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Oil and gas industries including lower carbon energy — Piping systems on offshore production platforms and onshore plants —

Part 3: Fabrication

Industries du pétrole et du gaz, y compris les énergies à faible teneur en carbone — Conception et installation des systèmes de tuyauterie sur les plates-formes de production en mer et les installations à terre —

Partie 3: Fabrication

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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 document 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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This document was prepared by Technical Committee ISO/TC 67, *Oil and gas industries including lower carbon energy*, Subcommittee SC 6, *Process equipment, piping, systems, and related safety*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 12, Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This first edition of ISO 13703-3, together with ISO 13703-1 and ISO 13703-2, cancels and replaces ISO 13703:2000. It also incorporates the Technical Corrigendum ISO 13703:2000/Cor.1:2002.

The main changes compared to the previous edition are as follows:

— deletion of the installation and quality control requirements of Clause 10;

— deletion of previous Annex C as requirements are addressed in ASME B31.3.

A list of all parts in the ISO 13703 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 aim of this document is to establish common requirements for the fabrication, welding, inspection, examination and testing of new, metallic process piping systems designed in accordance with the requirements of ISO 13703-1, and using bulk piping materials in accordance with ISO 13703-2.

This document makes normative reference to ASME B31.3 as the base code for process piping. Alternative codes to ASME B31.3 exist for the fabrication, welding, inspection, examination and testing of process piping systems along with the potential need to comply with local or national regulatory/jurisdictional requirements. The user of this document is expected to assess the implications arising from local or national regulatory/jurisdictional requirements in implementing the requirements herein, including the need to specify additional requirements to those stated. ASME B31.3, Appendix N provides guidance on its use internationally, and specifically its use within the European Union for which additional requirements to those specified in ASME B31.3 will be necessary to meet the requirements of Directive 2014/68/EU on the harmonization of the laws of the Member States relating to the making available on the market of pressure equipment (PED).

This document is not intended to inhibit a user from accepting alternative fabrication, welding, examination or testing solutions for the individual application. This can be particularly appropriate where there is innovative or developing technology. Where an alternative to the requirements in this document is offered, the user is expected to review the implications in meeting the performance requirements within this document.

Oil and gas industries including lower carbon energy — Piping systems on offshore production platforms and onshore plants —

Part 3: Fabrication

1 Scope

This document specifies requirements for the fabrication, installation, welding, inspection, examination and testing of new, metallic piping systems , within temperature range limits for the materials meeting the requirements of ASME B31.3, on fixed and floating offshore production facilities and onshore production, processing and gas liquefaction plants. For piping systems above pressure class 2500, the requirements of chapter IX of ASME B31.3 shall be complied with, in addition to the requirements stated in this standard.

This document is applicable to all pressure retaining components and any non-pressure retaining component, such as a member of a pipe support, welded directly to a pressure retaining component.

This document is not applicable to the following:

— marine-related piping systems, e.g. ballasting piping systems, systems covered by classification societies;

— metallic tubing used for subsea umbilical systems;

NOTE 1 Reference can be made to ISO 13628-5 or API Spec 17E for welding and examination of these components.

— piping systems with corrosion resistant cladding (either integrally clad or mechanically lined) or weld overlay, including buttering and associated dissimilar welds;

NOTE 2 Reference can be made to DNVGL-RP-B204 for welding and examination of these systems.

— refractory alloys [with exception of CP titanium Grade 1 (UNS R50250) or Grade 2 (UNS R50400)];

— non-metallic piping assemblies;

— transportation pipeline systems, including flow-lines, designed in accordance with a recognized pipeline design code.

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 3834-2, *Quality requirements for fusion welding of metallic materials — Part 2: Comprehensive quality requirements*

ISO 8249, *Welding — Determination of Ferrite Number (FN) in austenitic and duplex ferritic-austenitic Cr-Ni stainless steel weld metals*

ISO 9015-1, *Destructive tests on welds in metallic materials — Hardness testing — Part 1: Hardness test on arc welded joints*

ISO 9606 (all parts), *Qualification testing of welders — Fusion welding*

ISO 9712, *Non-destructive testing — Qualification and certification of NDT personnel*

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

ISO 11666:2018, *Non-destructive testing of welds — Ultrasonic testing — Acceptance levels*

ISO 11699-1, *Non-destructive testing — Industrial radiographic film — Part 1: Classification of film systems for industrial radiography*

ISO 14175, *Welding consumables — Gases and gas mixtures for fusion welding and allied processes*

ISO 14344, *Welding consumables — Procurement of filler materials and fluxes*

ISO 14731, *Welding coordination — Tasks and responsibilities*

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

ISO 15156-2, *Petroleum and natural gas industries — Materials for use in H2S containing environments in oil and gas production — Part 2: Cracking-resistant carbon and low alloy steels, and the use of cast irons*

ISO 15156-3, *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 15609-1, *Specification and qualification of welding procedures for metallic materials — Welding procedure specification — Part 1: Arc welding*

ISO 15614-1, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys*

ISO 15614-5, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 5: Arc welding of titanium, zirconium and their alloys*

ISO 15614-6, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 6: Arc and gas welding of copper and its alloys*

ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

ISO 17636-2, *Non-destructive testing of welds — Radiographic testing — Part 2: X- and gamma-ray techniques with digital detectors*

ISO 17781:2017, *Petroleum, petrochemical and natural gas industries — Test methods for quality control of microstructure of ferritic/austenitic (duplex) stainless steels*

ISO 18265, *Metallic materials — Conversion of hardness values*

ISO 22825, *Non-destructive testing of welds — Ultrasonic testing — Testing of welds in austenitic steels and nickel-based alloys*

ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*

API RP 686, *Machinery Installation and Installation Design*

ASME B31.3, *Process Piping*

Boiler ASME, and Pressure Vessel Code, Section II, Materials, Part C:2019, Specifications for welding rods, electrodes, and filler metals

Boiler ASME, and Pressure Vessel Code, Section V:2019, Non Destructive Testing

Boiler ASME, and Pressure Vessel Code, Section IX:2019, Welding and Brazing Qualifications

ASNT CP-189, *Standard for Qualification and Certification of Nondestructive Testing Personnel*

ASNT SNT-TC-1A, *Personnel Qualification and Certification in Nondestructive Testing*

ASTM A380, *Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems*

ASTM E140, *Standard Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, Scleroscope Hardness, and Leeb Hardness*

ASTM E1815, *Standard Test Method for Classification of Film Systems for Industrial Radiography*

ASTM G48, *Standard Test Methods for Pitting and Crevice Corrosion Resistance of Stainless Steels and Related Alloys by Use of Ferric Chloride Solution*

AWS A4.2M, *Standard Procedures for Calibrating Magnetic Instruments to Measure the Delta Ferrite Content of Austenitic and Duplex Ferritic-Austenitic Stainless Steel*

AWS D10.10, *Recommended Practices for Local Heating of Welds in Piping and Tubing*

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

PFI ES-3, *Fabricating Tolerances*

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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
alkaline service
service environments containing alkaline compounds such as amines, caustic, carbonates

3.2
bolted connection
connections with bolts, to allow assembly and disassembly, that uses flanges or clamps as connectors.

3.3
carbon equivalent
C_E
numerical value for a steel's composition that represents the contribution of the relevant elements to the hydrogen cracking susceptibility of steel

Note 1 to entry: The carbon equivalent is based on:

$$C_E = \%C + \left(\frac{\%\,Mn}{6}\right) + \left(\frac{\%\,Cr + \%\,Mo + \%\,V}{5}\right) + \left(\frac{\%\,Ni + \%\,Cu}{15}\right)$$

where all mass fractions are expressed in percent.

3.4
closure weld
final weld connecting piping systems, assemblies or sub-assemblies that have been successfully leak tested, but that itself is not subject to leak testing

Note 1 to entry: Closure welds include any welds made after leak or tightness testing, such as seal welds to threaded connections, or repair welds made in the event of a leak that are not subject to further leak test, if approved by owner.

Note 2 to entry: Closure welds are often also referred to as 'golden welds'.

3.5
computerized imaging technique
CIT
manual or encoded ultrasonic examination technique with capability for computer processed display or analysis and display of ultrasonic data to provide two or three dimensional surfaces

3.6
confined space
space that is substantially but not necessarily entirely enclosed, and where serious injury can occur from hazardous substances or conditions within the space or nearby (e.g. lack of oxygen)

Note 1 to entry: Confined space includes access into the internal bore of pipes to install, inspect and remove internal backing gas dams, and during cleaning, flushing, leak and tightness testing activities.

3.7
cryogenic service
service environments with a minimum design temperature lower than –104 °C

3.8
low-alloy steel
steel with significant alloy additions (e.g. Groups 4 to 6 according to ISO 15608, or P-No. 3 to P-No 5 and P-No. 15E according to ASME B31.3)

3.9
extrados
outer curved portion of a bend

3.10
fabricator
organization responsible for the fabrication, welding, examination and testing of piping systems including any externally provided products or services

Note 1 to entry: For the purposes of this document, "fabricator" is considered interchangeable with "manufacturer", "erector", "employer" or "purchaser" where these terms are used in referenced documents.

3.11
fibre elongation
elongation during bending or forming calculated as 100 r/R expressed as percentage

Note 1 to entry: Fibre elongation can be determined by physical measurement or calculation.

3.12
heat input
energy introduced into the weld region during welding per unit run length

Note 1 to entry: The reference for the calculation of heat input is ASME Boiler and Pressure Vessel Code, Section IX:2019 for the specific welding process.

3.13
high alloyed stainless steel
austenitic stainless steel typically having PREN ≥ 40 or [% Ni + 2 (% Mo)] > 30 where % Mo > 2, where all mass fractions are expressed as percent

EXAMPLE SS type 6Mo or SS type 565.

3.14
intrados
inner curved portion of a bend

3.15
leak testing
application of a pressure load greater than the design load to demonstrate the integrity of a piping assembly to safely withstand the design load

Note 1 to entry: Leak testing is also referred to as “hydrostatic leak testing” or “pneumatic leak testing”, or combination thereof, as defined in ASME B31.3.

3.16
lot
totality of welds completed by all welders, and accepted by visual examination on any one day, unless otherwise defined in the engineering design

[SOURCE: PFI ES48:2015]

3.17
low sulfur oil
heating oil with maximum sulfur content of 1 000 ppm

3.18
nepheleometric turbidity units
NTU
measurement of water turbidity

3.19
owner
person, partnership, organization or business ultimately responsible for design, construction, operation, and maintenance of a facility

[SOURCE: ASME B31.3]

3.20
pitting resistance equivalent number
number indicating the resistance of stainless steels to pitting corrosion and related to chemical composition

Note 1 to entry: PREN is calculated from one of the following formulas:

PREN = % Cr + 3,3 % Mo + 16 % N

PREN = % Cr + 3,3 % (Mo + 0,5 W) + 16 % N

where all mass fractions are expressed as percent.

Note 2 to entry: All PREN limits are absolute limits based upon the heat analysis. The calculated value shall not be rounded.

3.21
sour service
service environments that contain sufficient H_2S to cause cracking of materials

Note 1 to entry: For the purpose of the do document, the mechanisms that result in cracking are addressed in ISO 15156-2 or ISO 15156-3.

Note 2 to entry: For the purpose of this document, NACE MR0175-2 and NACE MR0175-3 are equivalent to ISO 15156-2 and ISO 15156-3, respectively.

3.22
stainless steel 300-series
SS 300-seriesaustenitic stainless steel with at least 16 % Cr (mass fraction) and 8 % Ni (mass fraction) possibly with other elements added to secure special properties

Note 1 to entry: Low carbon grades are typically used where welding is required.

EXAMPLE UNS S30400, UNS S30403, UNS S31600, UNS S31603.

3.23
stainless steel type 22Cr duplex
SS type 22Cr duplex
ferritic/austenitic stainless steel alloys with 30,0 < PREN < 40,0 and Cr ≥ 19 % (mass fraction)

EXAMPLE UNS S31803, UNS S32205.

3.24
stainless steel type 25Cr duplex
SS type 25Cr duplex
ferritic/austenitic stainless steel alloys with 40,0 ≤ PREN < 48,0

Note 1 to entry: This alloy is often referred to as “super duplex”.

EXAMPLE UNS S S32505, UNS S32550, UNS S32750, UNS S32760, UNS S39274, UNS S39277.

3.25
stainless steel type 6Mo
SS type 6Mo
austenitic stainless steel with PREN ≥ 40 and a nominal Mo alloying content of 6 % (mass fraction) and nickel alloys with Mo content in the range 6 % to 8 % (mass fraction)

EXAMPLE UNS S31254, UNS N08367, UNS N08926.

3.26
stainless steel type 565
SS type 565
manganese austenitic stainless steel with Mn content in the range 4 % to 12 % (mass fraction) and PREN ≥ 40

EXAMPLE UNS S34565.

3.27
tangent
straight section at the end of a bend

3.28
tightness testing
application of a pressure differential to a piping assembly to detect leakage paths or rates

Note 1 to entry: Tightness testing includes testing of mechanically completed piping systems as part of pre-commissioning activities, and sensitive leak tests as defined in ASME B31.3.

3.29
transition zone
areas of the start and stop points of induction heating, which include material that extends from the unheated mother pipe to the material that has been heated to the full bending temperature

3.30
weav bead
weld bead formed using weaving. See also stringer bead.

3.31
weaving
welding technique in which the energy source is oscillated transversely as it progresses along the weld path

3.32
weld zone
grouping of weld passes with similar parameters and function, e.g. root, fill and cap

3.33
stringer bead
weld bead formed without appreciable weaving

4 Abbreviated terms

4.1 Symbols

D	nominal pipe diameter, expressed in millimetres
H_{BW}	heated band width, expressed in millimetres
h	Maximum misalignment at a buttweld seam
L	length, expressed in millimetres
R	nominal bending radius to centreline of pipe, expressed in millimetres
r	nominal outside radius of the pipe, expressed in millimetres
t	nominal material thickness at the weld, expressed in millimetres
U_g	Geometric unsharpness

4.2 Abbreviated terms

AUT	Automatic Ultrasonic Testing
AWS	American Welding Society
aMDEA	activated MDEA
CMTR	certified material test report
CP	commercially pure (in relation to titanium materials)
CRA	corrosion resistant alloy
CSWIP	certification scheme for weldment inspection personnel
CWEng	certified welding engineer

DGA	di-glycol amine
DIPA	di-iso propyl amine
ECA	engineering critical assessment
EWE	European welding engineer
EWF	European Welding Federation
FCAW-G	flux cored arc welding – gas shielded
FCAW-S	flux cored arc welding – self shielded
FMC/TFM	full matrix capture/total focussing method
FN	ferrite number
GMAW	gas metal arc welding
GMAW-S	gas metal arc welding – short circuiting mode of transfer
GTAW	gas tungsten arc welding
HAZ	heat affected zone
HIP	hot isostatic pressed
HRC	Rockwell C hardness number
HV	Vickers hardness number
IIW	International Institute of Welding
ITP	inspection and test plan
MDEA	mono di-ethanol amine
MDMT	minimum design metal temperature (synonymous with design minimum temperature as defined in ASME B31.3)
MEA	mono ethanolamine
MT	magnetic particle testing (for use on magnetic materials)
NDT	non-destructive testing
NTU	neophelemetric turbidity units
OES	optical emission spectrometry
PAUT	phased array ultrasonic testing technique
PCN	Personal Certification for Non-Destructive Testing
PED	Pressure Equipment Directive (European Directive 2014/68/EU) see Annex D
PMI	positive materials identification
PREN	pitting resistance equivalent number
PT	liquid penetrant testing (for use on non-magnetic materials)

PQR	procedure qualification record
PWHT	post weld heat treatment
QL	quality level
QMS	quality management system
RT	radiographic testing
SAW	submerged arc welding
SMAW	shielded metal arc welding
SMYS	specified minimum yield stress
SS	stainless steel
SSC	sulphide stress cracking
SWPS	standard welding procedure specification
TOFD	time of flight diffraction
WPS	welding procedure specification
UNS	unified numbering system
UT	ultrasonic testing

5 Health, safety and quality requirements

5.1 Health and safety requirements

5.1.1 The fabricator shall at least provide the following safety equipment and systems:

a) ventilation and extraction facilities for welding-related activities or work in a confined space;

b) personal protective equipment including eye, breathing and hearing protection;

c) access/scaffolding/working platforms and fall-arrest protective equipment for working at height;

d) access and secure, temporary formwork for working below-grade;

e) protective systems to prevent electric shock, build-up or discharge of static electricity, and earthing of welding current through susceptible components in the piping assembly;

f) 'whip checks' on test hoses for flushing, cleaning, leak testing/tightness testing.

5.1.2 All work undertaken in a confined space shall be managed using a permit-to-work system.

NOTE 1 ISO 45001 specifies requirements for an occupational health and safety management system, and gives guidance for its use, to enable organizations to provide safe and healthy workplaces by preventing work-related injury and ill health, as well as by proactively improving its occupational health and safety performance. IOGP Report 423 describes a process by which clients can select suitable contractors, set out expectations and requirements, award contracts, and manage all the phases of the contracting process with a view to improving client and contractor management of health, safety and environmental risks for contracted activities.

Note 2 ANSI Z49.1 and ISO/TR/18786 give specific requirements and guidance on safety in Welding fabrication activities.