

---

---

---

---

ICS 913.07  
Language: English

# Piping fabrication, installation, flushing and testing

This NORSOK standard is developed with broad petroleum industry participation by interested parties in the Norwegian petroleum industry and is owned by the Norwegian petroleum industry represented by the Norwegian Oil and Gas Association and The Federation of Norwegian Industries. Please note that whilst every effort has been made to ensure the accuracy of this NORSOK standard, neither the Norwegian Oil and Gas Association nor The Federation of Norwegian Industries or any of their members will assume liability for any use thereof. Standards Norway is responsible for the administration and publication of this NORSOK standard.

Standards Norway  
P.O. Box 242, 1326 Lysaker  
NORWAY  
Visiting address  
Mustads vei 1, 0283 Oslo  
Copyrights reserved

Telephone: + 47 67 83 86 00  
Fax: + 47 67 83 86 01  
Email: [petroleum@standard.no](mailto:petroleum@standard.no)  
Website: [www.standard.no/petroleum](http://www.standard.no/petroleum)

## Piping fabrication, installation, flushing and testing

### Contents

|                                                                            |    |
|----------------------------------------------------------------------------|----|
| Foreword.....                                                              | 5  |
| 1 Scope .....                                                              | 7  |
| 2 Normative referanser.....                                                | 7  |
| 3 Terms and definitions .....                                              | 8  |
| 4 Abbreviation .....                                                       | 8  |
| 5 Materials .....                                                          | 9  |
| 5.1 Marking of materials.....                                              | 9  |
| 5.2 Material storage, handling, receiving and identification control ..... | 9  |
| 6 Fabrication of pipework .....                                            | 9  |
| 6.1 General requirements .....                                             | 9  |
| 6.2 Welding and NDE.....                                                   | 9  |
| 6.3 Metering and orifice runs .....                                        | 10 |
| 6.4 Screwed pipework.....                                                  | 10 |
| 6.5 Dimensional tolerances for pre-fabricated piping assemblies .....      | 11 |
| 6.6 Branch connections and outlets.....                                    | 12 |
| 6.7 Pipe flanges, mechanical hub and clamp coupling.....                   | 13 |
| 7 Installation of piping.....                                              | 13 |
| 7.1 Pipework erection.....                                                 | 13 |
| 7.2 Flanged joints.....                                                    | 13 |
| 7.3 Strain sensitive equipment with flange connections .....               | 14 |
| 7.4 Gaskets .....                                                          | 14 |
| 7.5 Bolting .....                                                          | 15 |
| 7.6 Pipe support.....                                                      | 15 |
| 7.7 Global tolerances, installation .....                                  | 15 |
| 8 Cleaning of pipework.....                                                | 16 |
| 8.1 General .....                                                          | 16 |
| 8.2 Hydro flushing .....                                                   | 16 |
| 8.3 Pressurised air shockblowing .....                                     | 16 |
| 8.4 Pneumatic flushing.....                                                | 17 |
| 8.5 Soft pigging .....                                                     | 17 |
| 8.6 Verification of cleanliness .....                                      | 17 |
| 9 Pressure tests .....                                                     | 17 |
| 9.1 General .....                                                          | 17 |
| 9.2 Test preparation .....                                                 | 17 |
| 9.3 Test media .....                                                       | 18 |
| 9.4 Hydrostatic testing.....                                               | 18 |
| 9.5 Pneumatic testing.....                                                 | 19 |
| 9.6 After completion of test .....                                         | 19 |
| 9.7 Test documentation.....                                                | 19 |
| 10 Chemical cleaning .....                                                 | 20 |
| 10.1 General .....                                                         | 20 |
| 10.2 Documentation .....                                                   | 20 |

|        |                                                                                                                                     |    |
|--------|-------------------------------------------------------------------------------------------------------------------------------------|----|
| 11     | Hot oil flushing .....                                                                                                              | 21 |
| 11.1   | General.....                                                                                                                        | 21 |
| 11.2   | Marking.....                                                                                                                        | 21 |
| 11.3   | Documentation .....                                                                                                                 | 21 |
| 12     | Tightness testing .....                                                                                                             | 22 |
| 13     | System colour coding of piping .....                                                                                                | 23 |
| 13.1   | Purpose .....                                                                                                                       | 23 |
| 13.2   | Types of markers.....                                                                                                               | 23 |
| 13.2.1 | General.....                                                                                                                        | 23 |
| 13.2.2 | Adhesive band/plastic tape glued to the pipe surface .....                                                                          | 23 |
| 13.2.3 | Laminated plastic signs.....                                                                                                        | 23 |
| 13.2.4 | Laminated plastic signs, mounted in aluminium or stainless steel frame brackets .....                                               | 23 |
| 13.3   | Insulated lines .....                                                                                                               | 23 |
| 13.4   | Plastic/rubber lined piping .....                                                                                                   | 23 |
| 13.5   | Obstruction .....                                                                                                                   | 23 |
| 13.6   | Materials of markers.....                                                                                                           | 24 |
| 13.6.1 | Adhesive tape/band .....                                                                                                            | 24 |
| 13.6.2 | Laminated plastic signs.....                                                                                                        | 24 |
| 13.7   | Fastening materials.....                                                                                                            | 24 |
| 13.8   | Marker text .....                                                                                                                   | 24 |
| 13.9   | Size and use of markers .....                                                                                                       | 24 |
| 13.10  | Positioning of markers.....                                                                                                         | 25 |
| 13.11  | Valve marking.....                                                                                                                  | 25 |
| 13.12  | Fluid description/colour code tabulation.....                                                                                       | 25 |
| 13.13  | Colour coding information .....                                                                                                     | 25 |
|        | Annex A (normative) Alternative test methods .....                                                                                  | 26 |
|        | Annex B (informative) Requirements for internal treatment of piping after prefabrication and installation before commissioning..... | 28 |

## Foreword

NORSOK L-004:2016 was adopted as NORSOK Standard in July 2016.

NORSOK L-004:2016 supersedes NORSOK L-004 Rev. 2, September 2010.

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 A is normative.

Annex B is informative.

## Revision information, 3<sup>rd</sup> edition updates:

The new edition has been given a general update that clarifies and simplifies requirements. Non relevant requirements have been removed and the revision should also be more in line with industry practice. Additional information has been included in the fabrication, cleaning and flushing and test requirements of pipework. The work has also focused on developing a standard with simpler and cost efficient solutions.



## 1 Scope

This NORSOK standard covers the basis for fabrication, installation, flushing, pressure testing, chemical cleaning, hot oil flushing and system colour coding of process, drilling and utility piping for offshore oil and/or gas production facilities.

This NORSOK standard does not cover the following:

- all instrument control/signal tubing downstream of first piping block valve;
- subsea pipework and risers;
- flexible hoses;
- sanitary piping systems within living quarters and other domestic areas, see NORSOK H-003;
- GRP piping, see ISO 14692 all parts;
- marine systems in hulls of vessels and floating platforms and land based plants.

## 2 Normative referanser

The following standards include provisions and guidelines, which through reference in this text, constitute provisions and guidelines of this NORSOK standard. Latest issue of the references shall be used unless otherwise agreed. Other recognized standards may be used provided it can be shown that they meet the requirements of the referenced standards

API 6A, *API standard 6A*

ASME B31.3, *Process Piping*

ASME B1.20.1, *Pipe Threads, General purpose, Inch*

ASME PCC-1, *Guidelines for Pressure Boundary Bolted Flange Joint Assembly*

ASME VIII, *Boiler and Pressure Vessel Code, Section VIII – Rules for construction of Pressure Vessels, Division 1*

EN 1591(all parts), *Flanges and their joints - Design rules for gasketed circular flange connections*

EN ISO 27509, *Petroleum and natural gas industries-Compact flanged connections with IX seal ring*

ISO 4406, *Hydraulic fluid power – Fluids – Method for coding the level of contamination by solid particles*

ISO 9095, *Steel tubes – Continuous character marking and colour coding for material identification*

Norsk Olje og Gass, *Håndbok for flensarbeid*

NORSOK I-106, *Fiscal metering systems for hydrocarbon liquid and gas*

NORSOK L-001, *Piping and Valves*

NORSOK L-002, *Piping design, layout and stress analysis*

NORSOK L-CR-003 (L-003), *Piping details*

NORSOK L-005, *Compact flanged connections*

NORSOK M-601, *Welding and inspection of piping*

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

NORSOK Z-DP-002, *Coding system*

NORSOK Z-006, *Preservation*

NS 813, *Piping systems – Identification colours for the content*

NS 4054, *Colours for identification*

### 3 Terms and definitions

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

#### 3.1 **shall**

expression in the content of a document conveying objectively verifiable criteria to be fulfilled and from which no deviation is permitted if compliance with the document is to be claimed

Note 1 to entry: Requirements are expressed using the verbal forms specified in ISO/IEC Directives, Part 2 clause 7.2 Table 3.

#### 3.2 **should**

expression in the content of a document conveying a suggested possible choice or course of action deemed to be particularly suitable without necessarily mentioning or excluding others d

Note 1 to entry: Recommendations are expressed using the verbal forms specified in ISO/IEC Directives, Part 2 clause 7.3 Table 4.

Note 2 to entry: In the negative form, a recommendation is the expression that a suggested possible choice or course of action is not preferred but it is not prohibited.

#### 3.3 **may**

expression in the content of a document conveying consent or liberty (or opportunity) to do something

Note 1 to entry: Permissions are expressed using the verbal forms specified in ISO/IEC Directives Part 2 clause 7.4 Table 5.

#### 3.4 **can**

expression in the content of a document conveying expected or conceivable material, physical or causal outcome

### 4 Abbreviation

For the purposes of this NORSOK standard, the following abbreviations apply:

|                   |                                                |
|-------------------|------------------------------------------------|
| ABS               | absolute                                       |
| API               | American Petroleum Institute                   |
| ASME              | American Society of Mechanical Engineers       |
| CO <sub>2</sub>   | carbondioxid                                   |
| EDS               | element data sheet                             |
| EN                | European Standard                              |
| GRP               | glass fibre reinforced plastic                 |
| He                | helium                                         |
| ISO               | International Organisation for Standardisation |
| IX                | special metallic seal ring, see NORSOK L-005   |
| N <sub>2</sub>    | nitrogen                                       |
| N <sub>2</sub> He | nitrogen helium                                |
| NDE               | non destructive examination                    |
| NPS               | nominal pipe size                              |
| NPT               | National Pipe Thread Taper                     |
| NS                | Norwegian Standard                             |
| O <sub>2</sub>    | oxygen                                         |

|      |                               |
|------|-------------------------------|
| OD   | outside diameter              |
| P&ID | piping and instrument diagram |
| PAS  | pressurised air shock blowing |
| ppm  | parts per million             |
| PVC  | polyester vinyl chloride      |
| UV   | ultra violet                  |

## 5 Materials

### 5.1 Marking of materials

A system of marking of materials shall be established. Colour coding according to ISO 9095 can be a solution.

If possible, gaskets shall be marked to be visible after installation.

### 5.2 Material storage, handling, receiving and identification control

Procedures for off-loading, storage, receiving, control, traceability and inspection of piping material supplied for fabrication and installation shall be established.

In general, the following applies:

- storage and preservation should adhere to requirements in NORSOK Z-006;
- piping and piping equipment shall be protected against degradation and damages during storage;
- materials shall be segregated to avoid any cross contamination;
- piping and piping equipment shall be protected against damage during handling from supplier to fabrication yard and further to final installation plant. Especially focus shall be made to sealing surfaces, bevelled areas, and contact between different material qualities to avoid surface contamination. This also includes protection during erection phase in order to protect against contamination from other activities on site.

## 6 Fabrication of pipework

### 6.1 General requirements

Prefabricated pipe spools shall be cleaned, coated (if required) and preserved prior to installation.

The fabrication yard shall be outfitted for work with relevant materials. Intermediate storing, lifting devices and handling equipment shall have a surface not causing contamination of the materials they are used for. All tools shall be restricted to the relevant material group to avoid contamination and shall be marked to avoid mixing of tools for different materials. Different grades of stainless steel materials can be handled with the same tools.

Fabrication of high alloy piping including titanium shall take place in sufficiently clean areas separated from areas where carbon steel piping is fabricated to avoid contamination.

All welded attachments to piping, including pads and doubler plates, shall be of a material compatible with the piping material.

Bending and forming of pipe shall be carried out in accordance with ASME B31.3, NORSOK M-630 (EDS NBE1 and EDS NBE2) and shall be carried out according to documented procedures.

### 6.2 Welding and NDE

All welding and NDE shall be in accordance with NORSOK M-601. Separation between welds shall be arranged to eliminate or minimise the heat transfer from adjacent welds.

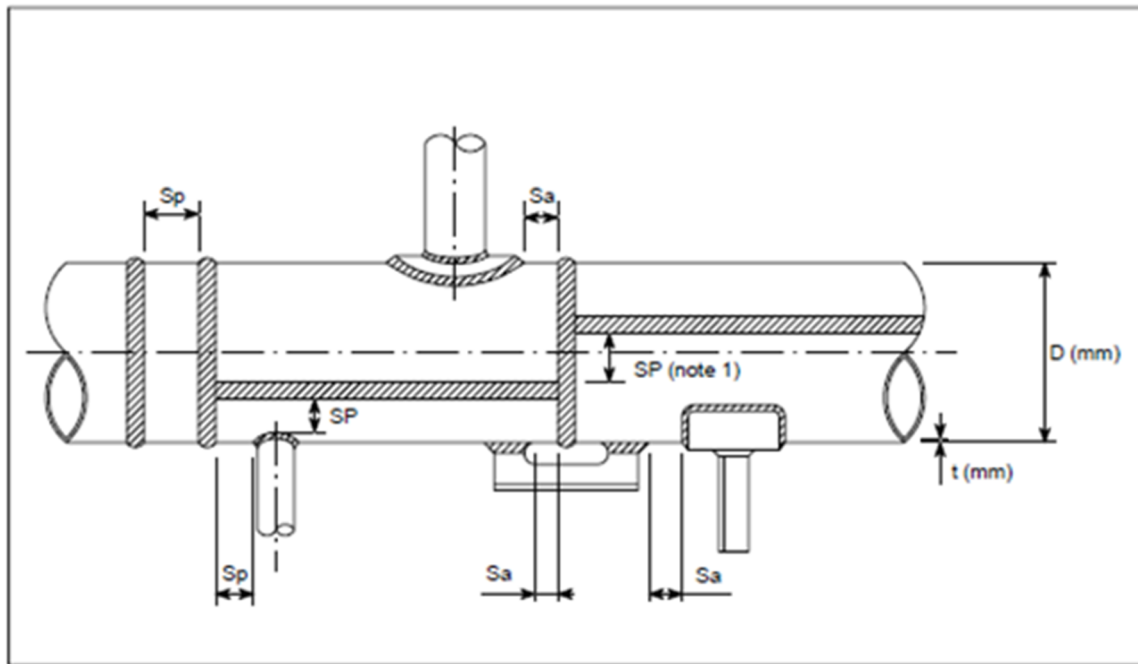


**Figure 1 – Recommended distance between welds**

where:

Separations  $S = S_p$  or  $S_a$  as applicable

$S_p$  = separation between any two pressure containing welds

$$\sqrt{D \times t} \text{ (mm) minimum}$$

$S_a$  = separation between an attachment weld and any other weld

= the greater of  $2t$  or 40 mm minimum

NOTE 1: When re-welding match-arc sections of welded pipe it is not necessary to achieve this staggering of the longitudinal weld.

Unless otherwise recommended by the valve/ equipment manufacturer, internals of in-line valves and equipment that could be damaged due to heat transfer shall be removed prior to welding and/or heat treatment.

### 6.3 Metering and orifice runs

For fiscal metering runs, reference is made to NORSOK I-106.

When the design of metering and orifice run necessitates welds, these shall be ground smooth and flush with the inside of the pipe, if the measurement accuracy so requires. Pipe-tap connections where required, shall be drilled through the pipe wall and be smooth inside.

### 6.4 Screwed pipework

Unless otherwise stated on approved drawing or specifications, pipe threads shall conform to ASME B1.20.1.

NPT threads need special attention to dimensional tolerances due to the conic configuration. Minimum engagement shall be 4.5 for NPT threads.

All threading shall be carried-out after bending, forging or heat treatment, but where this is not possible, suitable thread protection shall be provided.