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Petroleum and natural gas industries — Corrosion resistant alloy clad bends and fittings for pipeline transportation system —

Part 1: Clad bends

Industries du pétrole et du gaz naturel — Coudes et raccords recouverts d'alliage résistant à la corrosion pour système de transport par conduites —

Partie 1: Coudes recouverts

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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 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, *Oil and gas industries including lower carbon energy*, Subcommittee SC 2, *Pipeline transportation systems*.

A list of all parts in the ISO 24139 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.

Petroleum and natural gas industries — Corrosion resistant alloy clad bends and fittings for pipeline transportation system —

Part 1: Clad bends

1 Scope

This document specifies the technical delivery conditions regarding design, geometric dimensions, materials, manufacturing procedures, inspection methods, non-destructive testing (NDT), marking, package and storage for corrosion resistant alloy (CRA) clad bends for use in pipeline transportation systems for the petroleum and natural gas industries.

This document is applicable to CRA clad bends for use in transportation or process pipelines transporting corrosive media-containing single-phase or multi-phase fluid such as oil, gas and water for the petroleum and natural gas industries. It can also be used as reference in other fields.

Two technical delivery conditions classes for clad bends are designated. Class B provides a standard quality level for clad bends and Class S provides technical requirements for sour-service conditions. It is the responsibility of the purchaser to specify the appropriated class, based upon the intended use and design requirements.

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 148-1, *Metallic materials — Charpy pendulum impact test — Part 1: Test method*

ISO 3183:2019, *Petroleum and natural gas industries — Steel pipe for pipeline transportation systems*

ISO 6507 (all parts), *Metallic materials — Vickers hardness test*

ISO 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature*

ISO 6892-2, *Metallic materials — Tensile testing — Part 2: Method of test at elevated temperature*

ISO 7438, *Metallic materials — Bend test*

ISO 7539-2, *Corrosion of metals and alloys — Stress corrosion testing — Part 2: Preparation and use of bent-beam specimens*

ISO 8501-1:2007, *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 9712, *Non-destructive testing — Qualification and certification of NDT personnel*

ISO 10474, *Steel and steel products — Inspection documents*

ISO 10893-4, *Non-destructive testing of steel tubes — Part 4: Liquid penetrant inspection of seamless and welded steel tubes for the detection of surface imperfections*

ISO 10893-5, *Non-destructive testing of steel tubes — Part 5: Magnetic particle inspection of seamless and welded ferromagnetic steel tubes for the detection of surface imperfections*

ISO 10893-6, *Non-destructive testing of steel tubes — Part 6: Radiographic testing of the weld seam of welded steel tubes for the detection of imperfections*

ISO 10893-8, *Non-destructive testing of steel tubes — Part 8: Automated ultrasonic testing of seamless and welded steel tubes for the detection of laminar imperfections*

ISO 10893-9, *Non-destructive testing of steel tubes — Part 9: Automated ultrasonic testing for the detection of laminar imperfections in strip/plate used for the manufacture of welded steel tubes*

ISO 10893-10, *Non-destructive testing of steel tubes — Part 10: Automated full peripheral ultrasonic testing of seamless and welded (except submerged arc-welded) steel tubes for the detection of longitudinal and/or transverse imperfections*

ISO 10893-11, *Non-destructive testing of steel tubes — Part 11: Automated ultrasonic testing of the weld seam of welded steel tubes for the detection of longitudinal and/or transverse imperfections*

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

ISO 14732, *Welding personnel — Qualification testing of welding operators and weld setters for mechanized and automatic welding of metallic materials*

ISO 15156-1, *Petroleum and natural gas industries — Materials for use in H2S-containing environments in oil and gas production — Part 1: General principles for selection of cracking-resistant materials*

ISO 15156-3:2020, *Petroleum and natural gas industries — Materials for use in H2S-containing environments in oil and gas production — Part 3: Cracking-resistant CRAs (corrosion-resistant alloys) and other alloys*

ISO 15590-1:2018, *Petroleum and natural gas industries — Induction bends, fittings and flanges for pipeline transportation systems — Part 1: Induction bends*

ISO 15614-7, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 7: Overlay welding*

ISO 15614-8, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 8: Welding of tubes to tube-plate joints*

ISO 80000-1:2009, *Quantities and units — Part 1: General*

ASME BPVC Section II - Materials — Part C *Specifications for welding rods, electrodes, and filler metals*

ASME BPVC Section IX *Qualification standard for welding, brazing, and fusing procedures; welders; brazers; and welding, brazing, and fusing operators*

ASNT SNT-TC-1A, *Recommended practice No. SNT-TC-1A: Personnel qualification and certification in non-destructive testing*

ASTM A262-15, *Standard practices for detecting susceptibility to intergranular attack in austenitic stainless steels*

ASTM A263-12, *Standard specification for stainless Chromium steel-clad plate*

ASTM A264-12, *Standard specification for stainless Chromium-Nickel steel-clad plate*

ASTM A265-12, *Standard specification for Nickel and Nickel-base alloy-clad steel plate*

ASTM A370, *Standard test methods and definitions for mechanical testing of steel products*

ASTM A435, *Standard Specification for straight-beam ultrasonic examination of steel plates*

ASTM A578/A578M-17, *Standard specification for straight-beam ultrasonic examination of rolled steel plates for special applications*

ASTM A751, *Standard test methods, practices, and terminology for chemical analysis of steel products*

ASTM A923-14, *Standard test methods for detecting detrimental intermetallic phase in duplex austenitic/ferritic stainless steels*

ASTM E3, *Standard guide for preparation of metallographic specimens*

ASTM E92, *Standard test methods for Vickers hardness and Knoop hardness of metallic materials*

ASTM E165, *Standard test method for liquid penetrant examination*

ASTM E273, *Standard practice for ultrasonic testing of the weld zone of welded pipe and tubing*

ASTM E340, *Standard practice for macroetching metals and alloys*

ASTM E353, *Standard test methods for chemical analysis of stainless, heat-resisting, maraging, and other similar Chromium-Nickel-Iron alloys*

ASTM E407, *Standard practice for microetching metals and alloys*

ASTM E562, *Standard test method for determining volume fraction by systematic manual point count*

ASTM E587, *Standard practice for ultrasonic angle-beam contact testing*

ASTM E709, *Standard guide for magnetic particle testing*

ASTM G1, *Standard practice for preparing, cleaning, and evaluating corrosion test specimens*

ASTM G28-02, *Standard test methods for detecting susceptibility to intergranular corrosion in wrought, Nickel-rich, Chromium-bearing alloys*

ASTM G39, *Standard practice for preparation and use of bent-beam stress-corrosion test specimens*

ASTM G48-11, *Standard test methods for pitting and crevice corrosion resistance of stainless steels and related alloys by use of ferric chloride solution*

ASTM G111, *Standard guide for corrosion tests in high temperature or high pressure environment, or both*

NACE TM0177, *Standard test method laboratory testing of metals for resistance to sulfide stress cracking and stress corrosion cracking in* H_2S *environments*

NACE TM0284, *Standard test method — Evaluation of pipeline and pressure vessel steels for resistance to hydrogen-induced cracking*

3 Terms, definitions, abbreviated terms and symbols

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 15590-1 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/

3.1.1
backing steel
substrate of the clad plate, clad pipe or clad bends withstanding mechanical load or pressure, and made of carbon steel or low alloy steel

3.1.2
clad layer
layer of the corrosion resistant alloy metallurgically bonded to the surface of the backing steel of clad plate, clad pipe or clad bend

Note 1 to entry: Metallurgically bonded CRA layer is to be produced by hot roll bonding, weld overlaying, explosion cladding, coextruding or some other process that produces the atomic diffusion interface between CRA and carbon steel or low alloy steel.

3.1.3
corrosion resistant alloy
CRA
alloy such as stainless steel and nickel-based alloy intended to be resistant to general and localized corrosion of oilfield environments that are corrosive to carbon steel

[SOURCE: ISO 15156-1:2020, 3.6, modified — Examples of alloys have been added.]

3.1.4
manufacturer
firm, company or corporation responsible for making and marking the product in accordance with specific requirements

Note 1 to entry: The requirements of this document.

[SOURCE: ISO 15590-1:2018, 3.17]

3.1.5
mother clad pipe
metallurgical straight clad pipe from which the corrosion resistant alloy clad bend is made

3.1.6
mother steel bend
carbon steel or low-alloy steel bend onto which the clad bend is made by weld overlay with corrosion resistant alloy

3.1.7
neutral axis
region of the bend that does not suffer the stress of traction or compression during manufacture and that separates the region of the intrados (compressed region) from the extrados (region pulled), where it is not considered a reduction in wall thickness

3.1.8
neutral zone
zone near the neutral axis of the bend arc

3.1.9
bond shear strength
tangential stress per unit contact area required to separate the clad layer from the backing steel of the metallurgically bonded clad plate, clad pipe or clad bend

3.1.10
sour environment
exposure to oilfield environments that contain sufficient H_2S to cause cracking of metallic materials by mechanisms

Note 1 to entry: The mechanisms addressed by ISO 15156-1:2020.

[SOURCE: ISO 15156-1:2020, 3.20, modified — Note 1 to entry has been added.]

3.2 Abbreviated terms

CLB clad bend

CVN Charpy V-notch

FPB four-point bend beam

HAZ heat-affected zone

HIC hydrogen induced cracking

MPQT manufacturing procedure qualification test

MPS manufacturing procedure specification

MT magnetic particle testing

NDT non-destructive testing

PREN pitting resistance equivalent number

PT penetrant testing

RT radiographic testing

SCC stress corrosion cracking

SMYS specified minimum yield strength

SSC sulfide stress cracking

TIG tungsten inert-gas arc welding

UT ultrasonic testing

WPS welding procedure specification

WT wall thickness

3.3 Symbols

A elongation of tensile test specimen after fracture, expressed as a percentage

D nominal outside diameter of clad bend

d specified inside diameter at the tangent ends of a clad bend

L tangent length of a clad bend

t specified minimum wall thickness of clad layer of a clad bend

t_B nominal wall thickness of backing steel of clad bend

R_m ultimate tensile strength

$R_{t0,5}$ yield strength for 0,5 % total elongation

r_b radius of neutral axial of bends

4 General

4.1 Units of measurement

In this document, data are expressed in SI units. For a specific order item, unless otherwise stated, only one system of units shall be used, without combining data expressed in the other system.

4.2 Rounding

Unless otherwise stated in this document, observed or calculated values shall be rounded to the nearest unit in the last right-hand place of figures used in expressing the limiting value, in accordance with ISO 80000-1:2009, Annex B, Rule A.

5 Information supplied by the purchaser

5.1 General requirements

The purchaser shall provide the following information:

a) a reference to this document, i.e. ISO 24139-1:2022;

b) designation of each clad bend;

c) quantity of clad bends;

d) grade of backing steel;

e) CRA material type or identification of clad layer;

f) manufacturing process: induction bending or weld overlay or other process as agreed;

g) supply of mother clad pipes or mother steel bends by the purchaser or the manufacturer;

h) required clad bend dimensions, including:

- nominal outside diameter;
- specified inside diameter at the tangent end;
- minimum (or nominal) wall thickness of backing steel;
- minimum (or nominal) wall thickness of clad layer;
- bend radius;
- bend angle;
- tangent length.

i) end preparation if different from square ends.

5.2 Recommendations

The purchaser should specify additional information such as:

a) pipeline operating conditions, including composition of transported fluid, temperature and pressure;

b) minimum design temperature;

c) maximum design temperature;

d) maximum wall thickness for both backing steel and clad layer;

e) special dimensional requirements;

f) requirements for supplementary inspection and testing;

g) requirements for gauging and other measurements of dimensions, if different from this document;

h) pipeline design standard or design factors;

i) whether post-bending heat treatment is used;

j) whether ISO 15590-1:2018, Annex B is used for the backing layer of clad bends that are ordered for sour service;

k) mechanical property requirements for backing steel at high temperatures;

l) requirements for proof burst testing or hydrostatic testing;

m) requirements for corrosion resistance for both backing steel and clad layer;

n) surface condition requirements;

o) coating or painting requirements;

p) marking requirements, if different from this document;

q) packaging and shipping instructions;

r) third-party inspection organization;

s) specifications and materials of matching pipes;

t) other special requirements.

5.3 Requirements and recommendations on the mother clad pipe

5.3.1 If the mother clad pipe is supplied by the purchaser, the following shall be provided to the manufacturer:

a) purchasing specification;

b pipe diameter, inside or outside;

c) pipe wall thickness (nominal or minimum values for both backing steel and clad layer);

d) pipe length;

e) grade of backing steel;

f) CRA type of clad layer;

g) pipe manufacturer;

h) mill certificate.

5.3.2 If the mother clad pipe is supplied by the purchaser, the following should be provided to the manufacturer:

a) material specification of clad pipe, including chemical composition, carbon equivalent for the backing steel, heat treatment, mechanical properties, results of NDT and hydrostatic testing;

b) WPS and weld metal chemical composition for welded clad pipe;