PDHonline Course M184 (3 PDH)

Material Data Sheets for the Construction of Piping Systems

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Material data sheets for piping
Foreword

The NORSOK standards are developed by the Norwegian petroleum industry to ensure adequate safety, value adding 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 recognised 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 Subject to development and publication of international standards, the relevant NORSOK standard will be withdrawn.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-001.

The NORSOK standards are prepared and published with supported by OLF (The Norwegian Oil Industry Association) and TBL (Federation of Norwegian Manufacturing Industries). NORSOK standards are administered and published by NTS (Norwegian Technology Centre).

Introduction

This revision replace NORSOK standard M-630 rev 2, and the changes from rev. 2 to rev. 3 are only inclusion of 7 new MDS under material type P, Polymers including fibre reinforced.

MINOR DEVIATIONS FROM ASME B31.1 CODE REQUIREMENTS

The use of the piping materials according to NORSOK Standards (L-CR-001, M-630 and M-601) will result in some minor deviations from the ASME B31.3 code. All deviations have been carefully considered, and they are in line with Norwegian and European practice. The deviations are:

- NORSOK have of practical reasons limited the thickness for requiring impact testing to 6 mm
- If subsize Charpy V-notch impact test specimens are used, the energy requirement is increased instead of lowering the test temperature.
- Impact testing is not required in the qualification of the welding procedures for weldments in austenitic stainless steel when used in the temperature range from – 29 °C to – 105 °C.
- Eddy current examination is accepted as replacement for spot radiography of stainless steel welds for wall thicknesses less than 4.0 mm.
- Thin walled (thickness up to 7 mm) longitudinal welded pipes in 6 Mo austenitic stainless is accepted in as welded condition provided the plate material used is solution annealed.

In general, the MDS have supplementary requirement beyond the ASTM standard to ensure a proper safety level.
1 Scope
This standard includes material requirement in a collection of Piping Material Data Sheets (MDS) for use in piping systems, selected according to NORSOK L-001, Piping and Valves.

2 Normative references
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 or exceed the requirements and guidelines of the standards referenced below.

3 Definitions
3.1.1 can
verbal form used for statements of possibility and capability, whether material, physical or casual.

3.1.2 carbon steel type 235
carbon steel with SMYS $\geq$ 220MPa and not impact tested

3.1.3 carbon steel type 235LT
carbon steel with SMYS $\geq$ 220 MPa and impact tested at - 46 °C

3.1.4 carbon steel type 360LT
carbon steel with SMYS $\geq$ 350 MPa and impact tested at - 46 °C

3.1.5 may
verbal form used to indicate a course of action permissible within the limits of the standard

3.1.6 MDS
material data sheet

3.1.7 shall
verbal form used to indicate requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted, unless accepted by all involved parties

3.1.8 should
verbal form used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required

3.1.9 SMYS
specified minimum yield strength

3.1.10 stainless steel type 316
alloys with approx. 2.5 % Mo of type AISI 316
3.1.11
**stainless steel type 6Mo**
alloys with 6 % Mo and PRE > 40

3.1.12
**stainless steel type 22Cr duplex**
alloys with 22 % Cr according to UNS S31803

3.1.13
**stainless steel type 25Cr duplex**
alloys with 25 % Cr and PRE > 40, often also referred to as "super duplex".

4 **Collection of material data sheets**

4.1 **General**
Materials/components manufactured in accordance with M-CR-630 rev. 1 may be accepted. This shall be agreed with the actual project/company.

The material selection menu for material standards and grades relevant for the piping systems is shown in Table 1. The actual grades to be used with respect to piping design shall be stated on the piping class sheet.

The materials shall be delivered in accordance with the standard referred to. In addition the MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.

The actual types of materials covered are as follow:

- **C** - Carbon steels; Type 235, Type 235LT, Type 360LT
- **D** - Ferritic/Austenitic Stainless Steels; Type 22Cr, Type 25Cr
- **K** - Copper/Nickel 90/10 and other copper alloys
- **N** - Nickel base alloys; Type 625
- **P** - Polymers including fibre reinforced
- **R** - Austenitic Stainless Steels; Type 6Mo
- **S** - Austenitic Stainless Steels; Type 316
- **T** - Titanium
- **X** - High strength low alloyed steels.

Note: Welded products according to MDS D42, D43, D52, D53, R12, R13, S01 and T01 have acceptance classes which give welding factors 0.8 and 1.0. The correct class is specified on the piping class sheet. The order shall include acceptable classes.
<table>
<thead>
<tr>
<th>Product</th>
<th>Carbon steel Type 235 ¹)</th>
<th>Carbon steel Type 235LT impact tested</th>
<th>Carbon steel Type 360LT impact tested</th>
<th>Stainless steel Type 316</th>
<th>Stainless steel Type 22Cr Duplex</th>
<th>Stainless steel Type 25Cr Duplex</th>
<th>Stainless steel Type 6Mo ²)</th>
<th>Cu/NI 90/10 and other copper alloys</th>
<th>Nickel alloy</th>
<th>Titanium Grade 2 ³)</th>
<th>High strength low alloyed steel</th>
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<td>A312</td>
<td>B466 UNS C 70600</td>
<td>B705 UNS</td>
<td>B861 Gr 2</td>
<td>A519 AISI 4130</td>
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<td>A333 Grade 6</td>
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<td>A671 Grade CC60, CC70</td>
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<td><strong>Fittings</strong></td>
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<td>A420 Grade WPL 6</td>
<td>A403 Grade WP 316</td>
<td>A815 UNS S31803</td>
<td>A815</td>
<td>A403</td>
<td>-</td>
<td>B366 UNS</td>
<td>B363 Grade WPT2 / WPT2W</td>
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<td>A240</td>
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<td>B171 UNS</td>
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NORSOK standard M-630

Rev. 3, June. 2003

Table 1 – Material Selection Menu for Piping Systems
<table>
<thead>
<tr>
<th>Castings</th>
<th>A216 Grade WCB</th>
<th>A352 Grade LCC</th>
<th>A352 Grade LCC</th>
<th>A351 Grade CF8M or CF3M</th>
<th>A890 UNS Grade 4 (J92205)</th>
<th>A890 UNS J93404, UNS J93380</th>
<th>A 351 CK-3MCuN, CN-3MN</th>
<th>B148 UNS C 95800</th>
<th>B494 Grade CW-6MC (UNS N06625) Grade CX2MW (UNS N26022)</th>
<th>B367 Grade C2</th>
<th>ASTM A 487 Gr 2B ASTM A 487 Gr 2B (-46°C)</th>
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<tr>
<td>Bars</td>
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<td>A276 UNS S 31803</td>
<td>A276 UNS S 32550</td>
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<td>A276 UNS S 31259</td>
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<td>Tubes</td>
<td>A269 316</td>
<td>A789 UNS S 31803</td>
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<td>B444 UNS N06625</td>
<td>B338 Gr 2</td>
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</table>

NOTE 1) Type 235 should be used in piping systems with minimum design temperature above or equal to -15 °C and thicknesses less than approx. 15 mm.
NOTE 2) The grades UNS N08367, N08925 and N08926 are considered equivalent to UNS S31254. The grade CN-3 MN is considered equivalent to CK-3MCuN.
NOTE 3) GOST VT-1-0 is considered equivalent.
### 4.2 Referenced Standards and Corresponding MDS

<table>
<thead>
<tr>
<th>MDS No.</th>
<th>Rev. No.</th>
<th>Standard and Grade (Note 1)</th>
<th>Products</th>
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<td>A 106 Grade B (1995)</td>
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<td>C01</td>
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<td>A 672 Grade CC60, CC70 (1994)</td>
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<td>MDS No.</td>
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**Copper/Nickel 90/10**

| K01 1   |          | B 466 UNS C 70600 (1992) | Seaml. pipes & tubes |
|         |          | B 467 UNS C 70600 (1988) | Welded pipes |
|         |          | B 151 UNS C 70600 (1994) | Rod & bar |
|         |          | B 171 UNS C 70600 (1995) | Plates & sheets |
|         |          | - UNS C 70600 (1995) | Fittings |
|         |          | - UNS C 70600 (1995) | Flanges |

**Aluminium - Bronze Sand Castings**

| K02 1   |          | B 148 UNS C 9580 (1993) | Castings |

**Nickel Alloy Type 625**

|         |          | B 564 UNS N06625 (1996) | Forgings |
|         |          | B 443 UNS N06625 (1993) | Plates |
|         |          | B 446 UNS N06625 (1993) | Bars |
|         |          | B 444 UNS N06625 (1995) | Pipes and tubes |
| N02 2   |          | A 494 Grade CW-6MC (1993) | Castings |
| N02 2   |          | A 494 Grade CX 2MW (1993) |          |

**Polymers including fibre reinforced**

| P01 1   | UK00A    | GRP pipes and fittings |
| P11 1   | Hydrogenated Nitrile (HNBR) | O-ring |
| P12 1   | Fluorocarbon terpolymer (FKM) | O-ring |
| P13 1   | Fluorocarbon low T terpolymer (FKM GLT) | O-ring |
| P14 1   | Nitrile | O-ring |
| P21 1   | PEEK (Poly-ether-ether-ketone) | Back-up rings and seal inserts |
| P22 1   | PTFE (Poly-tetra-fluro-ethylene) | Lipseals, back-up rings and seal inserts |
| P23 1   | PEEK (Poly-ether-ether-ketone) with PTFE added | Seal inserts |
Austenitic Stainless Steel Type 6Mo

R11  2  A 312 UNS S31254 (1995)  Seamless pipes
R13  2  A 403 UNS S31254 (1996)  Wrought fittings
R14  2  A 182 Grade F44 (1996)  Forgings
R15  2  A 240 UNS S31254 (1996)  Plates
R16  2  A 351 Grade CK-3McuN (1994)  Castings
R17  2  A 276 UNS S31254 (1996)  Bars
R18  2  A 269 UNS S 31254 (1996)  Tubes

Austenitic Stainless Steel Type 316

S01  2  A 312 Grade TP 316 (1995)  Seamless & welded pipes
S01  2  A 358 Grade 316 (1995)  Welded pipes
S01  2  A 403 Grade WP 316 (1996)  Wrought fittings
S01  2  A 182 Grade F 316 (1996)  Forgings
S01  2  A 240 Grade 316 (1996)  Plates
S02  2  A 351 Grade CF8M (1994)  Castings
S02  2  A 351 Grade CF3M (1994)  Castings

Titanium Grade 2

T01  2  B 861 Grade 2 (1995)  Seamless pipes
T01  2  B 862 Grade 2 (1995)  Welded pipes
T01  2  B 381 Grade F2 (1995)  Forgings
T01  2  B 265 Grade 2 (1995)  Plates
T01  2  B 348 Grade 2 (1995)  Bars
T01  2  B 338 Grade 2 (1995)  Tubes
T02  2  B 367 Grade C2 (1993)  Castings

High Strength Low Alloy Steel

X01  1  A 519 AISI 4130 (1994)  Seamless pipes
X02  2  A 788 AISI 4140 (1994)  Forgings
X03  2  A 487 Grade 2B (1993)  Castings
X04  1  API 6A 60K (AISI 4130) (1996)  Forgings
X05  1  A 182 F22 (1996)  Forgings
X06  1  A 487 Grade 2B (-46 °C) (1993)  Castings

Note 1: The current year of issue of standards referenced is shown for guidance only. The latest year of issue shall be used unless otherwise specifically agreed.
### MATERIAL DATA SHEET MDS - C01 Rev. 2

#### TYPE OF MATERIAL: Carbon Steel Type 235

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>STANDARD</th>
<th>GRADE</th>
<th>ACCEPT. CLASS</th>
<th>SUPPL. REQ.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wrought fittings</td>
<td>ASTM A 234</td>
<td>WPB</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Welded pipes</td>
<td>API 5L</td>
<td>B</td>
<td>t ≤ 19 mm: Class 12</td>
<td>-</td>
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<tr>
<td></td>
<td>ASTM A 672</td>
<td>CC60, CC70</td>
<td>t &gt; 19 mm: Class 22</td>
<td>-</td>
</tr>
<tr>
<td>Seamless pipes</td>
<td>ASTM A 106</td>
<td>B</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Forgings</td>
<td>ASTM A 105</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Plates</td>
<td>ASTM A 516</td>
<td>60, 70</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

1. **SCOPE**
   This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.

2. **MANUFACTURING PROCESS**
   Welded pipes to API 5L: Electric resistance welded pipes are not acceptable.

3. **HEAT TREATMENT**
   Welded pipes to API 5L: Stress relieving when the nominal thickness t ≥ 19 mm.

4. **CHEMICAL COMPOSITION**
   \[ C \leq 0.22 \%; \ Si \geq 0.10 \%; \ Mn = 0.50 - 1.35\%; \ S \leq 0.025 \%; \ P \leq 0.030 \%; \ CE = C + Mn/6 + 0.04 \leq 0.43. \]

5. **TEST SAMPLING**
   Samples for production testing shall realistically reflect the properties in the actual component.

6. **DIMENSIONAL TOLERANCES**
   Fittings to A 234: Fittings with reference to MSS-SP-75 shall have maximum wall thickness undertolerance of 0.3 mm.
   Flanges to A 105: Flanges to MSS-SP-44 shall have a maximum wall thickness under tolerance of 0.3 mm for the hub at the welding end.

7. **NON DESTRUCTIVE TESTING**
   Pipes to API 5L: RT of weld seam or RT at ends and US/Eddy Current of the remaining weld.
   Fittings to A 234: UT is not acceptable as replacement of RT.

8. **CERTIFICATION**
   EN 10 204 Type 3.1B
<table>
<thead>
<tr>
<th><strong>PRODUCT</strong></th>
<th><strong>STANDARD</strong></th>
<th><strong>GRADE</strong></th>
<th><strong>ACCEPT. CLASS</strong></th>
<th><strong>SUPPL. REQ.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Castings</td>
<td>ASTM A 216</td>
<td>WCB</td>
<td>-</td>
<td>S4, S5</td>
</tr>
</tbody>
</table>

1. **SCOPE**
   This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.

2. **CHEMICAL COMPOSITION**
   C ≤ 0.22 % and CE = C + Mn/6 + 0.04 ≤ 0.43 for castings with butt weld ends.

3. **EXTENT OF TESTING**
   One set of tensile test is required for each melt and heat treatment load.

4. **TEST SAMPLING**
   Samples for mechanical testing shall realistically reflect the properties in the actual components.
   For castings with weight 250 kg and above the test blocks shall be integrally cast with the casting. The test blocks shall be heat treated together with the castings they represent.

5. **NON DESTRUCTIVE TESTING**
   **Magnetic particle testing:** Supplementary requirement S4 shall apply to all accessible surfaces of all castings. The examination shall be carried out after final machining. The acceptance criterias shall be ASME VIII, Div.1, Appendix 7.

   **Radiographic testing:** Supplementary requirement S5 shall apply to:
   - Critical areas as per ANSI B16.34 of the pilot cast of each pattern
   - All butt weld ends of each casting.
   - Class 1500 psi and above; all critical areas according to ANSI B16.34 of each casting.
   The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 7.

6. **CERTIFICATION**
   EN 10 204 Type 3.1B.
# MATERIAL DATA SHEET  MDS - C11  Rev. 2

## TYPE OF MATERIAL:
Carbon Steel Type 235LT

### PRODUCT

| Wrought fittings | ASTM A 420 | WPL 6 | - | S2, S4 |
| Welded pipes     | ASTM A 671 | CC60, CC70 | t ≤ 19 mm: Class 12; t > 19 mm: Class 22 | S2, S7 |
| Seamless pipes   | ASTM A 333 | 6 | - | - |
| Forgings         | ASTM A 350 | LF2 | Class 1 | S7 |
| Plates           | ASTM A 516 | 70 | - | S5 |

### 1. SCOPE
This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.

### 2. CHEMICAL COMPOSITION
C ≤ 0.22 %; Mn = 0.50 - 1.35 %; S ≤ 0.025 %; P ≤ 0.030 %; CE = C + Mn/6 + 0.04 ≤ 0.43.

### 3. IMPACT TESTING
Charpy V-notch testing at -46°C is required for the thicknesses ≥ 6 mm. For flanges apply the thickness at the weld neck. The minimum absorbed energy for full size specimens shall be 27 J average and 20 J single. Reduction factors for subsize specimens shall be: 7.5mm - 5/6 and 5 mm - 2/3.

### 4. EXTENT OF TESTING
- **Fittings to A 420:** Supplementary requirement S2 shall apply. Impact testing shall be carried out to the same extent as tensile testing (S2).
- **Pipes to A 671:** Supplementary requirement S2 shall apply to the same extent as tensile testing.
- **Forgings to A 350:** One set of tensile and impact testing shall be carried out for each heat and heat treatment load. A test lot shall not exceed 2000 kg for forgings with as forged weight ≤ 50 kg, and 5000 kg for forgings with as forged weight > 50 kg.

### 5. TEST SAMPLING
- **All products:** Samples for production testing shall realistically reflect the properties in the actual component.
- **Fittings to A 420:** Supplementary requirement S2 shall apply.
- **Forgings to A 350:** Sketches shall be established showing type, size and location of test samples and extraction of test specimens.

### 6. DIMENSIONAL TOLERANCES
- **Fittings to A 420:** Fittings with reference to MSS SP-75 shall have maximum wall thickness under tolerance of 0.3 mm in accordance with standard.
- **Flanges to A 350:** Flanges to MSS SP-44 shall have a maximum wall thickness under tolerance of 0.3 mm for the hub at the welding end.
<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>STANDARD</th>
<th>GRADE</th>
<th>ACCEPT. CLASS</th>
<th>SUPPL. REQ.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wrought fittings</td>
<td>ASTM A 420</td>
<td>WPL 6</td>
<td>-</td>
<td>S2, S4</td>
</tr>
<tr>
<td>Welded pipes</td>
<td>ASTM A 671</td>
<td>CC60, CC70</td>
<td>t ≤ 19 mm: Class 12</td>
<td>S2, S7</td>
</tr>
<tr>
<td>Seamless pipes</td>
<td>ASTM A 333</td>
<td>6</td>
<td>t &gt; 19 mm: Class 22</td>
<td>S2, S7</td>
</tr>
<tr>
<td>Forgings</td>
<td>ASTM A 350</td>
<td>LF2</td>
<td>Class 1</td>
<td>S7</td>
</tr>
<tr>
<td>Plates</td>
<td>ASTM A 516</td>
<td>70</td>
<td></td>
<td>S5</td>
</tr>
</tbody>
</table>

### 7. NON DESTRUCTIVE TESTING

**Fittings to A 420:** Ultrasonic testing is not acceptable as replacement of radiographic testing.

Supplementary requirement S4, magnetic particle testing, shall apply to 10% of all fittings (same test lot as defined for mechanical testing) for nominal thicknesses < 12.7mm and 100% of all fittings for nominal thicknesses ≥ 12.7 mm. The testing shall be carried out after calibration. The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 6.

**Forgings to A 350:** Supplementary Requirement S7.1, magnetic particle testing shall apply to 10% of all forgings (same test lot as defined for mechanical testing) with NPS > 2. The testing shall be carried out after final machining. The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 6.

### 8. REPAIR OF DEFECTS

Weld repair of base material is not acceptable.

### 9. MARKING

Heat treatment load number shall be permanently marked on the component where testing is required per. heat treatment load.

### 10. CERTIFICATION

EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.
### MATERIAL DATA SHEET  
**MDS - C12**  
**Rev. 2**

<table>
<thead>
<tr>
<th><strong>TYPE OF MATERIAL:</strong></th>
<th>Carbon Steel Type 235LT</th>
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<tbody>
<tr>
<td><strong>PRODUCT</strong></td>
<td>Castings</td>
</tr>
<tr>
<td><strong>STANDARD</strong></td>
<td>ASTM A 352</td>
</tr>
<tr>
<td><strong>GRADE</strong></td>
<td>LCC</td>
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<tr>
<td><strong>ACCEPT. CLASS</strong></td>
<td>-</td>
</tr>
<tr>
<td><strong>SUPPL. REQ.</strong></td>
<td>S4, S5</td>
</tr>
</tbody>
</table>

#### 1. SCOPE
This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.

#### 2. CHEMICAL COMPOSITION
C ≤ 0.22 % ; S ≤ 0.025 %; P ≤ 0.030 %;  
CE = C + Mn/6 + (Cr+Mo+V)/5 + (Cu+Ni)/15 ≤ 0.43

#### 3. IMPACT TESTING
The minimum absorbed energy for full size specimens shall be 27 J average and 20 J single.

#### 4. EXTENT OF TESTING
One set of tensile and impact test is required for each melt and heat treatment load.  
A test lot shall not exceed 5 000 kg.

#### 5. TEST SAMPLING
Samples for mechanical testing shall realistically reflect the properties in the actual components. Thickness of the test block shall be equal to the thickness of the actual components as heat treated up to a maximum thickness of 100 mm. For flanged components the largest flange thickness apply.

Test specimens shall be cut from the 1/4 T location from the surface where T is the thickness of the test block.

Test block shall be integrally cast or gated onto the castings and shall not be removed from the castings until after the final quality heat treatment.

#### 6. NON DESTRUCTIVE TESTING
*Magnetic Particle testing:* Supplementary requirement S4 shall apply to all accessible surfaces of all castings. The testing shall be carried out after final machining. The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 7.

*Radiographic testing:* Supplementary requirement S5 shall apply to:
- Critical areas as per ANSI B16.34 of the pilot cast of each pattern
- All butt weld ends of each casting.
- Class 1500 psi and above; all critical areas to ANSI B16.34 of each casting.

The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 7.

#### 7. REPAIR OF DEFECTS
A cast plate shall be used in the qualification of the repair welding procedure.

#### 8. MARKING
The component shall be marked to ensure full traceability to melt and heat treatment lot.

#### 9. CERTIFICATION
EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium shall be stated in the certificate.
1. **SCOPE**

This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.

2. **CHEMICAL COMPOSITION**

   C ≤ 0.20 %; Mn = 0.90 - 1.60 %; Si= 0.10-0.50 %; S ≤ 0.025 %; P ≤ 0.035 %; Ti ≤ 0.05 %; Nb ≤ 0.04 %; Al ≤ 0.06 %; N ≤ 0.015 %; V+Nb+Ti ≤ 0.10 %; V+Nb ≤ 0.07; CE = C + Mn/6 + (Cr+Mo+V)/5 + (Cu+Ni)/15 ≤ 0.43.

3. **IMPACT TESTING**

   Charpy V-notch testing according to ASTM A 370 at -46 °C is required for the thicknesses ≥ 6 mm. The minimum absorbed energy for full size specimen shall be 40 J average and 30 J single. Reduction factors for subsize specimens shall be: 7.5 mm - 5/6 and 5 mm - 2/3.

4. **EXTENT OF TESTING**

   **Forgings to A 694:** One set of tensile and impact testing shall be carried out for each heat and heat treatment lot. A test lot shall not exceed 2000 kg for forgings with as forged weight ≤ 50 kg, and 5000 kg for forgings with as forged weight > 50 kg.

5. **TEST SAMPLING**

   **All products:** Samples for production testing shall realistically reflect the properties in the actual component.

   **Forgings to A 694:** Test samples shall be from prolongations on actual components. Sacrificial forgings shall be used for die forged components. However, special agreements may be made for die forged components with as forged weight exceeding 50 kg. Test specimens shall be cut at the 1/4 T location from the surface where T is the thickness of the test samples as heat treated. Sketches shall be established showing type, size and location of test samples and extraction of test specimens.

6. **WELDING**

   **Fittings to A 860:** The WPQ shall be qualified in accordance with ASME IX or EN 288-3.

7. **DIMENSIONAL TOLERANCES**

   **Fittings to A 860:** Fittings with reference to MSS-SP-75 shall have maximum wall thickness under tolerance of 0.3 mm.

   **Flanges to A 694:** Flanges to MSS-SP-44 shall have a maximum wall thickness under tolerance of 0.3 mm for the hub at the welding end.

8. **NON DESTRUCTIVE TESTING**

   **Fittings to A 860:** Supplementary requirement S4, magnetic particle testing, shall apply to 10 % of all fittings (same test lot as defined for mechanical testing) for nominal thicknesses < 12.7 mm and 100 % of all fittings for nominal thicknesses ≥ 12.7 mm. The testing shall be carried out after calibration.

   **Forgings to A 694:** 10 % of all forgings with NPS > 2 (same test lot as defined for mechanical testing) shall be magnetic particle testing according to ASME V Article 7. The testing shall be carried out after final machining.

   **All products:** The acceptance criteria shall be to ASME VIII Div. 1, Appendix 6.
### MATERIAL DATA SHEET  MDS - C21  Rev. 2

**TYPE OF MATERIAL:** Carbon Steel Type 360LT

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>STANDARD</th>
<th>GRADE</th>
<th>ACCEPT. CLASS</th>
<th>SUPPL. REQ.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wrought fittings</td>
<td>ASTM A 860</td>
<td>WPHY 52</td>
<td>Seamless and welded</td>
<td>-</td>
</tr>
<tr>
<td>Forgings</td>
<td>ASTM A 694</td>
<td>F52</td>
<td></td>
<td></td>
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</tbody>
</table>

**9. REPAIR OF DEFECTS**
Weld repair of base material is not acceptable.

**10. MARKING**
The component shall be marked to ensure full traceability to melt and heat treatment lot.

**11. CERTIFICATION**
EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.
### NORSOK Standard

#### MATERIAL DATA SHEET  
**MDS - C22**  
**Rev. 2**

<table>
<thead>
<tr>
<th><strong>TYPE OF MATERIAL:</strong></th>
<th>Carbon Steel Type 360LT</th>
</tr>
</thead>
</table>

<table>
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<th><strong>PRODUCT</strong></th>
<th><strong>STANDARD</strong></th>
<th><strong>GRADE</strong></th>
<th><strong>ACCEPT. CLASS</strong></th>
<th><strong>SUPPL. REQ.</strong></th>
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</thead>
<tbody>
<tr>
<td>Seamless pipes</td>
<td>API 5L</td>
<td>X52</td>
<td>-</td>
<td>SR 4.3</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th><strong>1. SCOPE</strong></th>
<th>This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2. STEEL MAKING</strong></td>
<td>Fine grain treatment shall be carried out.</td>
</tr>
<tr>
<td><strong>3. HEAT TREATMENT/DELIVERY CONDITION</strong></td>
<td>Normalised or Quenched and Tempered.</td>
</tr>
<tr>
<td><strong>4. CHEMICAL COMPOSITION</strong></td>
<td>$C \leq 0.16%$; $Mn = 0.90 - 1.60%$; $Si = 0.10 - 0.50%$; $S \leq 0.025%$; $P \leq 0.035%$; $Ti \leq 0.05%$; $Nb \leq 0.04%$; $Al \leq 0.06%$; $N \leq 0.015%$; $V + Nb + Ti \leq 0.10%$; $V + Nb \leq 0.07%$; $CE = C + Mn/6 + (Cr + Mo + V)/5 + (Cu + Ni)/15 \leq 0.43$.</td>
</tr>
<tr>
<td><strong>5. IMPACT TESTING</strong></td>
<td>Charpy V-notch testing according to ASTM A 370 at -46°C is required for the thicknesses $\geq 6$ mm. The minimum absorbed energy for full size specimens shall be 40 J average and 30 J single. Reduction factors for subsize specimens shall be: 7.5 mm - $5/6$ and 5 mm - $2/3$.</td>
</tr>
<tr>
<td><strong>6. TEST SAMPLING</strong></td>
<td>Samples for production testing shall realistically reflect the properties in the actual component.</td>
</tr>
<tr>
<td><strong>7. NON-DESTRUCTIVE TESTING</strong></td>
<td>Supplementary requirement SR 4.3 with notch calibration of 5% of the nominal wall thickness shall apply for all thicknesses.</td>
</tr>
<tr>
<td><strong>8. SURFACE FINISH</strong></td>
<td>The surface finish shall comply with ASTM A 106 para. 18.3.2.</td>
</tr>
<tr>
<td><strong>9. REPAIR OF DEFECTS</strong></td>
<td>Weld repair is not acceptable.</td>
</tr>
<tr>
<td><strong>10. CERTIFICATION</strong></td>
<td>EN 10 204 Type 3.1B</td>
</tr>
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</table>
# MATERIAL DATA SHEET  
**MDS - D41**  
**Rev. 2**

<table>
<thead>
<tr>
<th>TYPE OF MATERIAL:</th>
<th>Ferritic / Austenitic Stainless Steel, Type 22Cr duplex</th>
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</thead>
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<tr>
<th>PRODUCT</th>
<th>STANDARD</th>
<th>GRADE</th>
<th>ACCEPT. CLASS</th>
<th>SUPPL. REQ.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seamless pipes</td>
<td>ASTM A 790</td>
<td>UNS S 31803</td>
<td>-</td>
<td>-</td>
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</tbody>
</table>

## 1. SCOPE
This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.

## 2. QUALIFICATION
Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.

## 3. STEEL MAKING
The steel melt shall be refined with AOD or equivalent.

## 4. CHEMICAL COMPOSITION
N = 0.14 - 0.20 %

## 5. HARDNESS
The hardness shall be maximum 28 HRC or alternatively 271 HB or 290 HV10.

## 6. IMPACT TESTING
Charpy V-notch testing (3 specimens) according to ASTM A 370 at - 46 °C is required for the thicknesses ≥ 6 mm. The minimum absorbed energy shall be 45 J average / 35 J single. Reduction factors for subsize specimens shall be: 7.5 mm - 5/6 and 5 mm - 2/3.

## 7. MICROGRAPHIC EXAMINATION
The micrographic examination shall cover the near surfaces and mid-thickness region of the pipe. The ferrite content shall be determined according to ASTM E 562 or equivalent and shall be within 35-55 %. The microstructure, as examined at 400 X magnification on a suitably etched specimen, shall be free from intermetallic phases and precipitates.

## 8. EXTENT OF TESTING
Charpy V-notch impact, microstructure, hardness and tensile testing shall be carried out for each lot as defined in the referred standard. For batch furnace charges the specified tests shall be carried out for each heat treatment charge.

## 9. TEST SAMPLING
Samples for production testing shall realistically reflect the properties in the actual components.

## 10. SURFACE FINISH
White pickled.

## 11. REPAIR OF DEFECTS
Weld repair is not acceptable.

## 12. MARKING
The component shall be marked to ensure full traceability to melt and heat treatment lot.

## 13. CERTIFICATION
EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.
1. SCOPE
This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.

2. QUALIFICATION
Manufacturers of product to this MDS shall comply with the requirement of NORSOK standard M-650.

3. STEEL MAKING
The steel melt shall be refined with AOD or equivalent.

4. HEAT TREATMENT
The pipes shall be solution annealed followed by water quenching.

5. CHEMICAL COMPOSITION
N = 0.14 - 0.20 %

6. TENSILE TESTING
Base material properties: Rp0.2 ≥ 450 MPa; Rm ≥ 620 MPa; A ≥ 25 %.

7. HARDNESS
The hardness shall be maximum 28 HRC or alternatively 271 HB or 290 HV10 for base material, HAZ and weld metal.

8. IMPACT TESTING
Charpy V-notch testing according to ASTM A 370 at - 46 °C is required for the thicknesses ≥ 6 mm. The minimum absorbed energy shall be 45 J average and 35 J single. Two sets, each 3 specimen, shall be carried out with notch located in weld metal and fusion line, respectively. Reduction factors for subsize specimens shall be: 7.5 mm - 5/6 and 5 mm - 2/3.

9. MICROGRAPHIC EXAMINATION
The micrographic examination shall cover the near surfaces and mid-thickness region of the pipe including the weld zone. The ferrite content shall be determined according to ASTM E 562 or equivalent and shall be within 35-55 % for base material and 25-60 % for weld metal. The microstructure, as examined at 400 X magnification on a suitably etched specimen, shall be free from intermetallic phases and precipitates.

10. EXTENT OF TESTING
Tensile test, impact test, hardness test and microstructure examination shall be carried out for each lot. The lot is defined as follows:
- For batch furnace a lot is defined as maximum 60 m of pipe of the same heat, size and heat treatment charge.
- For continuous heat treatment furnace the lot definition in para 8.1 of the ASTM standard apply

11. TEST SAMPLING
Samples for production testing shall realistically reflect the properties in the actual components.

12. WELDING
The PQR/WPAR shall be qualified in accordance with ASME IX or EN 288-3 and shall include the same examinations as for the production testing. The qualification shall be carried out on the same material grade (UNS number) as used in production. Change of specific make (brand name) of welding consumables requires requalification.

13. TOLERANCES
The pipes shall have a max. undertolerance of 0.3 mm.

14. NON DESTRUCTIVE TESTING
Eddy current testing according to ASTM A 450 is acceptable as replacement for spot radiography for wall thicknesses less than 4.0 mm.
Supplementary requirement S3, penetrant testing, according to ASME V Article 6 shall apply to the weld area of 10 % of the pipes (same test lot as defined for mechanical testing) delivered. The testing shall be carried out after calibration and pickling. Acceptance criteria shall be to ASME VIII, Div. 1 Appendix 8.
| **TYPE OF MATERIAL:** Ferritic/Austenitic Stainless Steel, Type 22Cr duplex | **Page 2 of 2** |
| **PRODUCT** | **STANDARD** | **GRADE** | **ACCEPT. CLASS** | **SUPPL. REQ.** |
| Welded pipes | ASTM A 928 | UNS S31803 | Class 1, 3 and 5 | S3 |

| **15. SURFACE FINISH** | White pickled. |
| **16. REPAIR OF DEFECTS** | Weld repair of base material is not acceptable. For repair of welds the same requirements to PQR/WPAR shall apply as for production welding. |
| **17. MARKING** | The component shall be marked to ensure full traceability to melt and heat treatment lot. |
| **18. CERTIFICATION** | EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate. |
## MATERIAL DATA SHEET  MDS - D43  Rev. 2

**TYPE OF MATERIAL:** Ferritic / Austenitic Stainless Steel, Type 22Cr duplex

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>STANDARD</th>
<th>GRADE</th>
<th>ACCEPT. CLASS</th>
<th>SUPPL. REQ.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wrought fittings</td>
<td>ASTM A 815</td>
<td>UNS S 31803</td>
<td>WP-W, WP-S or WP-WX</td>
<td>S7</td>
</tr>
</tbody>
</table>

### 1. SCOPE

This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.

### 2. QUALIFICATION

Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.

### 3. STEEL MAKING

The steel melt shall be refined with AOD or equivalent.

### 4. HEAT TREATMENT

The fittings shall be solution annealed followed by water quenching.

### 5. CHEMICAL COMPOSITION

\[ N = 0.14 - 0.20 \% \]

### 6. HARDNESS

The hardness shall be maximum 28 HRC or alternatively 271 HB or 290 HV10 for base material, HAZ and weld metal.

### 7. IMPACT TESTING

Charpy V-notch testing according to ASTM A 370 at - 46 °C is required for the thicknesses ≥ 6 mm. The minimum absorbed energy shall be 45 J single and 35 J single. Reduction factors for subsize specimens shall be: 7.5 mm - 5/6 and 5 mm - 2/3. The notch location and number of specimen shall be:

- Seamless fittings: One set, 3 specimen.
- Welded fittings: Two sets, each 3 specimen, located in weld metal and fusion line.

### 8. MICROGRAPHIC EXAMINATION

The micrographic examination shall cover the near surface and mid-thickness region of the fittings including the weld zone. The ferrite content shall be determined according to ASTM E 562 or equivalent and shall be within 35 - 55 % for base material and 25 - 60 % for weld metal. The microstructure, as examined at 400 X magnification on a suitably etched specimen, shall be free from intermetallic phases and precipitates.

### 9. EXTENT OF TESTING

Tensile test, impact test hardness test and microstructure examination shall be carried out for each heat, heat treatment load within a wall thickness range of 5 mm and welded with the same WPS.

### 10. TEST SAMPLING

Samples for production testing shall realistically reflect the properties in the actual components.

### 11. WELDING

The PQR/WPAR shall be qualified in accordance with ASME IX or EN 288-3 and shall include the same examinations as for the production testing. The qualification shall be carried out on the same material grade (UNS number) as used in production. Change of specific make of welding consumables requires requalification.

### 12. DIMENSIONAL TOLERANCES

Fitting with reference to MSS-SP-75 shall have maximum wall thickness under tolerance of 0.3 mm.

### 13. NON DESTRUCTIVE TESTING

Supplementary requirement S7, liquid penetrant testing, shall apply to 10 % of seamless (from the test lot as defined above) and 100 % of welded fittings above NPS 2. The testing shall be carried out after calibration and pickling. For welded fittings the testing shall cover the weld only. The acceptance criteria shall be ASME VIII, Div. 1, Appendix 8.
<table>
<thead>
<tr>
<th><strong>MATERIAL DATA SHEET</strong></th>
<th><strong>MDS - D43</strong></th>
<th><strong>Rev. 2</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TYPE OF MATERIAL:</strong></td>
<td>Ferritic / Austenitic Stainless Steel, Type 22Cr duplex</td>
<td>Page 2 of 2</td>
</tr>
<tr>
<td><strong>PRODUCT</strong></td>
<td><strong>STANDARD</strong></td>
<td><strong>GRADE</strong></td>
</tr>
<tr>
<td>Wrought fittings</td>
<td>ASTM A 815</td>
<td>UNS S31803</td>
</tr>
</tbody>
</table>

**14. SURFACE FINISH**
White pickled. Machined surfaces do not require pickling.

**15. REPAIR OF DEFECTS**
Weld repair of base material is not acceptable. For repair of welds the same requirements to PQR/WPAR shall apply as for production welding.

**16. MARKING**
The component shall be marked to ensure full traceability to melt and heat treatment lot.

**17. CERTIFICATION**
EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.
<table>
<thead>
<tr>
<th>MATERIAL DATA SHEET</th>
<th>MDS - D44</th>
<th>Rev. 2</th>
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<tbody>
<tr>
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<td><strong>PRODUCT</strong></td>
<td><strong>STANDARD</strong></td>
<td><strong>GRADE</strong></td>
</tr>
<tr>
<td>Forgings</td>
<td>ASTM A 182</td>
<td>F51</td>
</tr>
</tbody>
</table>

1. **SCOPE**
   This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.

2. **QUALIFICATION**
   Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.

3. **STEEL MAKING**
   The steel melt shall be refined with AOD or equivalent.

4. **MANUFACTURING PROCESS**
   The Hot Isostatic Pressed (HIP) process is an acceptable alternative to forging.

5. **HEAT TREATMENT**
   The forgings shall be solution annealed followed by water quenching.

6. **CHEMICAL COMPOSITION**
   \[ N = 0.14 - 0.20 \% \]

7. **HARDNESS**
   The hardness shall be less than 28 HRC (or alternatively 271 HB or 290 HV10).

8. **IMPACT TESTING**
   Charpy V-notch testing according to ASTM A 370 at -46 °C is required for the thicknesses \( \geq 6 \text{ mm} \) (thickness at the weld neck). The minimum absorbed energy shall satisfy 45 J average and 35 J single. Reduction factors for subsize specimens shall be: 7.5 mm - 5/6 and 5 mm - 2/3.

9. **MICROGRAPHIC EXAMINATION**
   The micrographic examination shall be carried out at the same area as location of specimens for mechanical. The area shall be minimum \( 10 \times 10 \text{ mm} \). The ferrite content shall be determined according to ASTM E 562 or equivalent and shall be within 35 - 55 %. The microstructure, as examined at 400 X magnification on a suitably etched specimen, shall be free from intermetallic phases and precipitates.

10. **EXTENT OF TESTING**
    One set of impact test, tensile test, hardness test and microstructure examination shall be carried out for each heat and heat treatment load. A test lot shall not exceed 2000 kg for forgings with as forged weight \( \leq 50 \text{ kg} \), and 5000 kg for forgings with as forged weight > 50 kg.

11. **TEST SAMPLING**
    Samples for production testing shall realistically reflect the properties in the actual components.
    Test samples shall be from prolongations on actual component. Sacrificial forgings shall be used for die forged components. However, special agreements may be made for die forged components with as forged weight exceeding 50 kg. Integrated test blocks shall be used for HIP.
    Test specimens shall be cut at the 1/4 T location from the surface where T is the thickness of the test samples as heat treated. Sketches shall be established showing type, size and location of test samples and extraction of test specimens.

12. **DIMENSIONAL TOLERANCES**
    Flanges to MSS SP-44 shall have maximum wall thickness under tolerance of 0.3 mm for the hub at the welding end.
<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>STANDARD</th>
<th>GRADE</th>
<th>ACCEPT. CLASS</th>
<th>SUPPL. REQ.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forgings</td>
<td>ASTM A 182</td>
<td>F51</td>
<td>-</td>
<td>S5</td>
</tr>
</tbody>
</table>

13. NON DESTRUCTIVE TESTING
Supplementary requirement S5, liquid penetrant testing, shall apply to 10% of forgings (from the lot as defined for mechanical testing) above NPS 2. The testing shall be carried out after final machining. Non-machined surfaces shall be pickled prior to the testing. The acceptance criteria shall be ASME VIII, Div. 1, Appendix 8.

14. SURFACE FINISH
White pickled. Machined surfaces do not require pickling.

15. REPAIR OF DEFECTS
Weld repair is not acceptable.

16. MARKING
The component shall be marked to ensure full traceability to melt and heat treatment lot.

17. CERTIFICATION
EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.
## MATERIAL DATA SHEET MDS - D45 Rev. 2

**TYPE OF MATERIAL:** Ferritic / Austenitic Stainless Steel, Type 22Cr duplex

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>STANDARD</th>
<th>GRADE</th>
<th>ACCEPT. CLASS</th>
<th>SUPPL. REQ.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plates</td>
<td>ASTM A 240</td>
<td>UNS S 31803</td>
<td>-</td>
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</tbody>
</table>

### 1. SCOPE
This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.

### 2. QUALIFICATION
Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.

### 3. STEEL MAKING
The steel melt shall be refined with AOD or equivalent.

### 4. HEAT TREATMENT
The plates shall be solution annealed followed by water quenching.

### 5. CHEMICAL COMPOSITION
N = 0.14 - 0.20 %

### 6. HARDNESS
The hardness shall be maximum 28 HRC or alternatively 271 HB or 290 HV10.

### 7. IMPACT TESTING
Charpy V-notch testing according to ASTM A 370 at - 46 °C is required for the thicknesses ≥ 6 mm. The minimum absorbed energy shall satisfy 45 J average and 35 J single. Reduction factors for subsize specimens shall be: 7.5 mm - 5/6 and 5 mm - 2/3.

### 8. MICROGRAPHIC EXAMINATION
The micrographic examination shall cover the near surface and mid-thickness region. The ferrite content shall be determined according to ASTM E 562 or equivalent and shall be within 35 - 55 %. The microstructure, as examined at 400 X magnification on a suitably etched specimen, shall be free from intermetallic phases and precipitates.

### 9. EXTENT OF TESTING
Impact test, tensile test, hardness test and micrographic examination shall be carried out for each heat, size and heat treatment load.

### 10. TEST SAMPLING
Samples for production testing shall realistically reflect the properties in the actual components.

### 11. SURFACE FINISH
White pickled.

### 13. REPAIR OF DEFECTS
Weld repair is not acceptable.

### 14. MARKING
The component shall be marked to ensure full traceability to melt and heat treatment lot.

### 15. CERTIFICATION
EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.
<table>
<thead>
<tr>
<th><strong>MATERIAL DATA SHEET</strong></th>
<th><strong>MDS - D46</strong></th>
<th><strong>Rev. 2</strong></th>
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<tbody>
<tr>
<td><strong>TYPE OF MATERIAL:</strong></td>
<td>Ferritic / Austenitic Stainless Steel, Type 22Cr duplex</td>
<td>Page 1 of 2</td>
</tr>
<tr>
<td><strong>PRODUCT</strong></td>
<td><strong>STANDARD</strong></td>
<td><strong>GRADE</strong></td>
</tr>
<tr>
<td>Castings</td>
<td>ASTM A 890</td>
<td>4 (UNS J9225)</td>
</tr>
</tbody>
</table>

1. **SCOPE**
   This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.

2. **QUALIFICATION**
   Manufacturers of product to this MDS shall comply with the requirement of NORSOK standard M-650.

3. **STEEL MAKING**
   The steel melt shall be with AOD or equivalent refining.

4. **HEAT TREATMENT**
   The castings shall be solution annealed followed by water quenching.

5. **CHEMICAL COMPOSITION**
   \[ N = 0.14 - 0.20 \% \]

6. **HARDNESS**
   The hardness shall be maximum 28 HRC or alternatively 271 HB or 290 HV10.

7. **IMPACT TESTING**
   Charpy V-notch testing is required according to ASTM A 370 at -46 °C. The minimum absorbed energy shall satisfy 45 J average and 35 J single.

8. **MICROGRAPHIC EXAMINATION**
   The micrographic examination shall be carried out at the same area as location of specimens for mechanical testing. The area shall be minimum 10 x 10 mm. The ferrite content shall be determined according to ASTM E 562 or equivalent and shall be within 35 - 55 %. The microstructure, as examined at 200 X and 400 X magnification on a suitably etched specimen, shall be free from intermetallic phases and precipitates.

9. **EXTENT OF TESTING**
   A full set of mechanical tests and microstructure examinations shall be made for each heat and heat treatment load. A test lot shall not exceed 5 000 kg.

10. **TEST SAMPLING**
    Samples for mechanical testing shall realistically reflect the properties in the actual components. Thickness of the test block shall be equal to the thickness of the actual components up to a maximum thickness of 100 mm. For flanged components the largest flange thickness shall apply.
    Test specimens shall be cut from the 1/4 T location from the surface where T is the thickness of the test block.
    Test block shall be integrally cast or gated onto the castings and shall not be removed from the castings until after the final quality heat treatment.

12. **NON DESTRUCTIVE TESTING**
    **Liquid penetrant testing:** Supplementary requirement S3 shall apply to all accessible surfaces of all castings. The examination shall be carried out after final machining. Non-machined surfaces shall be pickled prior to the testing. The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 7.
    **Radiographic testing:** Supplementary requirement S2 shall apply to:
    - Critical areas as per ANSI B16.34 of the pilot cast of each pattern.
    - All butt weld ends of each casting
    - Class 1500 psi and above; all critical areas to ANSI B16.34 of each casting.
    The acceptance criteria shall be to ASME VIII, Div. 1 Appendix 7.
### MATERIAL DATA SHEET  
**MDS - D46**  
**Rev. 2**

<table>
<thead>
<tr>
<th>TYPE OF MATERIAL:</th>
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<tr>
<th>PRODUCT</th>
<th>STANDARD</th>
<th>GRADE</th>
<th>ACCEPT. CLASS</th>
<th>SUPPL. REQ.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Castings</td>
<td>ASTM A 890</td>
<td>4 (UNS J9225)</td>
<td>-</td>
<td>S2, S3, S33</td>
</tr>
</tbody>
</table>

### 13. SURFACE FINISH
White pickled. Machined surfaces do not require pickling.

### 14. REPAIR OF DEFECTS
Supplementary requirement S33 shall apply.

The repair welding procedure qualification shall include the following:
- qualified on a cast plate of the same grade (UNS-number) which shall be welded
- change of specific make of filler metal (brand name) requires re-qualification
- examination of microstructure of base material and weld zone. The ferrite content shall be 35-55 % for the base material and 25-60 % for the weld metal.
- Charpy V-notch testing as specified above, with two sets each 3 specimens, with notch located in weld metal and fusion line, respectively.

### 15. MARKING
The component shall be marked to ensure full traceability to melt and heat treatment lot.

### 16. CERTIFICATION
EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.
**MATERIAL DATA SHEET**

**MDS - D47**

**TYPE OF MATERIAL:** Ferritic / Austenitic Stainless Steel, Type 22Cr duplex

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>STANDARD</th>
<th>GRADE</th>
<th>ACCEPT. CLASS</th>
<th>SUPPL. REQ.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bars</td>
<td>ASTM A 276</td>
<td>UNS S 31803</td>
<td>-</td>
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</tbody>
</table>

1. **SCOPE**
   This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.

2. **QUALIFICATION**
   Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.

3. **STEEL MAKING**
   The steel melt shall be refined with AOD or equivalent.

4. **HEAT TREATMENT**
   The bars shall be solution annealed followed by water quenching.

5. **CHEMICAL COMPOSITION**
   \( \text{N} = 0.14 - 0.20 \% \)

6. **HARDNESS**
   The hardness shall be maximum 28 HRC or alternatively 271 HB or 290 HV10.

7. **IMPACT TESTING**
   Charpy V-notch testing is required according to ASTM A 370 at -46 °C. The minimum absorbed energy shall satisfy 45 J average and 35 J single.

8. **MICROGRAPHIC EXAMINATION**
   The micrographic examination shall be carried out at the same area as location of specimens for mechanical testing. The area shall be minimum 10 x 10 mm. The ferrite content shall be determined according to ASTM E 562 or equivalent and shall be within 35 - 55 %. The microstructure, as examined at 400 X magnification on a suitably etched specimen, shall be free from intermetallic phases and precipitates.

9. **EXTENT OF TESTING**
   Impact test, hardness test and micrographic examination shall be carried out to the same extent as tensile test.

10. **TEST SAMPLING**
    Samples for production testing shall realistically reflect the properties in the actual components.

11. **SURFACE FINISH**
    White pickled. Machined surfaces do not require pickling.

12. **REPAIR OF DEFECTS**
    Weld repair is not acceptable.

13. **MARKING**
    The component shall be marked to ensure full traceability to melt and heat treatment lot.

14. **CERTIFICATION**
    EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.
**MATERIAL DATA SHEET**

**MDS - D48**

**Rev. 2**

**TYPE OF MATERIAL:** Ferritic / Austenitic Stainless Steel, Type 22Cr duplex

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>STANDARD</th>
<th>GRADE</th>
<th>ACCEPT. CLASS</th>
<th>SUPPL. REQ.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tubes</td>
<td>ASTM A 789</td>
<td>UNS S 31803</td>
<td>-</td>
<td>-</td>
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</tbody>
</table>

**1. SCOPE**

This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.

**2. QUALIFICATION**

Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.

**3. STEEL MAKING**

The steel melt shall be refined with AOD or equivalent.

**4. HEAT TREATMENT**

The tubes shall be solution annealed followed by water quenching.

**5. CHEMICAL COMPOSITION**

N = 0.14 - 0.20 %

**6. HARDNESS**

The hardness shall be maximum 28 HRC or alternatively 271 HB or 290 HV10.

**7. IMPACT TESTING**

Charpy V-notch testing (3 specimens) according to ASTM A 370 at -46 °C is required for the thicknesses ≥ 6 mm. The minimum absorbed energy shall be 45 J average / 35 J single. Reduction factors for subsize specimens shall be: 7.5 mm - 5/6 and 5 mm - 2/3.

**8. MICROGRAPHIC EXAMINATION**

The ferrite content shall be determined according to ASTM E 562 or equivalent and shall be within 35-55 %. The microstructure, as examined at 400 X magnification on a suitably etched specimen, shall be free from intermetallic phases and precipitates.

**9. EXTENT OF TESTING**

Microstructure, hardness and tensile testing shall be carried out for each lot as defined in the referred standard.

**10. TEST SAMPLING**

Samples for production testing shall realistically reflect the properties in the actual components.

**11. SURFACE FINISH**

White pickled.

**12. MARKING**

The component shall be marked to ensure full traceability to melt and heat treatment lot.

**13. CERTIFICATION**

EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.
# MATERIAL DATA SHEET MDS - D51

<table>
<thead>
<tr>
<th>TYPE OF MATERIAL:</th>
<th>Ferritic / Austenitic Stainless Steel, Type 25Cr duplex</th>
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<tr>
<th>PRODUCT</th>
<th>STANDARD</th>
<th>GRADE</th>
<th>ACCEPT. CLASS</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Seamless pipes</td>
<td>ASTM A 790</td>
<td>UNS S 32550</td>
<td>-</td>
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<td></td>
<td></td>
<td>UNS S 32750</td>
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<td></td>
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<td>UNS S 32760</td>
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</table>

1. **SCOPE**

This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard. This MDS is based on the mechanical properties of UNS S 32750 which is the only Type 25 Cr duplex listed in ASME B31.3.

2. **QUALIFICATION**

Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.

3. **STEEL MAKING**

The steel melt shall be refined with AOD or equivalent.

4. **HEAT TREATMENT**

The pipes shall be solution annealed followed by water quenching.

5. **CHEMICAL COMPOSITION**

PRE (% Cr + 3.3 % Mo + 16 % N) \( \geq 40.0 \)

6. **TENSILE TESTING**

\( R_{p0.2} \geq 550 \text{ MPa}; R_{m} \geq 800 \text{ MPa}; \)

7. **HARDNESS**

The harness shall be max. 32 HRC (or alternatively 301 HB or 330 HV 10).

8. **IMPACT TESTING**

Charpy V-notch testing (3 specimen) according to ASTM A 370 at - 46 °C is required for thicknesses \( \geq 6 \text{ mm} \). The minimum absorbed energy shall be 45 J average / 35 J single. Reduction factors for subsize specimens shall be: 7.5 mm - 5/6 and 5 mm - 2/3.

9. **CORROSION TEST**

Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. The specimen shall have the internal and external surfaces in the as-delivered condition (including pickling). Cut edges shall be prepared according to ASTM G 48, and the whole specimen shall be pickled (20 % HNO₃ + 5 % HF, 60 °C, 5 minute). The test shall expose the external and internal surfaces and a cross section surface in full wall thickness. The acceptance criteria are:

- No pitting 20 X magnification.
- The weight loss shall be less than 4.0 g/m².

10. **MICROGRAPHIC EXAMINATION**

The micrographic examination shall cover the near surfaces and mid-thickness region of the pipe. The ferrite content shall be determined according to ASTM E 562 or equivalent and shall be within 35-55 %. The microstructure, as examined at 400 X magnification on a suitably etched specimen, shall be free from intermetallic phases and precipitates.

11. **EXTENT OF TESTING**

Charpy V-notch impact, microstructure, hardness, corrosion and tensile testing shall be carried out for each lot as defined in the referred standard. For batch furnace charges the specified tests shall be carried out for each heat treatment charge.
**MATERIAL DATA SHEET**  MDS - D51  Rev. 2

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>STANDARD</th>
<th>GRADE</th>
<th>ACCEPT. CLASS</th>
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</thead>
<tbody>
<tr>
<td>Seamless pipes</td>
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<td>UNS S 32550</td>
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<td>UNS S 32760</td>
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</table>

12. **TEST SAMPLING**
Samples for production testing shall realistically reflect the properties in the actual components.

13. **SURFACE FINISH**
White pickled.

14. **REPAIR OF DEFECTS**
Weld repair is not acceptable.

15. **MARKING**
The component shall be marked to ensure full traceability to melt and heat treatment lot.

16. **CERTIFICATION**
EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.
## MATERIAL DATA SHEET MDS - D52 Rev. 2

**TYPE OF MATERIAL:** Ferritic / Austenitic Stainless Steel, Type 25Cr duplex

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>STANDARD</th>
<th>GRADE</th>
<th>ACCEPT. CLASS</th>
<th>SUPPL. REQ.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Welded pipes</td>
<td>ASTM A 928</td>
<td>UNS S 32550</td>
<td>Class 1, 3 and 5</td>
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</table>

### 1. SCOPE

This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard. This MDS is based on the mechanical properties of UNS S 32750 which is the only Type 25 Cr duplex listed in ASME B31.3.

### 2. QUALIFICATION

Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.

### 3. STEEL MAKING

The steel melt shall be refined with AOD or equivalent.

### 4. HEAT TREATMENT

The pipes shall be solution annealed followed by water quenching.

### 5. CHEMICAL COMPOSITION

PRE (% Cr + 3.3 % Mo + 16 % N) ≥ 40.0

### 6. TENSILE TESTING

$R_{p0.2} \geq 550$ MPa; $R_m \geq 795$ MPa; $A \geq 15\%

### 7. HARDNESS

The hardness shall be maximum 32 HRC (or alternatively 301 HB or 330 HV10) for base material, HAZ and weld metal.

### 8. IMPACT TESTING

Charpy V-notch testing according to ASTM A 370 at - 46 °C is required for thicknesses ≥ 6 mm. The minimum absorbed energy shall be 45 J average / 35 J single. Two sets, each 3 specimens, shall be carried out with notch located in weld metal and fusion line, respectively. Reduction factors for subsize specimens shall be: 7.5 mm - 5/6 and 5 mm - 2/3.

### 9. CORROSION TEST

Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. The specimen shall have the internal and external surfaces in the as-delivered condition (including pickling). Cut edges shall be prepared according to ASTM G48, and the whole specimen shall be pickled (20 % HNO3 + 5 % HF, 60 °C, 5 minute). The test shall expose the external and internal surfaces and a cross section surface including weld zone in full wall thickness. The acceptance criteria are:

- No pitting at 20 X magnification
- The weight loss shall be less than 4.0 g/m$^2$

### 10. MICROGRAPHIC EXAMINATION

The micrographic examination shall cover the near surfaces and mid-thickness region of the pipe including the weld and heat affected zone. The ferrite content shall be determined according to ASTM E 562 or equivalent and shall be within 35-55 % for base material and 25-60 % for weld metal. The microstructure, as examined at 400 X magnification on a suitably etched specimen, shall be free from intermetallic phases and precipitates.

### 11. EXTENT OF TESTING

Tensile, impact, hardness, corrosion and microstructure examination shall be carried out for each lot. The lot is defined as follows:

- For batch furnace a lot is defined as maximum 60 m of pipe of the same heat, size and heat treatment charge.
- For continuous heat treatment furnace the lot definition in para 8.1 of the ASTM standard apply.
# MATERIAL DATA SHEET

## TYPE OF MATERIAL:
Ferritic / Austenitic Stainless Steel, Type 25Cr duplex

### PRODUCT   | STANDARD | GRADE     | ACCEPT. CLASS | SUPPL. REQ.
---         | ---      | ---        | ---           | ---
Welded pipes | ASTM A 928 | UNS S 32550 | Class 1, 3 and 5 | -
|           |          | UNS S 32750 |               | -
|           |          | UNS S 32760 |               | -

### 12. TEST SAMPLING
Samples for production testing shall realistically reflect the properties in the actual components.

### 13. WELDING
The PQR/WPAR shall be qualified in accordance with ASME IX or EN 288-3 and shall include the same examinations as for the production testing. The qualification shall be carried out on the same material grade (UNS number) as used in production. Change of specific make (brand name) of welding consumables requires requalification.

### 14. TOLERANCES
The pipes shall have a max. undertolerance of 0.3 mm.

### 15. NON DESTRUCTIVE TESTING
Eddy current testing according to ASTM A 450 is acceptable as replacement for spot radiography for wall thicknesses less than 4.0 mm. Supplementary requirement S3, penetrant testing, according to ASME V Article 6 shall apply to the weld of 10 % of the pipes (same test lot as defined for mechanical testing) delivered. The testing shall be carried out after calibration and pickling. Acceptance criteria shall be to ASME VIII, Div 1, Appendix 8.

### 16. SURFACE FINISH
White pickled.

### 17. REPAIR OF DEFECTS
Weld repair of base material is not acceptable. For repair of welds the same requirements to PQR/WPAR shall apply as for production welding.

### 18. MARKING
The component shall be marked to ensure full traceability to melt and heat treatment lot.

### 19. CERTIFICATION
EN 10 204 Type 31.B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.
**MATERIAL DATA SHEET**  
**MDS - D53**  
**Rev. 2**

**TYPE OF MATERIAL:** Ferritic / Austenitic Stainless Steel, Type 25Cr duplex

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>STANDARD</th>
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<td>Wrought fittings</td>
<td>ASTM A 815</td>
<td>UNS S 32550</td>
<td>WP-S, WP-WX and WP-W</td>
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</table>

1. **SCOPE**

This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.

2. **QUALIFICATION**

Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.

3. **STEEL MAKING**

The steel melt shall be refined with AOD or equivalent.

4. **HEAT TREATMENT**

Solution annealing followed by water quenching.

5. **CHEMICAL COMPOSITION**

PRE (% Cr + 3.3 % Mo + 16 % N) ≥ 40.0

6. **TENSILE TESTING**

Base material properties:  $R_{p0.2} ≥ 550$ MPa; $R_m ≥ 800$ MPa;

7. **HARDNESS**

The hardness shall be maximum 32 HRC (or alternatively 301 HB or 330 HV10) for base material, HAZ and weld metal.

8. **IMPACT TESTING**

Charpy V-notch testing according to ASTM A 370 at -46 °C is required for the thicknesses ≥ 6 mm. The minimum absorbed energy shall be 45 J average / 35 J single. Reduction factors for subsize specimens shall be: 7.5 mm -5/6 and 5 mm -2/3. The notch location and number of specimen shall be:

Seamless fittings: One set, (3 specimens).

Welded fittings: Two sets, (each 3 specimen) located in weld metal and fusion line.

9. **CORROSION TEST**

Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. The specimen shall have the internal and external surfaces in the as-delivered condition (including pickling). Cut edges shall be prepared according to ASTM G 48, and the whole specimen shall be pickled (20 % HNO3 + 5 % HF, 60 °C, 5 minute). The test shall expose the external and internal surfaces and a cross section including weld zone (if relevant) in full wall thickness. The acceptance criteria are:

- No pitting at 20 X magnification.
- The weight loss shall be less than 4.0 g/m².

10. **MICROGRAPHIC EXAMINATION**

The micrographic examination shall cover the near surfaces and mid-thickness region. For welded fittings both the weld and the base material is required examined. The ferrite content shall be determined according to ASTM E 562 or equivalent and shall be within 35-55 % for base material and 25-60 % for weld metal. The microstructure, as examined at 400 X magnification on a suitably etched specimen, shall be free from intermetallic phases and precipitates.

11. **EXTENT OF TESTING**

Tensile testing, impact testing, hardness testing, corrosion testing and microstructure examination shall be carried out for each heat and heat treatment load within a wall thickness range of 5 mm and welded with the same WPS.
**MATERIAL DATA SHEET**  
**MDS - D53**  
**Rev. 2**

<table>
<thead>
<tr>
<th>TYPE OF MATERIAL:</th>
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<tr>
<td>PRODUCT</td>
<td>Wrought fittings</td>
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<tr>
<td>STANDARD</td>
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<tr>
<td>GRADE</td>
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<td>ACCEPT. CLASS</td>
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</table>

12. **TEST SAMPLING**  
Samples for production testing shall realistically reflect the properties in the actual components.

13. **WELDING**  
The PQR/WPAR shall be qualified in accordance with ASME IX or EN 288-3 and shall include the same examinations as for the production testing. The qualification shall be carried out on the same material grade (UNS number) as used in production. Change of specific make (brand name) of welding consumables requires requalification.

14. **DIMENSIONAL TOLERANCES**  
Fittings with reference to MSS-SP-75 shall have maximum wall thickness under tolerance of 0.3 mm.

15. **NON DESTRUCTIVE TESTING**  
Supplementary requirements S7, liquid penetrant examination, shall apply to 10% of seamless (from the test lot as defined above) and 100% of welded fittings above NPS 2. The examination shall be carried out after calibration and pickling. For welded fittings the examination shall cover the weld only. The acceptance criteria shall be ASME VIII, Div. 1, Appendix 8.

16. **SURFACE FINISH**  
White pickled.

17. **REPAIR OF DEFECTS**  
Weld repair of base material is not acceptable. For repair of welds the same requirements to PQR/WPAR shall apply as for production welding.

18. **MARKING**  
The component shall be marked to ensure full traceability to melt and heat treatment lot.

19. **CERTIFICATION**  
EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.
**TYPE OF MATERIAL:** Ferritic/Austenitic Stainless Steel, Type 25Cr duplex

<table>
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<td>F55 - UNS S 32760</td>
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</table>

1. **SCOPE**
   This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard. This MDS is based on the mechanical properties of UNS S 32750 which is the only Type 25 Cr duplex listed in ASME B31.3.

2. **QUALIFICATION**
   Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.

3. **STEEL MAKING**
   The steel melt shall be refined with AOD or equivalent.

4. **MANUFACTURING PROCESS**
   The Hot Isostatic Pressed (HIP) process is an acceptable alternative to forging.

5. **HEAT TREATMENT**
   Solution annealing followed by water quenching.

6. **CHEMICAL COMPOSITION**
   \[ \text{PRE (\% Cr + 3.3 \% Mo + 16 \% N)} \geq 40.0. \]

7. **TENSILE TESTING**
   \[ R_{p0.2} \geq 550 \text{ MPa}; \ R_m \geq 800 \text{ MPa}; \ A \geq 15 \%. \]

8. **HARDNESS**
   The hardness shall be less than 32 HRC (or alternatively 301 HB or 330 HV10).

9. **IMPACT TESTING**
   Charpy V-notch testing according to ASTM A 370 at -46 °C is required for the thicknesses \( \geq 6 \text{ mm} \) (thickness at the weld neck). The minimum absorbed energy shall satisfy 45 J average / 35 J single. Reduction factors for subsize specimens shall be: 7.5 mm - 5/6 and 5 mm - 2/3.

10. **MICROGRAPHIC EXAMINATION**
    The micrographic examination shall be carried out at the same area as location of specimens for mechanical testing. The area shall be minimum 10 x 10 mm. The ferrite content shall be determined according to ASTM E 562 or equivalent and shall be within 35 -55 %. The microstructure, as examined at 400 X magnification on a suitably etched specimen, shall be free from intermetallic phases and precipitates.

11. **CORROSION TEST**
    Corrosion test according to ASTM G 48, Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. The corrosion test specimen shall be at the same location as those for mechanical testing. Cut edges shall be prepared according to ASTM G 48 and pickled (20 % HNO3 + 5 % HF, 60 °C, 5 Minute). The acceptance criteria are:
    - No pitting at 20 X magnification.
    - The weight loss shall be less than 4.0 g/m^2.

12. **EXTENT OF TESTING**
    One set of impact, tensile, hardness, corrosion testing and microstructure examination shall be carried out for each heat and heat treatment load. A test lot shall not exceed 2000 kg for forgings with as forged weight \( \leq 50 \text{ kg} \), and 5000 kg for forgings with as forged weight > 50 kg.
**MATERIAL DATA SHEET**  
MDS - D54  
Rev. 2

<table>
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<td>- UNS S 32550 F53 - UNS S 32750 F55 - UNS S 32760</td>
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</table>

**13. TEST SAMPLING**  
Samples for production testing shall realistically reflect the properties in the actual components.

Test samples shall be from prolongations on actual component. Sacrificial forgings shall be used for die forged components. However, special agreements may be made for die forged components with as forged weight exceeding 50 kg. Integrated test blocks shall be used for HIP.

Test specimens shall be cut at the ¼ T location from the surface where T is the thickness of the test samples as heat treated. Sketches shall be established showing type, size and location of test samples and extraction of test specimens.

**14. DIMENSIONAL TOLERANCES**  
Flanges to MSS SP-44 shall have maximum wall thickness under tolerance of 0.3 mm for the hub at the welding end.

**15. NON DESTRUCTIVE TESTING**  
Supplementary requirement S5, liquid penetrant testing, shall apply to 10 % of forgings (from the lot as defined for mechanical testing) above NPS 2. The testing shall be carried out after final machining and pickling. The acceptance criteria shall be ASME VIII, Div. 1, Appendix 8.

**16. SURFACE FINISH**  
White pickled including machined surfaces.

**17. REPAIR OF DEFECTS**  
Weld repair is not acceptable.

**18. MARKING**  
The component shall be marked to ensure full traceability to melt and heat treatment lot.

**19. CERTIFICATION**  
EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.
1. SCOPE
This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard. This MDS is based on the mechanical properties of UNS S 32750 which is the only Type 25 Cr duplex listed in ASME B 31.3.

2. QUALIFICATION
Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.

3. STEEL MAKING
The steel melt shall be refined with AOD or equivalent.

4. HEAT TREATMENT
Solution annealing followed by water quenching.

5. CHEMICAL COMPOSITION
PRE (%Cr + 3.3 % Mo + 16 % N) ≥ 40.0.

6. TENSILE TESTING
Rp0.2 ≥ 550 MPa; Rm ≥ 750 MPa; A ≥ 15%.

7. HARDNESS
The hardness shall be maximum 32 HRC or alternatively 301 HB or 330 HV10.

8. IMPACT TESTING
Charpy V-notch testing is required according to ASTM A 370 at -46 °C. The minimum absorbed energy shall satisfy 45 J average / 35 J single. Reduction factors for subsize specimens shall be: 7.5 mm - 5/6 and 5 mm - 2/3.

9. MICROGRAPHIC EXAMINATION
The micrographic examination shall cover the near surface and mid-thickness region. The ferrite content shall be determined according to ASTM E 562 or equivalent and shall be within 35 - 55 %. The microstructure, as examined at 400 X magnification on a suitably etched specimen, shall be free from intermetallic phases and precipitates.

10. CORROSION TEST
Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. The specimen shall have surfaces in the as-delivered condition (including pickling). Cut edges shall be prepared according to ASTM G 48, and the whole specimen shall be pickled (20 % HNO3 + 5 % HF, 60 °C, 5 minute). The test shall expose both surfaces and a cross section in full wall thickness. The acceptance criteria are:
- No pitting at 20 X magnification.
- The weight loss shall be less than 4.0 g/m².

11. EXTENT OF TESTING
Test samples for impact testing, microstructure, hardness, corrosion and tensile testing shall be carried out for each heat and heat treatment lot.

12. TEST SAMPLING
Samples for production testing shall realistically reflect the properties in the actual components.

13. SURFACE FINISH
White pickled.

14. REPAIR OF DEFECTS
Repair welding is not acceptable.

15. MARKING
The component shall be marked to ensure full traceability to melt and heat treatment lot.

16. CERTIFICATION
EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.
### MATERIAL DATA SHEET

**TYPE OF MATERIAL:** Ferritic/Austenitic Stainless Steel, Type 25Cr duplex

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>STANDARD</th>
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</table>

#### 1. SCOPE

This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.

#### 2. QUALIFICATION

Manufacturers of product to this MDS shall be qualified in accordance with NORSOK Standard M-650.

#### 3. STEEL MAKING

The steel melt shall be refined with AOD or equivalent process.

#### 4. HEAT TREATMENT

According to Grade 5A (UNS J93404).

#### 5. CHEMICAL COMPOSITION

\[ \text{PRE (Cr + 3.3 \% Mo + 16 \% N)} \geq 40.0. \]

#### 6. TENSILE TESTING

\[ R_{p0,2} \geq 450 \text{ MPa}; \text{ R_m} \geq 700 \text{ MPa}; A \geq 15 \%. \]

#### 7. HARDNESS

The hardness shall be less than 32 HRC (or alternatively 301 HB or 330 HV10).

#### 8. IMPACT TESTING

Charpy V-notch testing is required according to ASTM A 370 at -46 °C. The minimum absorbed energy shall satisfy 45 J average / 35 J single.

#### 9. MICROGRAPHIC EXAMINATION

The micrographic examination shall be carried out at the same area as location of specimens for mechanical tests. The area shall be minimum 10 x 10 mm. On WPQ’s both the weld, HAZ and base material shall be examined. The ferrite content shall be determined according to ASTM E 562 or equivalent and shall be within 35 - 55 %. The microstructure, as examined at 200 X magnification on a suitably etched specimen, shall be free from intermetallic phases and precipitates.

#### 10. CORROSION TEST

Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. The corrosion test specimen shall be at the same location as those for mechanical testing. Cut edges shall be prepared according to ASTM G 48 and pickled (20 % HNO3 + 5 % HF, 60 °C, 5 minute). The acceptance criteria are:

- No pitting at 20X magnification.
- The weight loss shall be less than 4.0 g/m².

#### 11. EXTENT OF TESTING

A full set of mechanical and corrosion tests and microstructure examinations shall be made for each heat and heat treatment charge. A test lot shall not exceed 5 000 kg.

#### 12. TEST SAMPLING

Samples for production testing shall realistically reflect the properties in the actual components. Thickness of the test block shall be equal to the thickness of the actual components up to a maximum thickness of 100 mm. For flanged components the largest flange thickness shall apply.

Test specimens shall be cut from the 1/4 T location from the surface where T is the thickness of the test block.

Test block shall be integrally cast or gated onto the castings and shall not be removed from the castings until after the final quality heat treatment.
**MATERIAL DATA SHEET**

**MDS - D56**  
Rev. 2

**TYPE OF MATERIAL:** Ferritic/Austenitic Stainless Steel, Type 25Cr duplex  

<table>
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<td>Castings</td>
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<td>UNS J93380</td>
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13. **NON DESTRUCTIVE TESTING**  
*Liquid penetrant testing:* Supplementary requirement S3 shall apply to all accessible surfaces of all castings. The testing shall be carried out after final machining and pickling. The acceptance criteria shall be ASME VIII, Div. 1, Appendix 7.

*Radiographic testing:* Supplementary requirement S2 shall apply to:
- Critical areas as per ANSI B16.34 of the pilot cast of each pattern.
- All butt weld ends of each casting
- Class 1500 psi and above; all critical areas to ANSI B16.34 of each casting.

The acceptance criteria shall be to ASME VIII, Div. 1 Appendix 7.

14. **SURFACE FINISH**  
White pickled shall be carried out after any blasting and shall include finished machined surfaces.

15. **REPAIR OF DEFECTS**  
Supplementary requirement S33 shall apply. The repair welding procedure shall be qualified in accordance with ASME IX or EN 288-3 and this MDS. The repair welding procedure qualification shall include the following:
- qualified on a cast plate of the same grade (UNS number) which shall be welded
- change of specific make of filler metal (brand names) requires requalification
- examination of microstructure of base material and weld zone. The ferrite content shall be 35 - 55 % for the base material and 25 - 60 % for the weld metal.
- Charpy V-notch testing as specified above, with two sets (each 3 specimens), with notch located in weld metal and fusion line, respectively
- corrosion test as specified above. The specimen shall include weld zone.

16. **MARKING**  
The component shall be marked to ensure full traceability to melt and heat treatment lot.

17. **CERTIFICATION**  
EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.
**MATERIAL DATA SHEET**

**TYPE OF MATERIAL:** Ferritic/Austenitic Stainless Steel, Type 25Cr duplex

<table>
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</table>

1. **SCOPE**

   This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard. This MDS is based on the mechanical properties of UNS S 32750 which is the only Type 25 Cr duplex listed in ASME B 31.3.

2. **QUALIFICATION**

   Manufacturers of product to this MDS shall comply with the requirement in NORSOK Standard M-650.

3. **STEEL MAKING**

   The steel melt shall be refined with AOD or equivalent.

4. **HEAT TREATMENT**

   Solution annealing followed by water quenching.

5. **CHEMICAL COMPOSITION**

   PRE (% Cr + 3.3 % Mo + 16 % N) ≥ 40.0.

6. **TENSILE TESTING**

   $R_p0.2 ≥ 550$ MPa; $R_m ≥ 800$ MPa; $A ≥ 15\%$.

7. **HARDNESS**

   The hardness shall be less than 32 HRC (or alternatively 301 HB or 330 HV10).

8. **IMPACT TESTING**

   Charpy V-notch testing is required according to ASTM A 370 at -46 °C. The minimum absorbed energy shall satisfy 45 J average / 35 J single.

9. **MICROGRAPHIC EXAMINATION**

   The micrographic examination shall be carried out at the same area as location of specimens for mechanical testing. The area shall be minimum 10 x 10 mm. The ferrite content shall be determined according to ASTM E 562 or equivalent and shall be within 35 - 55 %. The microstructure, as examined at 400 X magnification on a suitably etched specimen, shall be free from intermetallic phases and precipitates.

10. **CORROSION TEST**

    Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. The corrosion test specimen shall be at the same location as those for mechanical testing. Cut edges shall be prepared according to ASTM G 48 and pickled (20 % HNO3 + 5 % HF, 60 °C, 5 minute). The acceptance criteria are:

    - No pitting at 20 X magnification.
    - The weight loss shall be less than 4.0 g/m².

11. **EXTENT OF TESTING**

    Test samples for impact testing, microstructure, hardness, corrosion and tensile testing shall be carried out for each heat and heat treatment lot.

12. **TEST SAMPLING**

    Samples for production testing shall realistically reflect the properties in the actual components.

15. **SURFACE FINISH**

    White pickled.

16. **REPAIR OF DEFECTS**

    Weld repair is not acceptable.

17. **MARKING**

    The component shall be marked to ensure full traceability to melt and heat treatment lot.

18. **CERTIFICATION**

    EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.
### MATERIAL DATA SHEET  MDS - D58  Rev. 1

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**1. SCOPE**
This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard. This MDS is based on the mechanical properties of UNS S 32750 which is the only Type 25 Cr duplex listed in ASME B31.3.

**2. QUALIFICATION**
Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.

**3. STEEL MAKING**
The steel melt shall be refined with AOD or equivalent.

**4. HEAT TREATMENT**
The tubes shall be solution annealed followed by water quenching.

**5. CHEMICAL COMPOSITION**
PRE (% Cr + 3.3 % Mo + 16 % N) ≥ 40.0.

**6. TENSILE TESTING**
Rp0.2 ≥ 550 MPa; Rm ≥ 750 MPa; A ≥ 15 %.

**7. HARDNESS**
The hardness shall be max. 32 HRC (or alternatively 301 HB or 330 HV10).

**8. IMPACT TESTING**
Charpy V-notch testing (3 specimens) according to ASTM A 370 at - 46 °C is required for the thicknesses ≥ 6 mm. The minimum absorbed energy shall be 45 J average / 35 J single. Reduction factors for subsize specimens shall be: 7.5 mm - 5/6 and 5 mm - 2/3.

**9. CORROSION TEST**
Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. The specimen shall have the internal and external surfaces in the as-delivered condition (including pickling). Cut edges shall be prepared according to ASTM G 48, and the whole specimen shall be pickled (20 % HNO3 + 5 % HF, 60 °C, 5 minute). The test shall expose the external and internal surfaces and a cross section surface in full wall thickness. The acceptance criteria are:
- No pitting at 20 X magnification.
- The weight loss shall be less than 4.0 g/m².

**10. MICROGRAPHIC EXAMINATION**
The ferrite content shall be determined according to ASTM E 562 or equivalent and shall be within 35 - 55 %. The microstructure, as examined at 400 X magnification on a suitably etched specimen, shall be free from intermetallic phases and precipitates.

**11. EXTENT OF TESTING**
Microstructure, hardness and tensile testing shall be carried out for each lot as defined in the referred standard.

**12. TEST SAMPLING**
Samples for production testing shall realistically reflect the properties in the actual components.

**13. SURFACE FINISH**
White pickled.

**14. MARKING**
The component shall be marked to ensure full traceability to melt and heat treatment lot.

**15. CERTIFICATION**
EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.
1. SCOPE
This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.

2. DESIGN AND DIMENSIONAL STANDARDS
The following EEMUA standards for: “90/10 Copper/Nickel Piping for Offshore Applications” shall be used:
- EEMUA Publication No. 144: “Tubes, Seamless and Welded”.
- EEMUA Publication No. 145: “Flanges, Composite and Solid”.
- EEMUA Publication No. 146: “Fittings”.

3. MATERIALS
Materials for fittings and flanges shall comply with the above listed standards and this MDS.

4. MANUFACTURING PROCESS
Forming:
Cold forming or hot forming may be used according to written procedures established in cooperation with the material manufacturers.

Welding:
An electric fusion welding process shall be used.

5. HEAT TREATMENT/DELIVERY CONDITION
Hot formed components:
Parts hot formed in the temperature range of 760 - 800 °C do not need annealing after forming.

Cold formed components:
Annealed.

Welded components:
Annealed, but acceptable as welded from annealed materials.

6. CHEMICAL COMPOSITION
For subsequent welding the chemical composition shall be modified as stated: Zn ≤ 0.50 %, Pb ≤ 0.02 % and C ≤ 0.05 %.

7. EXTENT OF TESTING
Tensile test specimens shall be taken from each lot. A lot is defined as all products of the same type, nominal size which are produced from the same heat of material and subject to the same finishing operation.

8. TEST SAMPLING
Samples for production testing shall realistically reflect the properties in the actual components.

Test samples shall be cut from the products themselves. Sacrificial components or overlength on the components may be used. Sketches shall be established showing type, size and location of test samples and extraction of test specimens.

9. WELDING
Welding procedures shall be established and qualified in accordance with ASME IX.
<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>STANDARD</th>
<th>GRADE</th>
<th>ACCEPT. CLASS</th>
<th>SUPPL. REQ.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sml pipes &amp; tubes</td>
<td>ASTM B 466</td>
<td>UNS C 70600</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Welded pipes</td>
<td>ASTM B 467</td>
<td>UNS C 70600</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Rod &amp; bar</td>
<td>ASTM B 151</td>
<td>UNS C 70600</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Plates &amp; sheets</td>
<td>ASTM B 171</td>
<td>UNS C 70600</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Fittings</td>
<td>-</td>
<td>UNS C 70600</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Flanges</td>
<td>-</td>
<td>UNS C 76000</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

10. NON DESTRUCTIVE TESTING

Welded Pipes to B 467:
Sch. 10S: Welded pipes shall be spot radiographed to the extent of not less than 12 in. (300 mm) of radiograph per 50 ft (15 m) of weld.
Otherwise: All welds shall be completely radiographed.
The radiographic testing shall be in accordance with the requirements of the ASME Boiler and Pressure Vessel Code, Section VIII, Div. 1, Paragraph UW-51 and UW-52 for 100 % and spot check tested respectively.

11. HYDROSTATIC TESTS

Sml. pipes & tubes to B 466 and Welded pipes to B 467:
Each length of finished pipe shall be subjected to the hydrostatic test in accordance with ASTM A 530.

12. CERTIFICATION

EN 10 204 Type 3.1B.
# MATERIAL DATA SHEET

## TYPE OF MATERIAL:
Aluminium - Bronze Sand Castings

## PRODUCT | STANDARD | GRADE | ACCEPT. CLASS | SUPPL. REQ.
--- | --- | --- | --- | ---
Castings | ASTM B 148 | UNS C95800 | - | -

## 1. SCOPE
This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.

## 2. CHEMICAL COMPOSITION
Pb < 0.02 %.

## 3. HEAT TREATMENT
Heat treatment shall be carried out at the discretion of the manufacturer, e.g. approx. 700 °C for 6 hours.

## 4. EXTENT OF TESTING
One tensile test shall be carried out for each lot, as defined by the in B148, and heat treatment load.

## 5. TEST SAMPLING
Samples for mechanical testing shall realistically reflect the properties in the actual components. Thickness of the test block shall be equal to the thickness of the actual components up to a maximum thickness of 100 mm. For flanged components the largest flange thickness shall apply.
Test specimens shall be cut from the 1/4 T location from the surface where T is the thickness of the test block.
Test block shall be integrally cast or gated onto the castings and shall not be removed from the castings until after the final quality heat treatment.

## 6. WELDING
Welding procedures shall be established and qualified in accordance with ASME IX for all repair welding.

## 7. NON DESTRUCTIVE TESTING
**Liquid penetration testing:**
100 % on all accessible surfaces of all castings. The testing shall be carried out after final machining. The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 7.

**Radiographic testing:**
- Critical areas as per ANSI B 16.34 of the pilot cast of each pattern.
- All butt weld ends of each casting.
- Class 1500 psi and above, all critical areas to ANSI B16.34 of each casting.
The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 7.

## 8. WELD REPAIR
The repair welding procedure shall be qualified in accordance with ASME IX and this MDS.
- A cast plate of the same material grade shall be used.
- A macro test shall be carried out.
- Repairs by peening and impregnation are prohibited.
- Change of filler metal brand names requires requalification.

## 9. CERTIFICATION
EN 10 204 Type 3.1B.
1. SCOPE
This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.

2. QUALIFICATION
Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.

3. HEAT TREATMENT/DELIVERY CONDITION
Annealed.

4. TEST SAMPLING
Samples for production testing shall realistically reflect the properties in the actual component.

5. DIMENSIONAL TOLERANCES

Flanges to B 381: Flanges to MSS SP-44 shall have a maximum wall thickness under tolerance of 0.3 mm at weld end.

6. NON DESTRUCTIVE TESTING

Fittings to B 366: Supplementary requirement S3, liquid penetrant testing, shall apply to the weld area at 10% of seamless (from the same lot as defined for mechanical testing) and 100% of welded fittings above NPS2. For welded fittings the testing shall cover the weld only.

Forgings to B 564: Liquid penetrant testing shall be performed at 10% of forgings above NPS 2 (of same lot as defined for mechanical testing).

7. SURFACE FINISH
White pickled. Shall be carried out after any blasting and shall include finished machined surfaces.

8. REPAIR OF DEFECTS
Weld repair of base material is not acceptable.

9. MARKING
The component shall be marked to ensure full traceability to melt and heat treatment lot.

10. CERTIFICATION
EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.
# MATERIAL DATA SHEET  MDS - N02  Rev. 2

## TYPE OF MATERIAL:  Cast Nickel alloy

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>STANDARD</th>
<th>GRADE</th>
<th>ACCEPT. CLASS</th>
<th>SUPPL. REQ.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Castings</td>
<td>ASTM A 494</td>
<td>Grade CW-6MC (UNS N06625)</td>
<td>Class 1</td>
<td>S2, S3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Grade CX2MW (UNS N26022)</td>
<td>Class 1</td>
<td>S2, S3</td>
</tr>
</tbody>
</table>

1. **SCOPE**

   This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.

2. **QUALIFICATION**

   Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.

3. **STEEL MAKING**

   The steel melt shall be refined with AOD or equivalent process. Remelting of AOD or equivalent steel in an electric furnace is acceptable. Use of internal scrap is not acceptable.

4. **HARDNESS**

   The hardness shall be maximum 35 HRC (or alternatively 301HB or 330HV).

5. **CORROSION TESTING**

   Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. The corrosion test specimen shall be at the same location as those for mechanical testing. Cut edges shall be prepared according to ASTM G 48 and pickled (20 % HNO3 + 5 % HF, 60 °C, 5 minute). The acceptance criteria are:
   - No pitting at 20 X magnification.
   - The weight loss shall be less than 4.0 g/m².

6. **EXTENT OF TESTING**

   Tensile test and corrosion test shall be made for each melt and heat treatment load. A test lot shall not exceed 5 000 kg.

7. **TEST SAMPLING**

   Samples for mechanical testing shall realistically reflect the properties in the actual components. Thickness of the test block shall be equal to the thickness of the actual components up to a maximum thickness of 100 mm. For flanged components the largest flange thickness shall apply.

   Test specimens shall be cut from the 1/4 T location from the surface where T is the thickness of the test block.

   Test block shall be integrally cast or gated onto the castings and shall not be removed from the castings until after the final quality heat treatment.

8. **NON DESTRUCTIVE TESTING**

   Liquid penetrant testing: Supplementary requirement S3 shall apply to all accessible surfaces of all castings. The testing shall be carried out after final machining and pickling. The acceptance criteria shall be ASME VIII, Div.1, Appendix 7.

   Radiographic testing: Supplementary requirement S2 shall apply to:
   - Critical areas as per ANSI B 16.34 of the pilot cast of each pattern.
   - All butt weld ends of each casting.
   - Class 1500 psi and above; all critical areas to ANSI B 16.34 of each casting.

   The acceptance criteria shall be ASME VIII, Div. 1, Appendix 7.

9. **SURFACE FINISH**

   White pickled. Shall be carried out after any blasting and shall include finished machined surfaces.
### MATERIAL DATA SHEET  
**TYPE OF MATERIAL:** Cast Nickel alloy

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>STANDARD</th>
<th>GRADE</th>
<th>ACCEPT. CLASS</th>
<th>SUPPL. REQ.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Castings</td>
<td>ASTM A 494</td>
<td>Grade CW-6MC (UNS N06625)</td>
<td>Class 1</td>
<td>S2, S3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Grade CX2MW (UNS N26022)</td>
<td>Class 1</td>
<td>S2, S3</td>
</tr>
</tbody>
</table>

#### 10. REPAIR OF DEFECTS
Repair welding shall be carried out in accordance with ASTM A 488. The repair welding procedure shall be qualified in accordance with ASME IX or EN 288-3 and this MDS.
- A cast plate of the same material grade (UNS number) which shall be used.
- A macro and corrosion test as specified above shall be carried out.
- Change of specific make of filler metal (brand name) requires requalification.
All casting with major repairs shall be given a solution heat treatment after welding.

#### 11. MARKING
The component shall be marked to ensure full traceability to melt and heat treatment lot.

#### 12. CERTIFICATION
EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.
NORSOK Standard

MATERIAL DATA SHEET

TYPE OF MATERIAL: Glassfibre Reinforced Plastics (GRP)

PRODUCT

<table>
<thead>
<tr>
<th>STANDARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipes, Fittings, Flanges, Adhesive and pre-fabricated spools</td>
</tr>
</tbody>
</table>

1. SCOPE

This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.

2. MANUFACTURING PROCESS

Pipes and fittings shall be made by filament winding or equivalent methods.

3. RESIN/HARDENER TYPE

Preferred resins are bisphenol A epoxies with aromatic or cycloaliphatic curing agents or vinylester.

4. INNER LINER

The internal lining when transporting non-aggressive fluids such as water, shall be a resin rich layer of min. 0,5 mm with C-glass or synthetic veil reinforcement.

For transporting concentrated sulphuric acid and hypochlorite, an internal liner of PVC of min. 3 mm should be used. Application of PVC liner shall be according to the German standard KRV A984/82-02. C-glass or ECR-glass reinforcement should be used in the structural part of the pipe wall. (KRV: Kunststoff Rohrverband).

For other aggressive fluids such as acids, the internal lining shall be a resin rich layer of min. 3,0 mm with C-glass or syntetic veil reinforcement. C-glass or ECR-glass reinforcement should be used in the structural part of the pipe wall.

5. QUALIFICATION TESTING

Qualification testing shall be performed according to UKOOA document, Part 2, chapter 2 with the following additional requirements:

Pressuring rating, (Section 2.1.2 or 2.1.3): Minimum requirements are that one representative diameter of pipe, fittings and joints shall be qualified according to option 1. For qualification option 3 the factor $f_1 = 0.85$ shall be moved to the numerator.

The qualification of flanges shall in addition to the UKOOA document comply with ASTM D 4024, clauses 6, 7, 8 and 11 with the additional requirements below.

The pressure rating of the flanges multiplied by 4 shall be above the 97.5 % confidence limit obtained from the Short-Term Rupture Strength test.

The test assembly for the maximum bolt torque test shall be fitted together using gasket and steel flange intended to be used during fabrication and installation.

No visual damage is allowed for the sealing test and the bolt torque test according to table 4.3.5 in UKOOA document.

Service Conditions Exceeding "Standard Conditions",(A new section 2.1.1.5 after section 2.1.1.4, Standard Service Conditions): For design life exceeding 20 years, the following shall apply:
<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>STANDARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipes, Fittings, Flanges, Adhesive and pre-fabricated spools</td>
<td>UKOOA: Specification and Recommended Practice for the Use of GRP Piping Offshore.</td>
</tr>
<tr>
<td></td>
<td>(UKOOA: United Kingdom Offshore Operators Association)</td>
</tr>
</tbody>
</table>

5. QUALIFICATION TESTING (Cont.)

- a) Assessment of previous well documented in-service experience.
- b) Qualification results from tests done according to Qualification Option 1 in section 2.1.2. or 2.1.3. Alternatively use a pipe with a pressure rating of minimum one class higher than for 20 years design.
- c) Design calculations shall be re-evaluated and extrapolation performed to verify the increased service life.

**Adhesive/resin for bonded/laminated joints** (A new section 2.1.9):

The adhesive used for bonded joints or resin used for laminated joints shall be qualified according to section 2.1.2 or 2.1.3. The adhesive/resin shall have suitable properties for field assembly and fulfilling the following requirements:

- The adhesive/resin shall have a suitable viscosity for application at room temperature. The viscosity shall not be above 0.4 kPas at 23°C with a shear rate of 10 rotations per second (absolute viscosity data).
- The fracture elongation of the cured adhesive/resin in joints shall not be less than that of the resin used in the piping.
- The glass transition temperature ($T_g$) or the residual heat of reaction of the cured adhesive/resin shall be determined by DSC according to Annex C, by measurement of samples taken from joints of components used in qualification testing.
- Alternatively, for polyester and vinylester based products, the residual styrene monomer content for joints in components used in qualification testing may be determined. The measurement shall be performed according to ISO 4901.

**Component Data for Fabrication, Prefabrication and Installation Quality Control Baselines** (A new section 2.1.10):

The manufacturer shall generate from the qualification programme baseline values including acceptance criteria for the fabrication and installation quality control programme.

This includes measurement of degree of cure and glass content:

- The degree of cure shall be determined by DSC in accordance with Annex C or by residual styrene content measurement in accordance with ISO 4901 for the adhesive used in bonded joints and the resin used in laminated joints. Reference to above new section 2.1.9.
- The percentage of fibreglass reinforcement in laminated joint shall be determined in accordance with ASTM D 2584. Three samples shall be taken from three locations situated 120° apart in the same joint cross section.
## 5. QUALIFICATION TESTING (Cont.)

### Chemical Resistance

For transported media other than the water used in the testing according to section 2.1, the chemical resistance of the material shall be determined. The tests shall be based on:

ASTM D 3681. The test duration and conditions shall be relevant for the service conditions, life time requirements and the criticality of the system and the safety risks of the conveyed fluid. Alternatively, well documented in-service experience under similar conditions can be used. Examples of typical fluids that can require specific documentation of compatibility if transported in GRP pipes are:

- hydraulic fluids,
- scale inhibitors,
- corrosion inhibitors (also diluted),
- injection chemicals (i.e. acid stimulation, etc.),
- completion fluids,
- packer fluids and methanol

Component Properties for System Design (section 2.4)

All listed properties shall be determined by the Manufacturer (Delete “Where applicable in UKOOA document)

Test Method for Determination of Degree of Cure by Differential Scanning Calorimetry (DSC) (Annex C)

C.5.3 (Delete sentence and replace with:)

Obtain the $T_{G1}$ (midpoint of the inflection in the DSC curve) and/or the residual heat of reaction from the first scan and second scan. (Sample not powdered).

C.6.5 (Delete sentence and replace with:)

Record of glass transition temperature (inflection value) as $T_{G1}$ and/or residual heat of reaction for both the first and second scan.

## 6. ELECTRIC CONDUCTIVITY

If conductive components are specified, the conductivity in the structural layers shall not be accomplished by adding carbon black to the resin.

## 7. PRODUCTION TESTING

Production testing shall be performed according to UKOOA document, Part 2, Chapter 4 with the following additional requirements.

Hydrostatic Mill Test (Section 4.3.1): 10% of produced pipes and 100% of all prefabricated spools shall be pressure tested to 1.5 times their nominal static pressure rating and pressure shall be maintained for a minimum of 15 minutes in order to ascertain there is no leakage.

Degree of Cure (Section 4.3.2, Add following sentences after last paragraph):

If the residual heat of reaction exceeds 10% of the measured value on the qualified component variant in the qualification tests, then the production lot shall be rejected, subject to the retest option of Section 4.3.8.

Alternatively, vinylester or polyester based products may be tested in accordance with ISO 4901. The residual styrene content shall be maximum 10% above the level measured during component qualification but not above 2% total content.
<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>STANDARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipes, Fittings, Flanges, Adhesive and pre-fabricated spools</td>
<td>UKOOA: Specification and Recommended Practice for the Use of GRP Piping Offshore. (UKOOA: United Kingdom Offshore Operators Association)</td>
</tr>
</tbody>
</table>

8. **FLANGES**  
Allowable bolt torque and flange mis-alignment shall be defined by manufacturer.

9. **NDT/VISUAL TESTING**  
According to UKOOA, Part 4 or BS 7159.

10. **CERTIFICATION**  
EN 10 204 Type 3.1B containing:  
- Hydrostatic mill test -  
- Degree of cure -  
- Short time failure pressure -  
- Glass content -  
- Visual inspection -  
- Wall thickness -  
- Resistivity (If conductive pipe is specified) - 
## Material Data Sheet MDS - P11 Rev. 1

### Type of Material: Hydrogenated Nitrile (HNBR)

<table>
<thead>
<tr>
<th>Product</th>
<th>Temperature</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>O-ring</td>
<td>-46°C to +150°C. Only short time exposure below -20°C acceptable.</td>
<td></td>
</tr>
</tbody>
</table>

### 1. Scope
- This MDS specifies the technical requirements for the HNBR O-ring material.

### 2. Purchase Information
- The purchase order shall contain the following information: Product form, dimensions, tolerances and/or referenced drawing(s) and grade designation.

### 3. Chemical Composition
- 36 – 40% acrylonitrile content (ACN)

### 4. Qualification Test Requirements
- The material shall be rapid pressure reduction resistant (ED resistant) and satisfy the following minimum requirements. The qualification shall be repeated if there are changes in the production route, manufacturing procedures, specified composition or properties of the product which exceeds the limits defined from qualification testing (each manufacturer and seal type shall be qualified):

  **ED-test**

  Qualification test requirements: O-ring cross section diameter 5.33 mm, 20% compression, test fixture, 70 – 85% groove fill, test medium 10% CO₂ in Methane, test temperature 100°C. 72 hours initial soak at full pressure, followed by 10 cycles of:
  - 200 bar (24h),
  - Depressurisation: 70 bar/min.
  - 1 hour rest time
  - Re-pressurisation
  - Leakage test

  No leakage shall occur in a leakage test at room temperature and service pressure following the 10 decompression cycles. Further, no cracks shall be longer than 50% of the sample thickness, based on dissection, after the leakage test.

  **Mechanical properties**

<table>
<thead>
<tr>
<th>Property</th>
<th>Standard</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardness (Shore A)</td>
<td>ASTM D 2240</td>
<td>90 +/- 5</td>
</tr>
<tr>
<td>Tensile strength (min.)</td>
<td>ASTM D 412/ 1414</td>
<td>20 MPa</td>
</tr>
<tr>
<td>Elongation at break (min.)</td>
<td>ASTM D 412/ 1414</td>
<td>100%</td>
</tr>
<tr>
<td>Compression set (%)</td>
<td>ASTM D 395</td>
<td>25%</td>
</tr>
</tbody>
</table>

  **Physical properties**

<table>
<thead>
<tr>
<th>Property</th>
<th>Standard</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific gravity</td>
<td>ASTM D 792</td>
<td>1.24 – 1.27 g/cm³</td>
</tr>
</tbody>
</table>

### 5. Dimensions
- BS 4518

### 6. Production Test Requirements
- The below properties shall be documented by testing for each production batch and satisfy the requirements listed above.

  **Specific gravity** (ASTM D 792)
  **Hardness** (ASTM D 2240)
  **Tensile and elongation properties** (ASTM D 412/ 1414)

### 7. Marking & Packaging
- Seals shall be supplied in sealed airtight bags. Markings on the bags shall clearly indicate batch number, and such markings shall ensure traceability through the producers QC system to raw materials, formulation and manufacturing details. In addition, the bags shall be marked with an expected shelf life assuming storage at room temperature and without direct exposure to sunlight.

### 8. Certification
- Inspection certificate to EN 10204 3.1 B shall contain ID no. and all test results.
**MATERIL DATA SHEET** MDS – P12 Rev. 1

<table>
<thead>
<tr>
<th>TYPE OF MATERIAL: Fluorocarbon terpolymer (FKM)</th>
</tr>
</thead>
</table>

| PRODUCT | TEMPERATURE | -46°C to +210°C. Only short time exposure below -20°C acceptable. |

1. SCOPE
This MDS specifies the technical requirements for the FKM O-ring material.

2. PURCHASE INFORMATION
The purchase order shall contain the following information: Product form, dimensions, tolerances and/or referenced drawing(s) and grade designation.

3. CHEMICAL COMPOSITION
Vinylidene fluoride (VF2), hexafluoropropylene (HFP), and tetrafluoroethylene (TFE) with necessary fillers, stabilisers, cross-link agents.

4. QUALIFICATION TEST REQUIREMENTS
The material shall be rapid pressure reduction resistant (ED resistant) and satisfy the following minimum requirements. The qualification shall be repeated if there are changes in the production route, manufacturing procedures, specified composition or properties of the product which exceeds the limits defined from qualification testing (each manufacturer and seal type shall be qualified):

**ED - test**
Qualification test requirements: O-ring cross section diameter 5.33 mm, 20% compression, test fixture, 70 – 85% groove fill, test medium 10% CO2 in Methane, test temperature 100°C. 72 hours initial soak at full pressure, followed by 10 Cycles of:
- 200 bar (24h),
- Depressurisation: 70 bar/min.
- 1 hour rest time
- Re-pressurisation
- Leakage test

No leakage shall occur in a leakage test at room temperature and service pressure following the 10 decompression cycles. Further, no cracks shall be longer than 50% of the sample thickness, based on dissection, after the leakage test.

**Mechanical properties**
- Hardness (Shore A) ASTM D 2240 90 +/- 5
- Tensile strength (min.) ASTM D 412/1414 11 MPa.
- Elongation at break (min.) ASTM D 412/1414 90%
- Compression set ASTM D 395 40%

(º max. 24 hr. 200ºC)

**Physical properties**
- Specific gravity ASTM D 792 1.65 - 1.72 g/cm³

5. DIMENSIONS
BS 4518

6. PRODUCTION TEST REQUIREMENTS
The below properties shall be documented by testing for each production batch and satisfy the requirements listed above.

<table>
<thead>
<tr>
<th>Specific gravity</th>
<th>ASTM D 792</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardness</td>
<td>ASTM D 2240</td>
</tr>
<tr>
<td>Tensile and elongation properties</td>
<td>ASTM D 412/1414</td>
</tr>
</tbody>
</table>

7. MARKING & PACKAGING
Seals shall be supplied in sealed airtight bags. Markings on the bags shall clearly indicate batch number, and such markings shall ensure traceability through the producers QC system to raw materials, formulation and manufacturing details. In addition, the bags shall be marked with an expected shelf life assuming storage at room temperature and without direct exposure to sunlight.

8. CERTIFICATION
Inspection certificate to EN 10204 3.1 B shall contain ID no. and all test results.
**TYPE OF MATERIAL:** Fluorocarbon low T terpolymer (FKM GLT)

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>TEMPERATURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>O-ring</td>
<td>-46°C to +200°C. Only short time exposure below -20°C acceptable.</td>
</tr>
</tbody>
</table>

1. **SCOPE**

This MDS specifies the technical requirements for the FKM-GLT O-ring material.

2. **PURCHASE INFORMATION**

The purchase order shall contain the following information: Product form, dimensions, tolerances and/or referenced drawing(s) and grade designation.

3. **CHEMICAL COMPOSITION**

36 – 40% acrylonitrile content (ACN)

4. **QUALIFICATION TEST REQUIREMENTS**

The material shall be rapid pressure reduction resistant (ED resistant) and satisfy the following minimum requirements. The qualification shall be repeated if there are changes in the production route, manufacturing procedures, specified composition or properties of the product which exceeds the limits defined from qualification testing (each manufacturer and seal type shall be qualified):

**ED-test**

Qualification test requirements: O-ring cross section diameter 5.33 mm, 20% compression, text fixture, 70 – 85% groove fill, test medium 10% CO2 in Methane, test temperature 100°C. 72 hours initial soak at full pressure, followed by 10 Cycles of:

- 200 bar (24h),
- Depressurisation: 70 bar/min.
- 1 hour rest time
- Re-pressurisation
- Leakage test

No leakage shall occur in a leakage test at room temperature and service pressure following the 10 decompression cycles. Further, no cracks shall be longer than 50% of the sample thickness, based on dissection, after the leakage test.

**Mechanical properties**

- Hardness (Shore A) ASTM D 2240 11 +/- 5
- Tensile strength (min.) ASTM D 412/1414 90% MPa
- Elongation at break (min.) ASTM D 412/1414 90%
- Compression set ASTM D 395 40% (% max. 24 hr. 200°C)

**Physical properties**

- Specific gravity ASTM D 792 1.65 - 1.72 g/cm^3

5. **DIMENSIONS**

BS 4518

6. **PRODUCTION TEST REQUIREMENTS**

The below properties shall be documented by testing for each production batch and satisfy the requirements listed above.

- Specific gravity (ASTM D 792)
- Hardness (ASTM D 2240)
- Tensile and elongation properties (ASTM D 412/1414)

7. **MARKING & PACKAGING**

Seals shall be supplied in sealed airtight bags. Markings on the bags shall clearly indicate batch number, and such markings shall ensure traceability through the producers QC system to raw materials, formulation and manufacturing details. In addition, the bags shall be marked with an expected shelf life assuming storage at room temperature and without direct exposure to sunlight.

8. **CERTIFICATION**

Inspection certificate to EN 10204 3.1 B shall contain ID no. and all test results.
## MATERIAL DATA SHEET  MDS – P14  Rev. 1

**TYPE OF MATERIAL:** Nitrile (NBR)

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>TEMPERATURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>O-ring</td>
<td>-46°C to +100°C. Only short time exposure below -20°C acceptable.</td>
</tr>
</tbody>
</table>

### 1. SCOPE
This MDS specifies the technical requirements for the NBR O-ring material.

### 2. PURCHASE INFORMATION
The purchase order shall contain the following information: Product form, dimensions, tolerances and / or referenced drawing(s) and grade designation.

### 3. CHEMICAL COMPOSITION
36 – 40% acrylonitrile content (ACN)

### 4. QUALIFICATION TEST REQUIREMENTS
The material shall not be used for gas service or gas containing fluids and hence, there are no need for be rapid pressure reduction testing (ED testing). The materials shall satisfy the following minimum requirements. The qualification shall be repeated if there are changes in the production route, manufacturing procedures, specified composition or properties of the product which exceeds the limits defined from qualification testing (each manufacturer and seal type shall be qualified):

**Oil resistance test**
Qualification test requirements: O-ring cross section diameter 5.33 mm, 20% compression, text fixture, 70 – 85% groove fill, test medium 10% toluene/90% Iso-octane/ ASTM oil no. 3, test temperature 70°C, 72 hours soak time. The test vessel shall be pressurised with nitrogen to 50 bar.

No leakage shall occur in a leakage test at room temperature and service pressure following the exposure time. Further, the volume change shall be within + 20%/-5%.

**Mechanical properties**
- Hardness (Shore A) ASTM D 2240 70 +/- 5
- Tensile strength (min.) ASTM D 412/1414 15 MPa
- Elongation at break (min.) ASTM D 412/1414 350%
- Compression set ASTM D 395 25%

(% max. 24 hr. 100°C)

**Physical properties**
- Specific gravity ASTM D 792 1.24 - 1.27 g/cm³

### 5. DIMENSIONS
BS 4518

### 6. PRODUCTION TEST REQUIREMENTS
The below properties shall be documented by testing for each production batch and satisfy the requirements listed above.

- Specific gravity (ASTM D 792)
- Hardness (ASTM D 2240)
- Tensile and elongation properties (ASTM D 412/1414)

### 7. MARKING & PACKAGING
Seals shall be supplied in sealed airtight bags. Markings on the bags shall clearly indicate batch number, and such markings shall ensure traceability through the producers QC system to raw materials, formulation and manufacturing details. In addition, the bags shall be marked with an expected shelf life assuming storage at room temperature and without direct exposure to sunlight.

### 8. CERTIFICATION
Inspection certificate to EN 10204 3.1 B shall contain ID no. and all test results.
# MATERIAL DATA SHEET MDS – P21 Rev. 1

**TYPE OF MATERIAL:** PEEK (Poly-ether-ether-ketone)

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>TEMPERATURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Back-up rings and seat inserts</td>
<td>-100°C to +250°C</td>
</tr>
</tbody>
</table>

## 1. SCOPE
This MDS specifies the technical requirements for the PEEK material.

## 2. PURCHASE INFORMATION
The purchase order shall contain the following information:
- Product form, dimensions, tolerances and / or referenced drawing(s) and grade designation.

## 3. CHEMICAL COMPOSITION
Poly-ether-ether-ketone polymer with necessary stabilisers and processing aids.

## 4. QUALIFICATION TEST REQUIREMENTS
The material shall satisfy the following minimum requirements. The qualification shall be repeated if there are changes in the production route, manufacturing procedures, specified composition or properties of the product which exceed the limits defined from qualification testing:

### Mechanical properties
- Tensile strength: ASTM D 638
- Tensile Modulus: ASTM D 638
- Compressive strength: ASTM D 695
- HDT @ 1.81 MPa: ASTM D 648
- Impact strength (notched): ASTM D 256
- Ultimate elongation (%): ASTM D 638

### Physical properties
- Density (g/cm³)
  - Virgin: 1.3 - 1.33
  - Glass filled: 1.46 - 1.55
- Melting point (°C)
  - Virgin: 340°C
  - Glass filled: 340°C
- Water absorption (24 hrs.): Virgin: 0.15 %, Glass filled: 0.15%

## 5. DIMENSIONS
BS 4518

## 6. PRODUCTION TEST REQUIREMENTS
The below properties shall be documented by testing for each production batch and satisfy the requirements listed above.

- Density: ASTM D 792
- Tensile strength: ASTM D 638
- Ultimate elongation (%): ASTM D 638

## 7. MARKING & PACKAGING
Components shall be supplied in suitable packaging as to protect the items from physical damage prior to installation. Markings on the packaging shall clearly indicate material batch number, and such markings shall ensure traceability through the producers QC system to raw materials, formulation and manufacturing details.

## 8. CERTIFICATION
Inspection certificate to EN 10204 3.1 B shall contain ID no. and all test results.
MATERIAL DATA SHEET  MDS - P22  Rev. 1

**TYPE OF MATERIAL:** PTFE (Poly-tetra-fluoro-ethylene)

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>TEMPERATURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lip-seals, back-up rings and seat inserts</td>
<td>-190°C to +200°C</td>
</tr>
</tbody>
</table>

**1. SCOPE**

This MDS specifies the technical requirements for the PTFE material.

**2. PURCHASE INFORMATION**

The purchase order shall contain the following information:
Product form, dimensions, tolerances and / or referenced drawing(s) and grade designation.

**3. CHEMICAL COMPOSITION**

Carbon and fluorine, polymeric di-fluoromethane with necessary fillers, stabilisers and process aids. Also with graphite, glass or carbon fibre fillers. The lip-seal must be energised internally by a metallic spring (UNS R30003) or similar.

**4. QUALIFICATION TEST REQUIREMENTS**

The material shall satisfy the following minimum requirements. The qualification shall be repeated if there are changes in the production route, manufacturing procedures, specified composition or properties of the product which exceeds the limits defined from qualification testing:

<table>
<thead>
<tr>
<th>Mechanical properties</th>
<th>Virgin</th>
<th>25%Glass</th>
<th>25%Graph</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile strength (MPa)</td>
<td>ASTM D 638</td>
<td>&gt;25</td>
<td>&gt;15</td>
</tr>
<tr>
<td>Hardness (Shore D)</td>
<td>ASTM D 785</td>
<td>50 - 60</td>
<td>50 - 60</td>
</tr>
<tr>
<td>Compressive strength (1%) (MPa)</td>
<td>ASTM D 695</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Compressive modulus</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HDT @ 1.81 MPa</td>
<td>ASTM D 695</td>
<td>&gt;400</td>
<td>&gt;600</td>
</tr>
<tr>
<td>Impact strength (notched) (J/m)</td>
<td>ASTM D 648</td>
<td>54°C</td>
<td>110°C</td>
</tr>
<tr>
<td>Ultimate elongation (%)</td>
<td>ASTM D 256</td>
<td>&gt;145</td>
<td>&gt;130</td>
</tr>
<tr>
<td>Physical properties</td>
<td>ASTM D 638</td>
<td>&gt;180</td>
<td>&gt;180</td>
</tr>
</tbody>
</table>

| Density (g/cm³) | ASTM D 792 | 2.2 | 2.24 | 1.9- 2.1 |
| Melting point (°C) | ASTM 3418 | 325 | 325 | 325 |
| Water absorption (24 hrs.) | ASTM D 570 | 0.01 % | 0.02% | 0.01% |

**5. PRODUCTION TEST REQUIREMENTS**

The below properties shall be documented by testing for each production batch and satisfy the requirements listed above.

| Hardness (Shore D) | ASTM D 785 |
| Density | ASTM D 792 |
| Tensile strength | ASTM D 638 |
| Ultimate elongation (%) | ASTM D 638 |

**6. MARKING & PACKAGING**

Components shall be supplied in suitable packaging as to protect the items from physical damage prior to installation. Markings on the packaging shall clearly indicate material batch number, and such markings shall ensure traceability through the producers QC system to raw materials, formulation and manufacturing details.

**7. CERTIFICATION**

Inspection certificate to EN 10204 3.1 B shall contain ID no. and all test results.
**MATERIAL DATA SHEET MDS - P23 Rev. 1**

**TYPE OF MATERIAL:** PEEK (Poly-ether-ether-ketone) with PTFE added

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>TEMPERATURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seat inserts</td>
<td>-100°C to +200°C</td>
</tr>
</tbody>
</table>

**1. SCOPE**

This MDS specifies the technical requirements for the PEEK/PTFE material.

**2. PURCHASE INFORMATION**

The purchase order shall contain the following information:
Product form, dimensions, tolerances and/or referenced drawing(s) and grade designation.

**3. CHEMICAL COMPOSITION**

Poly-ether-ether-ketone polymer with necessary stabilisers and processing aids and 10 to 20% PTFE (Poly-tetra-fluoro-ethylene) added.

**4. QUALIFICATION TEST REQUIREMENTS**

The material shall satisfy the following minimum requirements. The qualification shall be repeated if there are changes in the production route, manufacturing procedures, specified composition or properties of the product which exceeds the limits defined from qualification testing:

<table>
<thead>
<tr>
<th>Mechanical properties</th>
<th>Virgin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile strength</td>
<td>ASTM D 638</td>
</tr>
<tr>
<td>Hardness (Shore D)</td>
<td>ASTM D 785</td>
</tr>
<tr>
<td>Tensile modulus</td>
<td>ASTM D 638</td>
</tr>
<tr>
<td>Compressive strength</td>
<td>ASTM D 695</td>
</tr>
<tr>
<td>HDT @ 1.81 MPa</td>
<td>ASTM D 648</td>
</tr>
<tr>
<td>Impact strength (notched)</td>
<td>ASTM D 256</td>
</tr>
<tr>
<td>Ultimate elongation (%)</td>
<td>ASTM D 638</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Physical properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density (g/cm³)</td>
</tr>
<tr>
<td>Melting point</td>
</tr>
<tr>
<td>Water absorption (24 hrs.)</td>
</tr>
</tbody>
</table>

**5. DIMENSIONS**

BS 4518

**6. PRODUCTION TEST REQUIREMENTS**

The below properties shall be documented by testing for each production batch and satisfy the requirements listed above.

<table>
<thead>
<tr>
<th>Hardness</th>
<th>ASTM D 785</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>ASTM D 792</td>
</tr>
<tr>
<td>Tensile strength</td>
<td>ASTM D 638</td>
</tr>
<tr>
<td>Ultimate elongation (%)</td>
<td>ASTM D 638</td>
</tr>
</tbody>
</table>

**7. MARKING & PACKAGING**

Components shall be supplied in suitable packaging as to protect the items from physical damage prior to installation. Markings on the packaging shall clearly indicate material batch number, and such markings shall ensure traceability through the producers QC system to raw materials, formulation and manufacturing details.

**8. CERTIFICATION**

Inspection certificate to EN 10204 3.1 B shall contain ID no. and all test results.
# MATERIAL DATA SHEET

## MDS - R11

### Rev. 2

**TYPE OF MATERIAL:** Austenitic stainless steel, Type 6Mo

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>STANDARD</th>
<th>GRADE</th>
<th>ACCEPT. CLASS</th>
<th>SUPPL. REQ.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seamless pipes</td>
<td>ASTM A 312</td>
<td>UNS S31254</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>UNS N08367</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>UNS N08925</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>UNS N08926</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. **SCOPE**

This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard. Material grades not included in A 312 shall comply to the test and tolerance requirements given to Grade UNS S31254.

2. **QUALIFICATION**

Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.

3. **STEEL MAKING**

The steel melt shall be refined by AOD or equivalent.

4. **HEAT TREATMENT**

The pipes shall be solution annealed followed by water quenching.

5. **CORROSION TESTING**

Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. Test specimens shall have the internal and external surfaces in the as-delivered condition (including pickling). Cut edges shall be prepared according to ASTM G48, and the whole specimen shall be pickled (20 % HNO3 + 5 % HF, 60 °C, 5 minute). The test shall expose the external and internal surfaces and a cross section surface in full wall thickness. The acceptance criteria are:
- No pitting at 20 X magnification.
- The weight loss shall be less than 4.0 g/m.

6. **EXTENT OF TESTING**

Corrosion test shall be carried out to the same extent as stated for mechanical tests in the referred standard.

7. **TEST SAMPLING**

Samples for production testing shall realistically reflect the properties in the actual components.

8. **SURFACE FINISH**

White pickled.

9. **REPAIR OF DEFECTS**

Weld repair is not acceptable.

10. **MARKING**

The component shall be marked to ensure full traceability to melt and heat treatment lot.

11. **CERTIFICATION**

EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.
# NORSOK Standard

## MATERIAL DATA SHEET

**TYPE OF MATERIAL:** Austenitic Stainless Steel, Type 6Mo

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>STANDARD</th>
<th>GRADE</th>
<th>ACCEPT. CLASS</th>
<th>SUPPL. REQ.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Welded Pipes</td>
<td>ASTM A 358</td>
<td>UNS S31254, UNS N08367, UNS N08925, UNS N08926</td>
<td>Class 1, 3 and 5.</td>
<td>S3</td>
</tr>
</tbody>
</table>

1. **SCOPE**

   This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard. Material grades not included in A 240 shall comply with the test and tolerance requirements given to Grade UNS S31254.

2. **QUALIFICATION**

   Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.

3. **STEEL MAKING**

   Steel melt shall be refined with AOD or equivalent refining.

4. **HEAT TREATMENT**

   The pipes shall be solution annealed followed by water quenching. Post weld solution annealing is not required of pipes with nominal wall thickness up to 7.11 mm manufactured out of solution annealed plate material as stated in chapter 5.3.2.2 of A 358.

5. **CHEMICAL COMPOSITION**

   UNS N08925 and N08926: N = 0.18 - 0.22 %.

6. **CORROSION TESTING**

   Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. Test specimens shall have the internal and external surfaces in the as-delivered condition (including pickling). Cut edges shall be prepared according to ASTM G 48, and the whole specimen shall be pickled (20 % HNO3 + 5 % HF, 60 °C, 5 minute). The test shall expose the external and internal surfaces and a cross section surface including weld zone in full wall thickness. The acceptance criteria are:
   - No pitting at 20 X magnification.
   - The weight loss shall be less than 4.0 g/m².

7. **EXTENT OF TESTING**

   Tensile and corrosion testing shall be carried out for each lot defined as follows:
   - For batch furnace a lot is defined as maximum 60 m pipe of the same heat, size and heat treatment charge.
   - For continuous heat treatment furnace a lot is defined as maximum 60 m of pipe of the same heat and size and which are heat treated the same day.

8. **TEST SAMPLING**

   Samples for production testing shall realistically reflect the properties in the actual components.

9. **WELDING**

   The PQR/WPAR shall be qualified in accordance with ASME IX or EN 288-3 and this MDS:
   - The weld consumable shall be Ni-base and the alloying content shall be: Mo ≥ 8.0 %; Cr ≥ 15.0 %; (Mo + Cr) ≥ 28 %; C ≤ 0.030 %; S ≤ 0.015 % and Nb < 0.5 %.
   - The PQR/WPAR shall be corrosion tested as specified above.

   The qualification shall be carried out on the same material grade (UNS number) as used in production. Change of specific make (brand name) of welding consumables requires requalification.
### MATERIAL DATA SHEET  
**MDS - R12**  
**Rev. 2**

**TYPE OF MATERIAL:** Austenitic Stainless Steel, Type 6Mo  

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>STANDARD</th>
<th>GRADE</th>
<th>ACCEPT. CLASS</th>
<th>SUPPL. REQ.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Welded Pipes</td>
<td>ASTM A 358</td>
<td>UNS S31254 UNS N08367</td>
<td>Class 1, 3 and 5.</td>
<td>S3</td>
</tr>
</tbody>
</table>

### 10. NON DESTRUCTIVE TESTING
Eddy current testing according to ASTM A 450 is acceptable as replacement for radiography for wall thicknesses less than 4.0 mm.
Supplementary requirement S3, penetrant testing, shall apply according to ASME V Article 6, to the weld area of 10 % of the pipes (same test lot as defined for mechanical testing) delivered. The testing shall be carried out after calibration and pickling. Acceptance criteria shall be to ASME VIII Div. 1 Appendix 8.

### 11. SURFACE FINISH
White pickled.

### 12. REPAIR OF DEFECTS
Weld repair of base material is not acceptable. For repair of welds same requirements to PQR/WPAR as for production welding.

### 13. MARKING
The component shall be marked to ensure full traceability to melt and heat treatment lot.

### 14. CERTIFICATION
EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.
**MATERIAL DATA SHEET**  
**MDS - R13**  
**Rev. 2**

**TYPE OF MATERIAL:** Austenitic Stainless Steel, Type 6Mo

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>STANDARD</th>
<th>GRADE</th>
<th>ACCEPT. CLASS</th>
<th>SUPPL. REQ.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wrought fittings</td>
<td>ASTM A 403</td>
<td>WP S31254</td>
<td>WP-S, WP-WX and WP-W</td>
<td>S2, S7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>UNS N08367</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>UNS N08925</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>UNS N08926</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. **SCOPE**
   
   This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard. Material grades not included in A 403 shall comply with the test and tolerance requirements given to Grade UNS S31254.

2. **QUALIFICATION**
   
   Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.

3. **STEEL MAKING**
   
   Steel melt shall be refined with AOD or equivalent.

4. **HEAT TREATMENT**
   
   The fittings shall be solution annealed followed by water quenching.

5. **CORROSION TESTING**
   
   Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. The specimen shall have the internal and external surfaces in the as-delivered condition (including pickling). Cut edges shall be prepared according to ASTM G 48, and the whole specimen shall be pickled (20 % HNO3 + 5 % HF, 60 °C, 5 minute). The test shall expose the external and internal surfaces and a cross section including weld zone (if relevant) in full wall thickness. The acceptance criteria are:
   - No pitting at 20 X magnification.
   - The weight loss shall be less than 4.0 g/m².

6. **EXTENT OF TESTING**
   
   Tensile and corrosion testing shall be performed for each heat, heat treatment load with a wall thickness range of 5 mm and welded with the same WPS.

7. **TEST SAMPLING**
   
   Samples for production testing shall realistically reflect the properties in the actual components.

8. **WELDING**
   
   The welding procedure shall be qualified in accordance with ASME IX or EN 288-3 and this MDS:
   - The weld consumable alloying content shall be: Mo ≥ 8.0 %; Cr ≥ 15.0 %; (Mo + Cr) ≥ 28 %; C ≤ 0.030 %; S ≤ 0.015 %; Nb < 0.5 %.
   - The PQR/WPAR shall be corrosion tested as specified above.
   
   The qualification shall be carried out on the same material grade (UNS number) as used in production. Change of specific make (brand name) of welding consumables requires requalification.

9. **DIMENSIONAL TOLERANCES**
   
   Fittings with reference to MSS-SP-75 shall have maximum wall thickness under tolerance of 0.3 mm.

10. **NON DESTRUCTIVE TESTING**
    
    Supplementary requirement S7, liquid penetrant testing, shall apply to 10 % of seamless fittings (from the test lot as defined above) and 100 % of welded fittings above NPS 2. For welded fittings the testing shall cover the weld only. The resting shall be carried out after calibration and pickling. The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 8.
# MATERIAL DATA SHEET

**MDS - R13**

**Rev. 2**

<table>
<thead>
<tr>
<th>TYPE OF MATERIAL:</th>
<th>Austenitic Stainless Steel, Type 6Mo</th>
</tr>
</thead>
</table>

## PRODUCT | STANDARD | GRADE | ACCEPT. CLASS | SUPPL. REQ. |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Wrought fittings</td>
<td>ASTM A 403</td>
<td>WP S31254, UNS N08367, UNS N08925, UNS N08926</td>
<td>WP-S, WP-WX and WP-W</td>
<td>S2, S7</td>
</tr>
</tbody>
</table>

### 11. SURFACE FINISH
White pickled.

### 12. REPAIR OF DEFECTS
Weld repair of base material is not acceptable. For repair of welds the same requirement to PQR/WPAR shall apply as for production testing.

### 13. MARKING
The component shall be marked to ensure full traceability to melt and heat treatment lot.

### 14. CERTIFICATION
EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.
<table>
<thead>
<tr>
<th>TYPE OF MATERIAL:</th>
<th>Austenitic Stainless Steel, Type 6Mo</th>
<th>Page 1 of 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRODUCT</td>
<td>FORGINGS</td>
<td></td>
</tr>
<tr>
<td>STANDARD</td>
<td>ASTM A 182</td>
<td></td>
</tr>
<tr>
<td>GRADE</td>
<td>F44</td>
<td></td>
</tr>
<tr>
<td>ACCEPT. CLASS</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>SUPPL. REQ.</td>
<td>S5</td>
<td></td>
</tr>
<tr>
<td>UNS N08367</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UNS N08925</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UNS N08926</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. **SCOPE**
   This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard. Material grades not included in A 182 shall comply with the test and tolerance requirements given to Grade F44.

2. **QUALIFICATION**
   Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.

3. **STEEL MAKING**
   The steel melt shall be refined with AOD or equivalent.

4. **MANUFACTURING PROCESS**
   The Hot Isostatic Pressed (HIP) process is an acceptable alternative to forging.

5. **HEAT TREATMENT**
   The forgings shall be solution annealed followed by water quenching.

6. **CHEMICAL COMPOSITION**
   UNS N08925 and N08926: N = 0.18 - 0.22 %

7. **CORROSION TESTING**
   Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. The corrosion test specimens shall be at the same location as those for mechanical testing. Cut edges shall be prepared according to ASTM G 48 and pickled (20 % HNO₃ + 5 % HF, 60 °C, 5 minute). The acceptance criteria are:
   - No pitting at 20 X magnification.
   - The weight loss shall be less than 4.0 g/m².

8. **EXTENT OF TESTING**
   One set of tensile test and corrosion test shall be carried out for each heat and heat treatment load. A test lot shall not exceed 2000 kg for forgings with as forged weight ≤ 50 kg, and 5000 kg for forgings with as forged weight > 50 kg.

9. **TEST SAMPLING**
   Samples for production testing shall realistically reflect the properties in the actual components.
   Test samples shall be from prolongations on actual component. Sacrificial forgings shall be used for die forged components. However, special agreements may be made for die forged components with as forged weight exceeding 50 kg. Integrated blocks shall be used for HIP.
   Test specimens shall be cut at the 1/4 T location from the surface where T is the thickness of the test samples as heat treated. Sketches shall be established showing type, size and location of test samples and extraction of test specimens.

10. **DIMENSIONAL TOLERANCES**
    Flanges to MSS SP-44 shall have maximum wall thickness under tolerance of 0.3 mm at the welding end.
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</tr>
<tr>
<td>Forgings</td>
<td>ASTM A 182</td>
<td>F44</td>
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| 11. NON DESTRUCTIVE TESTING | Supplementary requirement S5, liquid penetrant testing, shall apply to 10% of all forgings (from the lot as defined for mechanical testing) above NPS 2. The testing shall be carried out after final machining and pickling. The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 8. |
| 12. SURFACE FINISH | White pickled including machined surfaces. |
| 13. REPAIR OF DEFECTS | Weld repair is not acceptable. |
| 14. MARKING | The component shall be marked to ensure full traceability to melt and heat treatment lot. |
| 15. CERTIFICATION | EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate. |
## MATERIAL DATA SHEET

### TYPE OF MATERIAL:
Austenitic Stainless Steel, Type 6Mo

### PRODUCT
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<tr>
<td></td>
<td></td>
<td>UNS N08926</td>
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</table>

### 1. SCOPE
This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard. Material grades not included in A 240 shall comply with the test and tolerance requirements given to Grade UNS S31254.

### 2. QUALIFICATION
Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.

### 3. STEEL MAKING
The steel melt shall be refined with AOD or equivalent.

### 4. HEAT TREATMENT
The plates shall be solution annealed followed by water quenching.

### 5. CHEMICAL COMPOSITION
UNS N08925 and N08926: N = 0.18 - 0.22 %

### 6. CORROSION TESTING
Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. Test specimens shall have the surfaces in the as-delivered condition (including pickling). Cut edges shall be prepared according to ASTM G 48, and the whole specimen shall be pickled (20% HNO3 + 5% HF, 60 °C, 5 minute). The test shall expose the external and internal surfaces and a cross section surface in full wall thickness. The acceptance criteria are:
- No pitting at 20 X magnification.
- The weight loss shall be less than 4.0 g/m².

### 7. EXTENT OF TESTING
Corrosion testing shall be carried out to the same extent as stated for mechanical tests in the referred standard.

### 8. TEST SAMPLING
Samples for production testing shall realistically reflect the properties in the actual components.

### 9. SURFACE FINISH
White pickled.

### 10. REPAIR OF DEFECTS
Weld repair is not acceptable.

### 11. MARKING
The component shall be marked to ensure full traceability to melt and heat treatment lot.

### CERTIFICATION
EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.
# NORSOK Standard

## NORSOK Standard

### MATERIAL DATA SHEET MDS - R16 Rev. 2

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<tr>
<td>STANDARD</td>
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<td>GRADE</td>
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</table>

1. **SCOPE**  
This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.

2. **QUALIFICATION**  
Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.

3. **STEEL MAKING**  
The steel melt shall be refined with AOD or equivalent process. Remelting of AOD or equivalent steel in an electric furnace is acceptable. Use of internal scrap is not acceptable.

4. **HEAT TREATMENT**  
Solution annealed at temperature $\geq 1225^\circ C$.

5. **CHEMICAL**  
$P \leq 0.030 \%$

6. **CORROSION TESTING**  
Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. The corrosion test specimen shall be at the same location as those for mechanical testing. Cut edges shall be prepared according to ASTM G 48 and pickled (20 % HNO3 + 5 % HF, 60 °C, 5 minute). The acceptance criteria are:
- No pitting at 20 X magnification.
- The weight loss shall be less than 4.0 g/m².

7. **EXTENT OF TESTING**  
Tensile test and corrosion test shall be made for each melt and heat treatment load. A test lot shall not exceed 5 000 kg.

8. **TEST SAMPLING**  
Samples for mechanical testing shall realistically reflect the properties in the actual components. Thickness of the test block shall be equal to the thickness of the actual components up to a maximum thickness of 100 mm. For flanged components the largest flange thickness shall apply.

9. **NON DESTRUCTIVE TESTING**  
Liquid penetrant testing: Supplementary requirement S6 shall apply to all accessible surfaces of all castings. The testing shall be carried out after final machining and pickling. The acceptance criteria shall be ASME VIII, Div.1, Appendix 7.

Radiographic testing: Supplementary requirement S5 shall apply to:
- critical areas as per ANSI B 16.34 of the pilot cast of each pattern
- All butt weld ends of each casting
- Class 1500 psi and above; all critical areas to ANSI B16.34 of each casting.

The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 7.

10. **SURFACE FINISH**  
White pickled. Shall be carried out after any blasting and shall include finished machined surfaces.
## TYPE OF MATERIAL
Austenitic Stainless Steel, Type 6Mo

### PRODUCT
| Castings  | ASTM A 351 | CK-3MCuN CN-3MN | -   | S5, S6 |

### 11. REPAIR OF DEFECTS
Repair welding shall be carried out with Ni-based consumables with alloying content: Mo ≥ 8.0 %; Cr ≥ 15.0 %; (Mo + Cr) ≥ 28 %; C ≤ 0.030 %; S ≤ 0.015 %; Nb < 0.5 %. Welding consumables with matching chemical composition is acceptable provided solution annealing heat treatment after welding. The repair welding procedure shall be qualified in accordance with ASME IX or EN 288-3 and this MDS.
- A cast plate shall be used for the test welding.
- A macro and corrosion test as specified above shall be carried out.
- Change specific make of filler metal (brand name) requires requalification.
All casting with major repairs shall be given a solution heat treatment after welding.

### 12. MARKING
The component shall be marked to ensure full traceability to melt and heat treatment lot.

### 13. CERTIFICATION
EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.
MATERIAL DATA SHEET  MDS - R17  Rev. 2

TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo

<table>
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1. SCOPE This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard. Material grades not included in A 276 shall comply with the test and tolerance requirements given to UNS S31254.

2. QUALIFICATION Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.

3. STEEL MAKING The steel melt shall be refined with AOD or equivalent.

4. HEAT TREATMENT Solution annealing followed by water quenching.

5. CHEMICAL COMPOSITION \[\text{UNS N08925 and N08926: } N = 0.18 - 0.22 \%\]

6. CORROSION TESTING Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. The corrosion test specimens shall be at the same location as those for mechanical testing. Cut edges shall be prepared according to ASTM and pickled (20 % HNO3 + 5 % HF, 60 °C, 5 minute). The acceptance criteria are:
   - No pitting at 20 X magnification.
   - The weight loss shall be less than 4.0 g/m².

7. EXTENT OF TESTING One tensile test and corrosion test shall be carried out for each heat and heat treatment load.

8. TEST SAMPLING Samples for production testing shall realistically reflect the properties in the actual components.

9. SURFACE FINISH Finished product shall be white pickled.

10. REPAIR OF DEFECTS Weld repair is not acceptable

11. MARKING The component shall be marked to ensure full traceability to melt and heat treatment lot.

12. CERTIFICATION EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.
# NORSOK Standard

## MATERIAL DATA SHEET

**MATERIAL DATA SHEET**

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<th>TYPE OF MATERIAL:</th>
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</table>

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</table>

## 1. SCOPE

This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard. Material grades not included in A 269 shall comply to the test and tolerance requirements given to Grade UNS S31254.

## 2. QUALIFICATION

Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.

## 3. STEEL MAKING

The steel melt shall be refined by AOD or equivalent.

## 4. HEAT TREATMENT

The tubes shall be solution annealed followed by water quenching.

## 5. CORROSION TESTING

Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. Test specimens shall have internal and external surfaces in an as-delivered condition (including pickling). Cut edges shall be prepared according to ASTM G 48 and the whole specimen shall be pickled (20 % HNO3 + 5 % HF, 60 °C, 5 minute). The acceptance criteria are:

- No pitting at 20 X magnification.
- The weight loss shall be less than 4.0 g/m².

## 6. EXTENT OF TESTING

Corrosion testing shall be carried out to the same extent as stated for mechanical tests in the referred standard.

## 7. TEST SAMPLING

Samples for production testing shall realistically reflect the properties in the actual components.

## 8. SURFACE FINISH

White pickled.

## 9. REPAIR OF DEFECTS

Weld repair is not acceptable.

## 10. MARKING

The component shall be marked to ensure full traceability to melt and heat treatment lot.

## 11. CERTIFICATION

EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.
## MATERIAL DATA SHEET  
**MDS - R18**  
**Rev. 2**

### TYPE OF MATERIAL:
Austenitic stainless steel, Type 6Mo

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<tbody>
<tr>
<td>Tubes</td>
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<tr>
<td></td>
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</tbody>
</table>

1. **SCOPE**

This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard. Material grades not included in A 269 shall comply to the test and tolerance requirements given to Grade UNS S31254.

2. **QUALIFICATION**

Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.

3. **STEEL MAKING**

The steel melt shall be refined by AOD or equivalent.

4. **HEAT TREATMENT**

The tubes shall be solution annealed followed by water quenching.

5. **CORROSION TESTING**

Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. Test specimens shall have internal and external surfaces in an as-delivered condition (including pickling). Cut edges shall be prepared according to ASTM G 48 and the whole specimen shall be pickled (20 % HNO₃ + 5 % HF, 60 °C, 5 minute). The acceptance criteria are:

- No pitting at 20 X magnification.
- The weight loss shall be less than 4.0 g/m².

6. **EXTENT OF TESTING**

Corrosion testing shall be carried out to the same extent as stated for mechanical tests in the referred standard.

7. **TEST SAMPLING**

Samples for production testing shall realistically reflect the properties in the actual components.

8. **SURFACE FINISH**

White pickled.

9. **REPAIR OF DEFECTS**

Weld repair is not acceptable.

10. **MARKING**

The component shall be marked to ensure full traceability to melt and heat treatment lot.

11. **CERTIFICATION**

EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.
**MATERIAL DATA SHEET**

**TYPE OF MATERIAL:** Austenitic Stainless Steel, Type 316

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<tr>
<td>Welded pipes</td>
<td>ASTM A 358</td>
<td>316</td>
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1. **SCOPE**
   This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.

2. **CHEMICAL COMPOSITION**
   All products: C ≤ 0.035 %
   Plates to A 240: S ≤ 0.015 %

3. **TENSILE TESTING**
   Grade 316 L with Rp0.2 ≥ 205 MPa and Rm ≥ 515 MPa is acceptable.

4. **TEST SAMPLING**
   Samples for production testing shall realistically reflect the properties in the actual component.

5. **DIMENSIONAL TOLERANCES**
   Flanges to A 182: Flanges to MSS SP-44 shall have a maximum wall thickness under tolerance of 0.3 mm at weld end.

6. **NON DESTRUCTIVE TESTING**
   Welded pipes to A 358: Eddy current testing according to ASTM A450 is acceptable as replacement for spot radiography for wall thicknesses less than 4.0 mm.
   Welded tubes to A269: Eddy current testing according to ASTM A 450, section 23 is required.

7. **SURFACE FINISH**
   White pickled. Machined surfaces do not require pickling.

8. **REPAIR OF DEFECTS**
   Weld repair of base material is not acceptable.

9. **CERTIFICATION**
   EN 10 204 Type 3.1B
# MATERIAL DATA SHEET  MDS - S02  Rev. 2

**TYPE OF MATERIAL:** Austenitic Stainless Steel Castings  

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<td>CF3M</td>
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</table>

## 1. SCOPE
This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.

## 2. EXTENT OF TESTING
Tensile testing is required for each heat and heat treatment load.

## 3. TEST SAMPLING
For castings with weight 250 kg and above the test blocks shall be integrally cast with the casting. The test blocks shall be heat treated together with the castings they represent. Samples for mechanical testing shall realistically reflect the properties in the actual components.

## 4. NON DESTRUCTIVE TESTING
- **Liquid penetrant testing:** Supplementary requirement S6 shall apply to all accessible surfaces of all castings. The testing shall be carried out after final machining and pickling. The acceptance criteria shall be ASME VIII, Div.1, Appendix 7.
- **Radiographic testing:** Supplementary requirement S5 shall apply to:
  - Critical areas as per ANSI B16.34 of the pilot cast of each pattern
  - All butt weld ends of each casting.
  - Class 1500 psi and above; all critical areas according to ANSI B16.34 of each casting.
  - The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 7.

## 5. SURFACE FINISH
White pickled. Machined surfaces do not require pickling.

## 6. CERTIFICATION
EN 10 204 Type 3.1B
1. **SCOPE**  
This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard. Equivalent Titanium grade (GOST VT 1-0) is acceptable provided the requirements in the referred standard and this MDS is fulfilled.

2. **CHEMICAL COMPOSITION**  
Chemical composition other than Grade 2 (GOST VT 1-0) is acceptable.

3. **HEAT TREATMENT**  
- Wrought fittings to B 363, Forgings to B 381, Plates to B 265 and Bars to B 348: Annealed condition if not the tensile properties in the referred standard can be achieved in as formed condition.

4. **EXTENT OF TESTING**  
- Wrought fittings to B 363: Tensile test shall be carried out for each heat, heat treatment load, type and size.
- Forgings to B 381: Tensile test specimen shall be taken from each lot. A lot is defined as all products of the same heat and heat treatment load with a maximum deviation from the test block thickness of 10 mm.
- Bars to B 348: Tensile test specimen shall be taken from each lot. A lot is defined as all products of the same heat and heat treatment load with a maximum deviation from the test block thickness of 10 mm.

5. **TEST SAMPLING**  
All products: Samples for production testing shall realistically reflect the properties in the actual component.

6. **WELDING**  
Welded pipes to B 862: Welding procedures shall be qualified in accordance with ASME IX.

7. **DIMENSIONAL TOLERANCES**  
- Flanges to B 381: Flanges to MSS SP-44 shall have a maximum wall thickness under tolerance of 0.3 mm at weld end.

8. **CERTIFICATION**  
EN 10 204 Type 3.1B.
MATERIAL DATA SHEET

MDS - T02

Rev. 2

TYPE OF MATERIAL: Titanium Grade 2

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1. SCOPE

This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard. Equivalent Titanium grades (GOST VT 1-0) are acceptable provided the requirements in this MDS is fulfilled.

2. QUALIFICATION

Manufacturers of product to this MDS shall be qualified in accordance with NORSOK Standard M-650.

3. CHEMICAL COMPOSITION

Chemical composition other than Grade 2 (GOST VT 1-0) is acceptable.

4. EXTENT OF TESTING

Tensile testing is required for each heat and heat treatment load.

5. TEST SAMPLING

Samples for mechanical testing shall realistically reflect the properties in the actual components.

For castings with weight 250 kg and above the test blocks shall be integrally cast with the casting. The test blocks shall be heat treated together with the castings they represent.

6. NON DESTRUCTIVE TESTING

Liquid penetrant testing: Supplementary requirement S2 shall apply to all accessible surfaces of all castings. The testing shall be carried out after final machining. The acceptance criteria shall be ASME VIII, Div.1, Appendix 7.

Radiographic testing: Supplementary requirement S1 shall apply to:
- Critical areas as per ANSI B16.34 of the pilot cast of each pattern
- All butt weld ends of each casting.
- Class 1500 psi and above; all critical areas according to ANSI B16.34 of each casting.

The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 7.

7. MARKING

The component shall be marked to ensure full traceability to melt and heat treatment lot.

8. CERTIFICATION

EN 10 204 Type 3.1B
MATERIAL DATA SHEET            MDS - X01             Rev. 1

**TYPE OF MATERIAL:** Low Alloyed Steel Type AISI 4130

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1. **SCOPE**
   This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.

2. **HEAT TREATMENT**
   Fittings and pipes shall be delivered in the liquid quenched and tempered condition. The tempering temperature shall be minimum 650 °C.

3. **MANUFACTURING PROCESS**
   Pipes shall be manufactured by means of the hot finished (HF) sizing method. Only seamless fittings are acceptable.

4. **CHEMICAL COMPOSITION**
   Max. sulphur content: S ≤ 0.025 %
   Max. phosphorous content: P ≤ 0.025 %

5. **TENSILE TESTING**
   Minimum yield strength: $R_e \geq 415$ MPa
   Minimum tensile strength: $R_m \geq 620$ MPa
   Minimum elongation: $A_5 \geq 18$ %
   Minimum red. of area: $Z \geq 35$ %

6. **IMPACT TESTING**
   Charpy V-notch impact testing shall be carried out according to ASTM A 370 for thicknesses $t \geq 6$ mm. Full sized Charpy V-notch specimens shall be used wherever possible. The notch shall be perpendicular to the surface. The test temperature shall be -30 °C. The minimum absorbed energy for full size specimens shall be 42 J average and 30 J single. Reduction factors for subsize specimens shall be: 7.5 mm - 5/6 and 5 mm - 2/3.

7. **EXTENT OF TESTING**
   One set of tensile and impact test shall be carried out for each lot. A lot is defined as all products of the same type, nominal size and wall thickness, produced from the same heat and heat treatment load. For pipes heat treated in continuous furnace the maximum lot size shall be 60 m.

8. **TEST SAMPLING**
   Samples for production testing shall realistically reflect the properties in the actual component.
   **Fittings:** According to supplementary requirement S2.

9. **NON DESTRUCTIVE TESTING**
   **Pipes:** All pipes shall be 100 % tested in accordance with API 5L supplementary requirement 4 (SR4). Alternatively, ultrasonic testing according to SEL 1915 may be carried out.
   **Fittings:** Fittings shall be 100 % magnetic particle tested in accordance with ASME VIII, div. 1, Appendix 6.

10. **REPAIR OF DEFECTS**
    Weld repair is not acceptable.

11. **MARKING**
    The component shall be marked to ensure full traceability to melt and heat treatment lot.

12. **CERTIFICATION**
    EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.
**Material Data Sheet MDS - X02**

<table>
<thead>
<tr>
<th>Type of Material:</th>
<th>High Strength Low Alloved Steel Type AISI 4140</th>
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</table>

**Product**

<table>
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<tr>
<th>ASTM A 788</th>
<th>AISI 4140</th>
<th>-</th>
<th>S18</th>
</tr>
</thead>
</table>

**1. Scope**

This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.

**2. Manufacturing Process**

The forgings shall be finished hot-worked.

**3. Heat Treatment**

The forgings shall be austenitised, liquid quenched and tempered.

**4. Chemical Composition**

According to ASTM A 29, AISI 4140

**5. Tensile Testing**

Minimum yield strength: Reh ≥ 620 MPa
Minimum tensile strength: Rm ≥ 850 MPa
Minimum elongation: A5 ≥ 15%

**6. Impact Testing**

Charpy V-notch testing is required according to ASTM A 370 at -30 °C. The notch shall be perpendicular to the surface. The minimum absorbed energy for full size specimens shall be 42 J average and 30 J single.

**7. Extent of Testing**

One set of tensile and impact test shall be carried out for each melt, section thickness +/− 25 % and heat treatment load.

**8. Test Sampling**

Samples for production testing shall realistically reflect the properties in the actual component.

Test samples shall be from prolongations on actual components. Sacrificial forgings shall be used for die forged components. However, special agreements may be made for die forged components with as forged weight exceeding 50 kg.

Test specimens shall be cut at the 1/4 T location from the surface where T is the thickness of the test samples as heat treated. Sketches shall be established showing type, size and location of test samples and extraction of test specimens.

**9. Non Destructive Testing**

Supplementary Requirement, S18, magnetic particle tested, shall apply to 10 % of all forgings (from the lot as defined for mechanical testing). The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 6.

**10. Repair of Defects**

Weld repair is not acceptable.

**11. Marking**

The component shall be marked to ensure full traceability to melt and heat treatment lot.

**12. Certification**

EN 10 204 Type 3.1B

Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.
**MATERIAL DATA SHEET**

**MDS - X03**

**Rev. 2**

<table>
<thead>
<tr>
<th>TYPE OF MATERIAL:</th>
<th>High Strength Low Alloy Steel</th>
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<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>STANDARD</th>
<th>GRADE</th>
<th>ACCEPT. CLASS</th>
<th>SUPPL. REQ.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Castings</td>
<td>ASTM A 487</td>
<td>Grade 2B, 2C</td>
<td>-</td>
<td>S4, S5</td>
</tr>
</tbody>
</table>

1. **SCOPE**

   This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.

2. **IMPACT TESTING**

   Charpy V-notch testing is required according to ASTM A 370 at -30 °C. The notch shall be perpendicular to the surface. The minimum absorbed energy shall be 42 J average (of 3 specimens) and 30 J single value.

3. **EXTENT OF TESTING**

   One set of tensile and impact test is required for each melt and heat treatment load. A test lot shall not exceed 5000 kg.

4. **TEST SAMPLING**

   Samples for mechanical testing shall realistically reflect the properties in the actual components. Thickness of the test block shall be equal to the thickness of the actual components up to a maximum thickness of 100 mm. For flanged components the largest flange thickness shall apply.

   Test specimens shall be cut from the 1/4 T location from the surface where T is the thickness of the test block.

   Test block shall be integrally cast or gated onto the castings and shall not be removed from the castings until after the final quality heat treatment.

5. **NON DESTRUCTIVE TESTING**

   Magnetic particle testing: Supplementary requirement S4 shall apply to all accessible surfaces of all castings. The examination shall be carried out after machining. The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 7.

   Radiographic testing: Supplementary requirement S5 shall apply to:
   - Critical areas as per ANSI B16.34 of the pilot cast of each pattern.
   - All butt weld ends of each casting.
   - Class 1500 psi and above; all critical areas to ANSI B16.34 of each casting.

   The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 7.

6. **REPAIR OF DEFECTS**

   All weld repairs shall be post weld heat treated. The repair welding procedure qualification shall include the following:
   - qualification on a cast plate of the same grade
   - one set of impact test (3 specimens), shall be taken from weld metal and fusion line.

7. **MARKING**

   The component shall be marked to ensure full traceability to melt and heat treatment lot.

8. **CERTIFICATION**

   EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.
# MATERIAL DATA SHEET MDS - X04 Rev. 1

**TYPE OF MATERIAL:** High Strength Low Alloied Steel Type AISI 4130

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>STANDARD</th>
<th>GRADE</th>
<th>ACCEPT. CLASS</th>
<th>SUPPL. REQ.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forgings</td>
<td>API 6A</td>
<td>60K (AISI 4130)</td>
<td>Product Specification Level (PSL) 3</td>
<td>-</td>
</tr>
</tbody>
</table>

## 1. SCOPE
This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.

## 2. MANUFACTURING PROCESS
The flanges shall be forged to shape. Flanges machined out of bar and or plate are not accepted.

## 3. HEAT TREATMENT/DELIVERY CONDITION
The flanges shall be austenitised, liquid quenched and tempered.

## 4. CHEMICAL COMPOSITION
The steel chemistry shall comply with the requirements of AISI 4130, however modified in accordance with the requirements PSL 3 given in table 404.6 of API 6A. The chemical composition shall be agreed.

## 5. IMPACT TESTING
Charpy V-notch testing at -30 °C is required. The minimum absorbed energy for full size specimens shall be 42 J average and 30 J single.

## 6. EXTENT OF TESTING
One set of tensile and impact test shall be carried out for each melt, section thickness according to API 6A, PSL 3, and heat treatment load. A test lot shall not exceed 2000 kg.

## 7. TEST SAMPLING
Samples for production testing shall realistically reflect the properties in the actual component.

Test samples shall be from prolongations on actual components. Sacrificial forgings shall be used for die forged components. However, special agreements may be made for die forged components with as forged weight exceeding 50 kg.

Test specimens shall be cut at the 1/4 T location from the surface where T is the thickness of the test samples as heat treated. Sketches shall be established showing type, size and location of test samples and extraction of test.

## 8. DIMENSIONAL TOLERANCES
Flanges to MSS SP-44 shall have a maximum wall thickness under tolerance of 0.3 mm for the hub at the welding end.

## 9. NON DESTRUCTIVE TESTING
NDT shall be carried out after final heat treatment:
- 100 % MT according to ASME VIII, Div.1, App.6, shall be carried out.
- 100 % UT according to ASTM A 388, shall be carried out. The acceptance criterias shall be according to ASTM A 388 para 8.

## 10. REPAIR OF DEFECTS
Weld repair is not acceptable.

## 11. MARKING
The component shall be marked to ensure full traceability to melt and heat treatment lot.

## 12. CERTIFICATION
EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.
1. SCOPE

This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.

2. HEAT TREATMENT

Normalized and tempered.

3. IMPACT TESTING

Charpy V-notch testing at -46 °C is required. The minimum absorbed energy for full size specimens shall be 27 J average and 20 J single. Reduction factors for subsize specimens shall be: 7.5 mm - 5/6 and 5 mm - 2/3.

4. EXTENT OF TESTING

One set of tensile and impact test shall be carried out for each heat and heat treatment load. A test lot shall not exceed 2000 kg.

5. TEST SAMPLING

Samples for production testing shall realistically reflect the properties in the actual component.

Test samples shall be from prolongations on actual components. Sacrificial forgings shall be used for die forged components. However, special agreements may be made for die forged components with as forged weight exceeding 50 kg.

Test specimens shall be cut at the 1/4 T location from the surface where T is the thickness of the test samples as heat treated. Sketches shall be established showing type, size and location of test samples and extraction of test specimens.

6. DIMENSIONAL TOLERANCES

Flanges to MSS SP -44 shall have a maximum wall thickness under tolerance of 0.3 mm for the hub at the welding end.

7. NON DESTRUCTIVE TESTING

Supplementary Requirement, S4, Magnetic Particle testing, shall apply to 10 % of all forgings (from the lot as defined for mechanical testing). The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 6.

8. REPAIR OF DEFECTS

Weld repair of base material is not acceptable.

9. MARKING

The component shall be marked to ensure full traceability to melt and heat treatment lot.

10. CERTIFICATION

EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.
1. **SCOPE**

   This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.

2. **CHEMICAL COMPOSITION**

   C \leq 0.14 \%; Si \leq 0.50 \%; Mn = 1.30-1.60 \%; Cr \leq 0.20 \%; Ni = 0.90-1.10 \% and Mo = 0.15-0.25 \%.

3. **IMPACT TESTING**

   Charpy V-notch testing is required according to ASTM A 370 at -46 °C. The notch shall be perpendicular to the surface. The minimum absorbed energy shall be 42 J average (of 3 specimens) and 30 J single value.

4. **EXTENT OF TESTING**

   One set of tensile and impact test is required for each melt and heat treatment load. A test lot shall not exceed 5000 kg.

5. **TEST SAMPLING**

   Samples for mechanical testing shall realistically reflect the properties in the actual components. Thickness of the test block shall be equal to the thickness of the actual components as heat treated up to a maximum thickness of 100 mm. For flanged components the largest flange thickness apply.

   Test specimens shall be cut from the 1/4 T location from the surface where T is the thickness of the test block.

   Test block shall be integrally cast or gated onto the castings and shall not be removed from the castings before after the final quality heat treatment.

6. **NON DESTRUCTIVE TESTING**

   **Magnetic particle testing:** Supplementary requirement S4 shall apply to all accessible surfaces of all castings. The examination shall be carried out after machining. The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 7.

   **Radiographic testing:** Supplementary requirement S5 shall apply to:
   - critical areas as per ANSI B16.34 of the pilot cast of each pattern
   - all butt weld ends of each casting
   - Class 1500 psi and above; all critical areas to ANSI B16.34 of each casting.

   The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 7.

7. **REPAIR OF DEFECTS**

   All weld repairs shall be post weld heat treated. The repair welding procedure qualification shall include the following:
   - qualification on a cast plate of the same grade
   - one set of impact test (3 specimens) shall be taken from weld metal and fusion line.

8. **MARKING**

   The component shall be marked to ensure full traceability to melt and heat treatment lot.

9. **CERTIFICATION**

   EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.