isolation joints should be used wherever possible, for all electrical isolation requirements. Unless these joints are exposed to unplanned forces, they have been shown to be much more reliable than the use of insulating gaskets, sleeves and washers in a conventional flange. Due to the impact of isolation failure on pipeline integrity, monolithic or monobloc isolation joints should be used at the interfaces between offshore and onshore pipelines.

7 Design parameters

7.1 General

The design of a pipeline CP system shall be based on:

- detailed information on the pipeline to be protected, including material, length, wall thickness, outside diameter, pipe-laying procedures, route, laying conditions on the sea bottom, temperature profile (operating and shut in) along its whole length, type and thickness of corrosion protective

coating(s) for pipes and fittings, presence, type and thickness of thermal insulation, mechanical protection and/or weight coating;

- environmental conditions, including diurnal and seasonal variations, such as seawater salinity, temperature and resistivity, tides and seabed resistivity along the whole length of the pipeline;
- burial status (extent of backfilling after trenching or natural burial) and soil resistivity;
- design life of the system;
- information on existing pipelines in close proximity to or crossing the new pipeline, including location, ownership and corrosion-control practices;
- information on existing CP systems (platforms, landfalls, subsea structures, etc.) and electrical pipeline isolation;
- availability of electrical power, electrical isolating devices, electrical bonds;
- applicable local legislation;
- construction dates, start-up date (required for hot lines);
- presence of fittings, J-tubes, risers, clamps, wyes, tees and other appurtenances; and
- performance data on CP systems in the same environment.

If CP performance data for similar environments is not available (for example when moving into deeper water), data on the seawater characteristics (dissolved oxygen, salinity, pH, sea currents, and fouling) shall be obtained as these can affect cathodic polarization and calcareous deposit formation. For these situations, the required information shall be obtained from field surveys and/or corrosion test data including the following:

- protective current requirements to meet applicable criteria;
- electrical resistivity of the electrolyte, including seasonal changes if relevant;
- pipe burial depth (if buried) and identification of exposed span lengths and locations;
- water temperature at the seabed;
- oxygen concentration at the seabed;
- water flow rate at the seabed, including seasonal changes if relevant;
- seabed topography.

When reviewing operating experience, the following additional data should be considered:

- electrical continuity;
- electrical isolation;
- external coating integrity;
- deviation from specifications;
- maintenance and operating data.

Design procedures for the CP based on galvanic anode systems shall be in accordance with Annex A.