

Published: 2016-04-29

Language: English

Welding and inspection of piping

DRAFT

DRAFT

ICS: 75.180.01; 913.08

Copyright protected document

Unless otherwise specified, no part of this document may be reproduced or used in any form or in any way without written permission obtained in advance. This includes photocopies and electronic use, such as publishing on the Internet or an intranet. Any reproduction that violates this may lead to seizure, liability and/or legal prosecution. Requests related to reproduction are to be directed to Standard Online AS.

Welding and inspection of piping

Content

Foreword.....	3
1 Scope	5
2 Normative references	5
3 Terms and definitions	6
4 Abbreviations.....	8
5 Information for use of this standard (Informative)	9
5.1 General	9
5.2 Deviations to ASME B31.3.....	9
5.3 Listed alternatives to ASME V and IX.....	9
5.4 European Pressure Equipment Directive.....	9
5.5 Tolerances and significant digits.....	10
6 Quality assurance.....	10
6.1 General	10
6.2 Welding and NDT quality system.....	10
6.3 Welding coordination.....	10
6.4 Welder and welding operator qualification.....	11
6.5 Welding inspection.....	11
6.6 Qualification of inspectors and non-destructive testing operators.....	11
6.7 Quality system for test laboratories.....	11
7 Drawings for fabrication.....	11
8 Welding qualification requirements	11
8.1 General	11
8.2 Welding position.....	12
8.3 Heat input.....	12
8.4 Measuring and recording of test welds	12
8.5 Non-destructive testing of test welds	13
8.6 Mechanical testing	13
8.6.1 General	13
8.6.2 Impact tests.....	13
8.6.3 Macro-sections.....	13
8.6.4 Hardness tests	13
8.6.5 Corrosion testing.....	14
8.6.6 Micro-structural examination.....	14
8.7 Essential variables	14
8.7.1 General	14
8.7.2 Base materials	15
8.7.3 Consumables	15
8.7.4 Joints.....	15
8.7.5 Gas.....	15

9	Welding requirements.....	15
9.1	General.....	15
9.2	Colour coding of materials and welding consumables.....	16
9.3	Welding consumables	16
9.3.1	General	16
9.3.2	Carbon steels	16
9.3.3	Austenitic stainless steels type 6Mo and type 565	16
9.3.4	Duplex stainless steels.....	16
9.3.5	Titanium base alloys	17
9.3.6	Consumables for joining of dissimilar materials.....	17
9.4	Preheat and interpass temperature.....	17
9.5	Backing and shielding gas	17
9.6	Welds with buttering	17
9.7	Welding of o-lets.....	18
9.8	Cutting, grinding, brushing and weld cleaning	18
9.9	Post weld heat treatment	18
9.10	Production test	18
9.11	Temporary attachments	18
10	Inspection and non-destructive testing.....	19
10.1	General.....	19
10.2	Extent of non-destructive testing.....	19
10.3	Visual testing	20
10.4	Surface testing	20
10.5	Radiographic testing	20
10.6	Ultrasonic testing.....	20
10.7	Alternative non-destructive testing methods.....	21
10.8	Acceptance criteria.....	21
11	Repair.....	21
11.1	General.....	22
11.2	Repair in carbon steel	22
11.3	Repair in stainless steel and titanium	22
12	Positive material identification	22
	Annex A (Informative) Alternative acceptance criteria for normal service.....	23
	Annex B (Normative) Acceptable oxidations of welds in stainless steels	26
	Annex C (Informative) Weld inspection	27
	Annex D (Informative) Welding coordination/inspection functions	29
	Annex E (Informative) Colour coding systems for piping material and solid wire consumables	30
	Bibliography	31

Foreword

NORSOK M-601:2016 was adopted as NORSOK Standard in April 2016.

NORSOK M-601:2016 supersedes NORSOK M-601 Rev. 5, April 2008.

The NORSOK standards are developed by the Norwegian petroleum industry to ensure adequate safety, added value and cost effectiveness for petroleum industry developments and operations. Furthermore, NORSOK standards are as far as possible intended to replace oil company specifications and serve as references in the authorities' regulations.

The NORSOK standards are normally based on recognized international standards, adding the provisions deemed necessary to fill the broad needs of the Norwegian petroleum industry. Where relevant, NORSOK standards will be used to provide the Norwegian industry input to the international standardisation process. Subject to development and publication of international standards, the relevant NORSOK standards will be withdrawn.

The NORSOK standards are developed according to the consensus principle, generally applicable standards work and according to established procedures defined in NORSOK A-001N.

The NORSOK standards are prepared and published with support by the Norwegian Oil and Gas Association, the Federation of Norwegian Industries, Norwegian Shipowners' Association and The Petroleum Safety Authority (PSA) Norway.

NORSOK standards are administered and published by Standards Norway.

Annex B is normative. Annex A, C, D and E are informative.

DRAFT

Introduction

The intention of this NORSOK standard is to provide additional requirements regarding welding and inspection of piping systems designed to ASME B31.3 for hydrocarbon production and process systems and supporting utility systems.

In this edition the following main changes are introduced:

- the scope of the standard has been amended;
- definition of carbon steel is added;
- references to EN 473 is replaced with ISO 9712;
- references to EN 287 is replaced with ISO 9606-1;
- a new informative Clause for use of this standard is added;
- new sections for weld qualification with respect to welding position and range of heat input/arc energy are added;
- requirements related to low alloy steel and nickel base alloys are deleted;
- weld qualification requirements for austenitic stainless steel type 565 is added;
- recommendation for minimum distance between girth welds is added;
- requirement for documentation of compliance with ISO 3834-2 is added;
- requirement for organization chart and responsibility for responsible weld co-ordinator are added;
- requirements for measurement and recording of weld parameters during qualification test weld are added;
- requirements to the documentation dossier of WPQR/PQR is added;
- references to EN 1418 are replaced with ISO 14732;
- the corrosion test temperature of type 25Cr duplex is reduced to 35 °C;
- essential variable for change in groove angle is modified;
- the maximum interpass temperature of type 25Cr duplex is reduced to 100 °C for manual welding;
- requirements for measurement and maximum content of oxygen content in backing gas for welding of SS and titanium alloy is added;
- requirement for purging of gas when welding attachments to pipes is added;
- requirements to welds with buttering is added;
- requirement for PWHT procedure is added;
- requirements to removal of temporary attachments are added;
- visual testing of internal root run during welding o-lets to header is added;
- new section for visual testing is added;
- option to replace radiographic testing with ultrasonic testing is added for all materials;
- requirements for reporting level of UT is added;
- requirements for alternative NDT methods are added;
- acceptance criteria for oxidation of welds in titanium is modified;
- requirements to weld repair is modified;
- extent of PMI is modified.

In addition minor changes and modifications in wording are made.

1 Scope

This NORSOK standard covers additional and optional technical requirements to ASME B31.3 for welding and weld inspection of piping systems in material types carbon steel with SMYS \leq 360 MPa, SS type 316, type 6Mo, type 565, type 22Cr duplex and type 25Cr duplex, titanium grade 2 and copper-nickel alloys. The materials shall be selected and specified in accordance with piping class sheets included in NORSOK L-001. That means that this standard covers piping systems with nominal outside diameter greater than 20 mm and wall thickness ranging from 2,5 mm and above.

The standard applies to all welding and weld inspection of piping fabrication at all stages from prefabrication, through module or skid mounted unit assembly, site and field installation and modification work during operation.

2 Normative references

The following standards include provisions and guidelines, which through reference in this text, constitute provisions and guidelines of this NORSOK standard.

ASME Section II, *Materials Part C – Specifications for Welding Rods, Electrodes and Filler Metals*

ASME Section V, *Nondestructive Examination*

ASME Section VIII, *Rules for Construction of Pressure Vessels Division 1*

ASME Section IX, *Welding and Brazing Qualifications*

ASME B31.3, *Process Piping*

ASME PCC-2, *Repair of Pressure Equipment and Piping*

ASTM E 29, *Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications*

ASTM E 562, *Practice for Determining Volume Fraction by Systematic Manual Point Count*

ASTM G 48, *Standard Test Method for Pitting and Crevice Corrosion Resistance of Stainless Steel and Related Alloys by the use of Ferric Chloride Solution*

AWS A2.4, *Standard Symbols for Welding, Brazing, and Nondestructive Examination*

EN 1011-1, *Welding – Recommendations for welding of metallic materials – Part 1: General guidance for arc welding*

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

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

ISO 2553, *Welding and allied processes – Symbolic representation on drawings – Welded joints*

ISO 3059, *Non-destructive testing – Penetration testing and magnetic particle testing – Viewing conditions*

ISO 3452, *Non-destructive testing – Penetrant testing*

ISO 3690, *Welding and allied processes – Determination of hydrogen content in arc weld metal*

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

ISO 6520-1, *Welding and allied processes – Classification of geometric imperfections in metallic materials – Part 1: Fusion welding*

ISO 9001, *Quality management systems – Requirements*

ISO 9606-1, *Qualification testing of welders – Fusion welding – Part 1: Steels*

ISO 9606-3, *Approval testing of welders – Fusion welding – Part 3: Copper and copper alloys*

ISO 9606-4, *Approval testing of welders – Fusion welding – Part 4: Nickel and nickel alloys*

ISO 9606-5, *Approval testing of welders – Fusion welding – Part 5: Titanium and titanium alloys, zirconium and zirconium alloys*

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

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

ISO 14731, *Welding coordination – Tasks and responsibility*

ISO 14732, *Welding personnel – Qualification testing of welding operators 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 17025, *General requirements for the competence of testing and calibration laboratories*

ISO 17020, *Conformity assessment – Requirements for the operation of various types of bodies performing inspection*

ISO 17637, *Non-destructive testing of welds – Visual testing of fusion-welded joint*

ISO 17638, *Non-destructive testing of welds – Magnetic particle testing*

NORSOK L-001, *Piping and Valves*

NORSOK M-630, *Material data sheets and element data sheets for piping*

NS 477, *Welding inspectors – Tasks, education and certification*

3 Terms and definitions

For the purposes of this NORSOK standard, the following terms and definitions apply:

3.1

can

verbal form used for statements of possibility and capability, whether material, physical or casual

3.2

carbon equivalent CE_{IIW}

equivalent carbon content is used to understand how the different alloying elements affect hardness of the steel being welded. The formula $CE_{IIW} = C + Mn/6 + (Cr + Mo + V)/5 + (Ni + Cu)/15$ has been adopted by IIW and found suitable for predicting hardenability in plain carbon and carbon-manganese steels.

3.3

carbon steel

alloy of carbon and iron containing up to 2 % (mass fraction) carbon, up to 1,65 % (mass fraction) manganese and residual quantities of other elements, except those intentionally added in specific quantities for deoxidation (usually silicon and/or aluminium)