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Petroleum and natural gas industries - Cathodic protection of pipeline transportation systems - Part 1: On-land pipelines (ISO 15589-1:2003 modified)

Petroleum and natural gas industries - Cathodic protection of pipeline transportation systems - Part 1: On-land pipelines (ISO 15589-1:2003 modified)

Erdöl- und Erdgasindustrie - Kathodischer Schutz für Transportleitungssysteme - Teil 1: On-land pipelines (Land-Rohrleitungen)

Industries du pétrole et du gaz naturel - Protection cathodique des systemes de transport par conduites - Partie 1 : Conduites terrestres (ISO 15589-1:2003 modifiée)

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Contents

page

Explanatory Note ... 4

Foreword ... 5

Introduction ... 6

1 Scope ... 7

2 Normative references ... 7

3 Terms and definitions ... 7

4 Symbols and abbreviations ... 9

5 Design requirements ... 10
5.1 General ... 10
5.2 Design information ... 10
5.3 Criteria for CP ... 11
5.4 Predesign investigations ... 12
5.5 Electrical isolation ... 13
5.6 Electrical earthing ... 13
5.7 Electrical continuity ... 14
5.8 Current requirements ... 14
5.9 Type of CP system and selection of sites ... 15

6 Impressed-current systems ... 16
6.1 Power supply ... 16
6.2 Groundbeds ... 17
6.3 Current output control and distribution ... 19

7 Galvanic-anode systems ... 20
7.1 General ... 20
7.2 Zinc anodes ... 20
7.3 Magnesium anodes ... 21
7.4 Anode backfill ... 22
7.5 Cables and cable connections ... 22

8 Monitoring facilities ... 22
8.1 General ... 22
8.2 Monitoring stations (test posts) ... 22
8.3 Bonding to other pipelines ... 23
8.4 Test facilities at cased crossings ... 23
8.5 Test facilities at isolating joints ... 23
8.6 Drain-point test facilities ... 23
8.7 Miscellaneous monitoring facilities ... 23

9 Special facilities ... 23
9.1 Temporary protection ... 23
9.2 Protective casings ... 24
9.3 Parallel power lines or a.c. traction systems ... 24
9.4 Lightning protection ... 24
9.5 Surge arrestors ... 24
9.6 CP cables and cable connections ... 25
9.7 Monitoring stations and distribution boxes ... 26

10 Commissioning ... 26
10.1 General ... 26
10.2 Equipment tests ... 26

10.3 System tests 27

11 Inspection and monitoring 27
11.1 General 27
11.2 Frequencies of inspection 28
11.3 Monitoring plan 29
11.4 Monitoring equipment 29
11.5 Specialized surveys 29

12 Maintenance and repair 30

13 Documentation 30
13.1 Design documentation 30
13.2 Commissioning documentation 31
13.3 Inspection and monitoring documentation 32
13.4 Operating and maintenance documentation 32
13.5 Maintenance records 32

Annex A (normative) CP measurements 33
A.1 General 33
A.2 Potential measurements 33
A.3 Control of electrical isolation 35

Annex B (normative) Electrical interference 37
B.1 General 37
B.2 d.c. interference 37
B.3 a.c. interference 39

Annex C (informative) Fault detection of impressed-current systems during operation 41

Annex D (informative) Description of specialized surveys 43
D.1 Pearson survey 43
D.2 Current attenuation survey 43
D.3 Close-interval potential survey (CIPS) 43
D.4 Direct-current voltage gradient survey (DCVG) 44
D.5 Intensive measurement technique 44

Annex ZA (normative) Normative references to international publications with their corresponding European publications 46

Bibliography 47

Explanatory Note

ISO 15589-1:2003, developed within ISO/TC 67 SC 2, has been taken over as a European Standard prEN 14919-1 (ISO 15589-1:2003 modified).

The scope of ISO/TC 67/SC 2 is pipeline transportation systems for the petroleum and natural gas industries without exclusions. However in CEN, the scopes of CEN/TC 12 and CEN/TC 234 overlapped until 1995. This scope overlap caused problems for the parallel procedure for the above-mentioned items. The conflict in scope was resolved when both the CEN/Technical Committees and the CEN/BT took the following resolution :

Resolution BT 38/1995 :

Subject : Revised scope of CEN/TC 12

"BT endorses the conclusions of the coordination meeting between CEN/TC 12 "Materials, equipment and offshore structures for petroleum and natural gas industries" and CEN/TC 234 "Gas supply" and modifies the CEN/TC 12 scope, to read :

"Standardization of the materials, equipment and offshore structures used in drilling, production, refining and the transport by pipelines of petroleum and natural gas, excluding on-land supply systems used by the gas supply industry and those aspects of offshore structures covered by IMO requirement (ISO/TC 8).

The standardization is to be achieved wherever possible by the adoption of ISO Standards."

Resulting from Resolution BT 38/1995, "***gas supply on land***" has been excluded from the scope of ISO 15589-1:2003 for the European adoption by CEN/TC 12.

Equivalence with European Standards is provided in annex ZA.

Foreword

The text of ISO 15589-1:2003 has been prepared by Technical Committee ISO/TC 67 "Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries" of the International Organization for Standardization (ISO) and has been taken over as prEN 14919-1:2004 by Technical Committee CEN/TC 12 “Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries”, the secretariat of which is held by AFNOR.

This document is currently submitted to the Unique Acceptance Procedure.

Annexes A, B and ZA are normative. Annexes C and D are informative.

This document includes a Bibliography.

ISO 15589-1 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.*

PrEN 14919-1 consists of the following parts, under the general title *Petroleum and natural gas industries — Cathodic protection of pipeline transportation systems* :

— *Part 1: On-land pipelines*

— *Part 2 : Offshore pipelines*

Introduction

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 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.

External corrosion control in general is covered by ISO 13623.

Users of this part of prEN 14919-1 should be aware that further or differing requirements may be needed for individual applications. This part of prEN 14919-1 is not intended to inhibit alternative equipment or engineering solutions to be used for the individual application. This may be particularly applicable where there is innovative or developing technology. Where an alternative is offered, any variations from this part of prEN 14919-1 should be identified.

1 Scope

This part of prEN 14919-1 specifies requirements and gives recommendations for the pre-installation surveys, design, materials, equipment, fabrication, installation, commissioning, operation, inspection and maintenance of cathodic protection systems for on-land pipelines, as defined in ISO 13623, for the petroleum and natural gas industries.

This part of prEN 14919-1 is applicable to buried carbon steel and stainless steel pipelines on land. It can also apply to landfalls of offshore pipeline sections protected by onshore-based cathodic protection installations.

This part of prEN 14919-1 is also applicable to retrofits, modifications and repairs made to existing pipeline systems.

NOTE Special conditions sometimes exist where cathodic protection is ineffective or only partially effective. Such conditions can include elevated temperatures, disbonded coatings, thermal-insulating coatings, shielding, bacterial attack and unusual contaminants in the electrolyte.

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).

ISO 8044, *Corrosion of metals and alloys — Basic terms and definitions.*

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

ISO 13847, *Petroleum and natural gas industries — Pipeline transportation systems — Welding of pipelines.*

ASTM G 97[1)], *Standard test method for laboratory evaluation of magnesium sacrificial anode test specimens for underground applications.*

3 Terms and definitions

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

3.1
anode backfill
material with a low resistivity, which may be moisture-retaining, immediately surrounding a buried anode, for the purpose of decreasing the effective resistance between the anode and the electrolyte and to prevent anode polarization

3.2
bond
metal conductor, usually copper, connecting two points on the same or on different structures, usually with the intention of providing electrical continuity between the points

1) American Society for Testing and Materials, 100 Barr Harbour Drive, West Conshohocken, PA 19428-2959, USA.

3.3
cathodic protection system
system consisting of a d.c. current source and an anode in order to provide protective current to a metallic structure

3.4
coupon
representative metal sample of known surface area used to quantify the extent of corrosion or the effectiveness of applied cathodic protection

3.5
d.c. decoupling device
protective device that conducts electricity when predetermined threshold voltage levels are exceeded

EXAMPLE Polarization cells, spark gaps and diode assemblies.

3.6
drain point
location of the negative cable connection to the protected structure through which the protective current returns to its source

3.7
galvanic anode
electrode that provides current for cathodic protection by means of galvanic action

3.8
groundbed
system of buried or immersed galvanic or impressed-current anodes

3.9
impressed-current anode
electrode that provides current for cathodic protection by means of impressed current

3.10
impressed-current station
station containing the equipment which provides cathodic protection by means of impressed current

3.11
impressed-current system
system which provides cathodic protection by means of impressed current

3.12
instant-on potential
structure-to-electrolyte potential measured immediately after turning on all sources of applied cathodic protection current

3.13
intensive measurement technique
technique which simultaneously measures pipe-to-electrolyte potentials and associated perpendicular potential gradients

NOTE The intensive measurement technique identifies coating defects and enables calculation of IR-free potentials at the defects.

3.14
IR drop
voltage, due to any current, developed between two points in the metallic path or in the lateral gradient in an electrolyte such as the soil, measured between a reference electrode and the metal of the pipe, in accordance with Ohm's Law

3.15
IR-free potential
polarized potential
structure-to-electrolyte potential measured without the voltage error caused by the IR drop from the protection current or any other current

3.16
isolating joint
electrically-insulating component inserted between two lengths of pipe to prevent electrical continuity between them

EXAMPLE Monobloc isolating joint, isolating flange, isolating coupling.

3.17
monitoring station
test post
station where measuring and test facilities for the buried pipeline are located

3.18
on-potential
structure-to-soil potential measured while the cathodic protection system is continuously operating

3.19
off potential
instant-off potential
structure-to-electrolyte potential measured immediately after interruption of all sources of applied cathodic protection current

NOTE This potential is normally measured immediately after the cathodic protection system is switched off and the applied electrical current stops flowing to the bare steel surface, but before polarization has decreased.

3.20
protection potential
structure-to-electrolyte potential for which the metal corrosion rate is insignificant

3.21
reference electrode
electrode whose open circuit potential is constant under similar conditions of measurement, used to measure the structure-to-electrolyte potential

3.22
remote earth
that part of the electrolyte in which no measurable voltages, caused by current flow, occur between any two points

NOTE This condition generally prevails outside the zone of influence of an earth electrode, an earthing system, an impressed-current groundbed or a protected structure.

3.23
stray current
current in the path other than the protective current under consideration

4 Symbols and abbreviations

a.c. alternating current

CP cathodic protection

CSE copper–copper sulfate (saturated) reference electrode

d.c. direct current

SCC stress corrosion cracking

SCE calomel reference electrode

5 Design requirements

5.1 General

For new construction projects, the design of the CP system shall be part of the total pipeline design and corrosion management. The details of the pipeline isolation (e.g. location of isolating joints) and the protective coating system shall be included.

Design, fabrication, installation, operation and maintenance of CP systems shall be carried out by experienced and qualified personnel.

5.2 Design information

The following technical information shall be collected and considered when designing a CP system :

— detailed information on the pipeline to be protected, e.g. length, diameter, wall thickness, type and grade of material, protective coating, operating temperature profile, design pressure ;

— products to be transported ;

— the required design life of the CP system ;

— relevant drawings of the pipeline route, showing existing CP systems, existing foreign structures/pipelines etc. ;

— environmental operating conditions for the CP equipment ;

— topographical details and soil conditions, including soil resistivity ;

— climatic conditions, e.g. frozen soil ;

— the possibility of telluric current activity ;

— location, route and rating of high-voltage overhead or buried power lines ;

— valves and regulating station locations ;

— water, railway and road crossings ;

— casing pipes that will remain after construction ;

— types of pipeline bedding material ;

— types and locations of isolating joints ;

— characteristics of neighbouring a.c. and d.c. traction systems (e.g. electrical substations and their operating voltages and polarities) and other interference-current sources ;

— types and locations of earthing systems ;

— availability of power supply.

The following information should be considered in the design of the pipeline CP system :

— soil pH, and the presence of bacteria which can cause corrosion ;

— types and locations of neighbouring telemetry systems which can be used for remote monitoring.

5.3 Criteria for CP

5.3.1 General

The metal-to-electrolyte potential at which the corrosion rate is less than 0,01 mm per year is the protection potential, E_p. This corrosion rate is sufficiently low so that corrosion will be within acceptable limits for the design life. The criterion for CP is therefore :

$$E \leq E_p$$

The protection potential of a metal depends on the corrosive environment (electrolyte) and on the type of metal used.

The protection potential criterion applies at the metal/electrolyte interface, i.e. a potential which is free from the IR drop in the corrosive environment (IR-free potential/polarized potential).

Some metals can be subject to hydrogen embrittlement at very negative potentials, and coating damage can also increase at very negative potentials. For such metals, the potential shall not be more negative than a limiting critical potential E_l. In such cases, the criterion for CP is :

$$E_l \leq E \leq E_p$$

5.3.2 Protection criteria

5.3.2.1 The CP system shall be capable of polarizing all parts of the buried pipeline to potentials more negative than – 850 mV referred to CSE, and to maintain such potentials throughout the design life of the pipeline. These potentials are those which exist at the metal-to-environment interface, i.e. the polarized potentials.

To prevent damage to the coating, the limiting critical potential should not be more negative than – 1 200 mV referred to CSE, to avoid the detrimental effects of hydrogen production and/or a high pH at the metal surface.

For high strength steels (specified minimum yield strength greater than 550 MPa) and corrosion-resistant alloys such as martensitic and duplex stainless steels, the limiting critical potential shall be determined with respect to the detrimental effects in the material due to hydrogen formation at the metal surface. Stainless steels and other corrosion-resistant alloys generally need protection potentials more positive than – 850 mV referred to CSE; however, for most practical applications this value can be used.

For pipelines operating in anaerobic soils and where there are known, or suspected, significant quantities of sulfate-reducing bacteria (SRB) and/or other bacteria having detrimental effects on pipeline steels, potentials more negative than – 950 mV referred to CSE should be used to control external corrosion.

For pipelines operating in soils with very high resistivity, a protection potential more positive than – 850 mV referred to CSE may be considered, e.g. as follows :

— – 750 mV for $100 < \rho < 1\,000$;