INTERNATIONAL STANDARD

ISO 15590-4

First edition
2019-09

Petroleum and natural gas industries — Factory bends, fittings and flanges for pipeline transportation systems —

Part 4: Factory cold bends

Reference number
ISO 15590-4:2019(E)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

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.

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).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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 and offshore structures for petroleum, petrochemical and natural gas industries*, Subcommittee SC 2, *Pipeline transportation systems*.

A list of all parts in the ISO 15590 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

This document makes reference to line pipe and bends with delivery conditions based on ISO 3183.

This document contains additional requirements for special applications as follows:

— Manufacturing procedure specification (Annex A);

— PSL 2S cold bends ordered for sour service (Annex B).

The requirements of the annexes apply only where they are specified on the purchase order. This document does not provide guidance on when it is necessary to specify the above supplementary requirements defined in the annexes. It is the responsibility of the purchaser to specify, based upon the intended use and design requirements, the supplementary requirements that will apply for a particular purchase order.

Further or differing requirements can be needed for individual applications. This document is not intended to inhibit a manufacturer from offering, or the purchaser from accepting, alternative equipment or engineering solutions for the individual application. This can be particularly applicable where there is innovative or developing technology. Where an alternative is offered, it is the responsibility of the manufacturer to identify and provide details of any variations from this document.

Petroleum and natural gas industries — Factory bends, fittings and flanges for pipeline transportation systems —

Part 4: Factory cold bends

1 Scope

This document specifies the technical delivery conditions for bends made by the cold bending process for bend with radii 5xOD or higher for use in pipeline transportation systems for the petroleum and natural gas industries as defined in ISO 13623.

This document also specifies the requirements for the manufacture of two product specification levels (PSLs) of cold bends corresponding to product specification levels given for pipe in ISO 3183. This document is applicable to cold bends made from seamless and welded pipe of unalloyed or low-alloy steels.

NOTE 1 These are typically C-Mn steels or low-alloy steels that are appropriate for the corresponding level and grade of line pipe in accordance with ISO 3183.

This document is not applicable to the selection of the cold bend product specification level. It is the responsibility of the purchaser to specify the PSL, based upon the intended use and design requirements.

NOTE 2 See also ISO 3183:2012, Introduction.

This document is not applicable to field cold bends and pipeline bends made by other manufacturing processes.

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

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

ISO 3183:2012, *Petroleum and natural gas industries — Steel pipe for pipeline transportation systems*

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

ISO 6508 (all parts), *Metallic materials — Rockwell 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, *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 10893-8, *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 10893-10:2011, *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 10893-11:2011, *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*

ASNT SNT-TC-1A, *Recommended Practice No. SNT-TC-1A: Personnel Qualification and Certification in Nondestructive Testing*

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, Standard Specification for Straight-Beam Ultrasonic Examination of Rolled Steel Plates for Special Applications*

ASTM E18, *Standard Test Methods for Rockwell Hardness of Metallic Materials*

ASTM E92, *Standard Test Method for Vickers Hardness of Metallic Materials*

ASTM E112, *Standard Test Methods for Determining Average Grain Size*

ASTM E165, *Standard Test Method for Liquid Penetrant Examination*

ASTM E213, *Standard Practice for Ultrasonic Testing of Metal Pipe and Tubing*

ASTM E214, *Standard Practice for Ultrasonic Pulse-Echo Straight-Beam Contact Testing*

ASTM E340, *Standard Test Method for Macroetching Metals and Alloys*

ASTM E709, *Standard Guide for Magnetic Particle Testing*

ASTM E797, *Standard Practice for Measuring Thickness by Manual Ultrasonic Pulse-Echo Contact Method*

ASTM G39, *Standard Practice for Preparation and Use of Bent-Beam Stress-Corrosion Test Specimens*

NACE/TM 0177:2016, *Laboratory Testing of Metals for Resistance to Sulfide Stress Cracking in Hydrogen Sulfide (H_2S) Environments*

NACE/TM 0284:2016, *Standard Test Method — Evaluation of Pipeline and Pressure Vessel Steels for Resistance to Hydrogen-Induced Cracking*

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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 http://www.electropedia.org/

3.1
arc
curved portion of a bend

3.2
agreed
agreed upon by the *manufacturer* (3.17) and *purchaser* (3.21), and specified in the purchase order

3.3
bend angle
amount of directional change through the cold bend

3.4
bend qualification test
qualification test that produces a cold bend in accordance with the *MPS* (3.18) and demonstrates that bends that meet the specified requirements of this document can be produced

3.5
bend radius
distance from the centre of curvature to the centreline axis of the bent pipe

3.6
chord
line segment connecting start and stop points of the bend zone measured at the centreline axis

3.7
defect
imperfection (3.11) of a size and/or population density greater than specific acceptance criteria

Note 1 to entry: The specific acceptance criteria are specified in ISO 3183.

3.8
extrados
outer curved section of the *arc* (3.1)

3.9
heat
batch of steel prepared in one steel-making operation

3.10
if agreed
required to be as prescribed, or more stringent than is prescribed, if agreed upon by the *manufacturer* (3.17) and the *purchaser* (3.21) and specified in the purchase order

3.11
imperfection
discontinuity or irregularity in the product wall or on the product surface that is detectable through inspection methods

3.12
indication
evidence obtained by *non-destructive inspection* (3.20)

3.13
cold bending
controlled bending process using presses at room temperature

3.14
inspection
activities, such as measuring, examining, testing, weighing or gauging one or more characteristics of a product and comparing the results of such activities with the specified requirements in order to determine conformity

3.15
intrados
inner curved section of the *arc* (3.1)

3.16
lamination
internal metal separation that creates layers, generally parallel to the pipe/bend surface

3.17
manufacturer
firm, company, or corporation responsible for making and marking the product

3.18
manufacturing procedure specification
MPS
document that specifies the properties and description of the *mother pipe* (3.19), the cold bending procedure, the post- bending heat treatment equipment and cycle, if applicable, the qualification bend testing results, the non-destructive testing procedures and the weld end bevel details used for the manufacture of the cold bends

3.19
mother pipe
straight section of pipe from which a cold bend is made

3.20
non-destructive inspection
inspection (3.14) to reveal *imperfections* (3.11), using radiographic, ultrasonic or other methods that do not involve disturbance, stressing or breaking of the materials

3.21
purchaser
party responsible for both the definition of the requirements for a product order and the payment of that order

3.22
submerged-arc welding
SAW
welding process that produces melting and coalescence of metals by heating them with an arc(s) between a bare metal consumable electrode(s) and the workpiece, wherein the *arc* (3.1) and molten metal are shielded by a blanket of granular flux

3.23
service condition
condition of use that is specified by the *purchaser* (3.21) in the purchase order

Note 1 to entry: In this document, “sour service” and “offshore service” are service conditions.

3.24
strip end weld
weld that joins strip ends together

3.25
plate end weld
weld that joins plate ends together

3.26
tangent
straight section at the ends of a cold bend

3.27
wall thinning
amount of reduction from the actual wall thickness of the pipe to the wall thickness in the *extrados* (3.8) after *cold bending* (3.13)

4 Symbols and abbreviated terms

4.1 Symbols

A	elongation of tensile test specimen after fracture, expressed as a percentage
L_{CVD}	crest to valley depth
D_2 and D_4	outside diameters of two adjacent crests
D_3	outside diameter of the intervening valley
D	specified diameter, outside or inside
D_{max}	maximum measured diameter, outside or inside
D_{min}	minimum measured diameter, outside or inside
Dn	nominal pipe diameter
L	distance between adjacent crests for waving
O	out-of-roundness
R_b	bend centreline radius
R_p	nominal mid-thickness radius of the mother pipe
R_m	ultimate tensile strength
$R_{t,0,5}$	yield strength for 0,5 % total elongation
t_i	minimum wall thickness at the bend intrados
t_{min}	minimum wall thickness required in accordance with ISO 13623, or other applicable design code, for the straight pipe adjacent to the bend, including any corrosion allowance

4.2 Abbreviated terms

BQT	cold bend qualification test
CB	cold bending
CTOD	crack tip opening displacement testing
CVD	crest to valley depth