1 FOREWORD

This standard has been developed by the NORSOK standardisation work group and agreed by the Norwegian industry for the widest possible national and international application.

Note: Materials of Type 6Mo and 25 Cr duplex manufactured prior to 01.01.95 can be accepted provided the following is satisfied:

- Corrosion tests have been carried out with acceptance criteria for pitting and weight loss according to NORSOK MDS’es at 40 °C.

- The microstructure is free from all grain boundary carbides and intermetallic phases.

2 SCOPE

This Standard is a collection of the Piping Material Data Sheets (MDS) applicable to selected material standards and grades for use in piping systems. The scope for the MDS’s is as follows:

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.

3 NORMATIVE REFERENCES

As stated in the individual data sheets.
4 DEFINITIONS

MDS  Material data sheet
SMYS  Specified minimum yield strength
Carbon Steel Type 235  Carbon steel with SMYS >= 220MPa and not impact tested
Carbon Steel Type 235LT  Carbon steel with SMYS >= 220 MPa and impact tested at - 46 °C
Carbon Steel Type 360LT  Carbon steel with SMYS >= 350 MPa and impact tested at - 46 °C
Stainless Steel Type 316  Alloys with approx. 2.5 % Mo of type AISI 316
Stainless Steel Type 6Mo  Alloys with 6 % Mo and PRE > 40
Stainless Steel Type 22Cr duplex  Alloys with 22 % Cr according to UNS S31803
Stainless Steel Type 25Cr duplex  Alloys with 25 % Cr and PRE > 40, often also referred to as "super duplex"

5 COLLECTION OF MATERIAL DATA SHEETS

5.1 General

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 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
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.
### Table 5.1 - Material Selection Menu for Piping Systems

<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 6Mo2)</th>
<th>Stainless steel Type 22Cr Duplex</th>
<th>Stainless steel Type 25Cr Duplex</th>
<th>Nickel alloy</th>
<th>Titanium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipes Seamless</td>
<td>A 106 Grade B</td>
<td>A 333 Grade 6</td>
<td>API 5L Grade X52</td>
<td>A 312 Grade TP 316</td>
<td>A 312 UNS S31354</td>
<td>A 790 UNS S31803</td>
<td>A790 UNS S32550</td>
<td>A790 UNS S32750</td>
<td>A790 UNS S32760</td>
</tr>
<tr>
<td>Pipes Welded</td>
<td>API 5L Grade B</td>
<td>A 671 Grade CC60 Class 12, 22</td>
<td>A 671 Grade CC70 Class 12, 22</td>
<td>A 312 Grade TP316</td>
<td>A 358 UNS S31254 Class 1, 3, 5</td>
<td>A 358 UNS S31803 Class 1, 3, 5</td>
<td>A358 UNS S32550</td>
<td>A358 UNS S32750</td>
<td>A358 UNS S32760 Class 1, 3 and 5</td>
</tr>
<tr>
<td>Fittings</td>
<td>A 234 Grade WPB</td>
<td>A 420 Grade WPL 6</td>
<td>A 860 Grade WPHY 52</td>
<td>A 403 Grade WP 316 Class S, W, WX</td>
<td>A 403 Grade WP S31254 Class S, W, WX</td>
<td>A 815 UNS S31803 Class S, W, WX</td>
<td>A815 UNS S32550</td>
<td>A815 UNS S32750</td>
<td>A815 UNS S32760 Class S, W, WX</td>
</tr>
<tr>
<td>Forgings</td>
<td>A 105 Grade LF2</td>
<td>A 350 Grade F52</td>
<td>A 694 Grade F52</td>
<td>A 182 Grade F316</td>
<td>A 182 Grade F44</td>
<td>A 182 Grade F51</td>
<td>A182 UNS S32550</td>
<td>A182 UNS S32750</td>
<td>A182 UNS S32760</td>
</tr>
</tbody>
</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 30 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.

5.2 Referenced Standards and Corresponding MDS

<table>
<thead>
<tr>
<th>MDS No.</th>
<th>Rev. No.</th>
<th>Standard and Grade</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Carbon Steel Type 235</td>
<td></td>
</tr>
<tr>
<td>C01</td>
<td>1</td>
<td>A 106 Grade B</td>
<td>Seamless pipes</td>
</tr>
<tr>
<td>C01</td>
<td>1</td>
<td>API 5L Grade B</td>
<td>Welded pipes</td>
</tr>
<tr>
<td>C01</td>
<td>1</td>
<td>A 234 Grade WPB</td>
<td>Wrought fittings</td>
</tr>
<tr>
<td>C01</td>
<td>1</td>
<td>A 105</td>
<td>Forgings</td>
</tr>
<tr>
<td>C01</td>
<td>1</td>
<td>A 516 Grade 60</td>
<td>Plates</td>
</tr>
<tr>
<td>C02</td>
<td>1</td>
<td>A 216 Grade WCB</td>
<td>Castings</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Carbon Steel Type 235LT</td>
<td></td>
</tr>
<tr>
<td>C11</td>
<td>1</td>
<td>A 333 Grade 6</td>
<td>Seamless pipes</td>
</tr>
<tr>
<td>C11</td>
<td>1</td>
<td>A 671 Grade CC60, CC70</td>
<td>Welded pipes</td>
</tr>
<tr>
<td>C11</td>
<td>1</td>
<td>A 420 Grade WPL 6</td>
<td>Wrought fittings</td>
</tr>
<tr>
<td>C11</td>
<td>1</td>
<td>A 350 Grade LF 2</td>
<td>Forgings</td>
</tr>
<tr>
<td>C11</td>
<td>1</td>
<td>A 516 Grade 70</td>
<td>Plates</td>
</tr>
<tr>
<td>C12</td>
<td>1</td>
<td>A 352 Grade LCC</td>
<td>Castings</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Carbon Steel Type 360LT</td>
<td></td>
</tr>
<tr>
<td>C21</td>
<td>1</td>
<td>A 694 Grade F52</td>
<td>Forgings</td>
</tr>
<tr>
<td>C21</td>
<td>1</td>
<td>A 860 WPHY 52</td>
<td>Wrought fittings</td>
</tr>
<tr>
<td>C22</td>
<td>1</td>
<td>API 5L Grade X52</td>
<td>Seamless pipes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>----</td>
<td>----</td>
<td>-----------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>D41</td>
<td>1</td>
<td>A 790 UNS S31803</td>
<td>Seamless pipes</td>
</tr>
<tr>
<td>D42</td>
<td>1</td>
<td>A 358 UNS S31803</td>
<td>Welded pipes</td>
</tr>
<tr>
<td>D43</td>
<td>1</td>
<td>A 815 UNS S31803</td>
<td>Wrought fittings</td>
</tr>
<tr>
<td>D44</td>
<td>1</td>
<td>A 182 Grade F51</td>
<td>Forgings</td>
</tr>
<tr>
<td>D45</td>
<td>1</td>
<td>A 240 UNS S31803</td>
<td>Plates</td>
</tr>
<tr>
<td>D46</td>
<td>1</td>
<td>A 890 UNS J92205</td>
<td>Castings</td>
</tr>
<tr>
<td>D47</td>
<td>1</td>
<td>A 276 UNS S31803</td>
<td>Bars</td>
</tr>
<tr>
<td>D48</td>
<td>1</td>
<td>A 289 UNS S31803</td>
<td>Tubes</td>
</tr>
</tbody>
</table>

**Ferritic/Austenitic Stainless Steel Type 25Cr Duplex**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>D51</td>
<td>1</td>
<td>A 790 UNS S32550</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A 790 UNS S32750</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A 790 UNS S32760</td>
</tr>
<tr>
<td>D52</td>
<td>1</td>
<td>A 358 UNS S32550</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A 358 UNS S32750</td>
</tr>
<tr>
<td>D53</td>
<td>1</td>
<td>A 358 UNS S32760</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A 815 UNS S32550</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A 815 UNS S32750</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A 815 UNS S32760</td>
</tr>
<tr>
<td>D54</td>
<td>1</td>
<td>A 182 UNS S32550</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A 182 UNS S32750</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A 182 UNS S32760</td>
</tr>
<tr>
<td>D55</td>
<td>1</td>
<td>A 240 UNS S32550</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A 240 UNS S32750</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A 240 UNS S32760</td>
</tr>
<tr>
<td>D56</td>
<td>1</td>
<td>A 890 UNS J93380 and UNS J93404</td>
</tr>
<tr>
<td>D57</td>
<td>1</td>
<td>A 276 UNS S32550</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A 276 UNS S32750</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A 276 UNS S32760</td>
</tr>
</tbody>
</table>

**Nickel Alloy Type 625**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>N01</td>
<td>1</td>
<td>B 366 UNS N06625</td>
</tr>
<tr>
<td>N01</td>
<td>1</td>
<td>B 775 UNS N06625</td>
</tr>
<tr>
<td>N01</td>
<td>1</td>
<td>B 564 UNS N06625</td>
</tr>
<tr>
<td>N01</td>
<td>1</td>
<td>B 443 UNS N06625</td>
</tr>
<tr>
<td>N01</td>
<td>1</td>
<td>B 446 UNS N06625</td>
</tr>
<tr>
<td>N02</td>
<td>1</td>
<td>A 494 Grade CW-6MC</td>
</tr>
</tbody>
</table>
### Polymers including fibre reinforced

<table>
<thead>
<tr>
<th>Code</th>
<th>Quantity</th>
<th>Material Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>P01</td>
<td>1</td>
<td>UK00A</td>
</tr>
</tbody>
</table>

### Austenitic Stainless Steel Type 6Mo

<table>
<thead>
<tr>
<th>Code</th>
<th>Quantity</th>
<th>Material Code</th>
<th>Material Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>R11</td>
<td>1</td>
<td>A 312 UNS S31254</td>
<td>Seamless pipes</td>
</tr>
<tr>
<td>R12</td>
<td>1</td>
<td>A 358 UNS S31254</td>
<td>Welded pipes</td>
</tr>
<tr>
<td>R13</td>
<td>1</td>
<td>A 403 UNS S31254</td>
<td>Wrought fittings</td>
</tr>
<tr>
<td>R14</td>
<td>1</td>
<td>A 182 Grade F44</td>
<td>Forgings</td>
</tr>
<tr>
<td>R15</td>
<td>1</td>
<td>A 240 UNS S31254</td>
<td>Plates</td>
</tr>
<tr>
<td>R16</td>
<td>1</td>
<td>A 351 Grade CK-3MCuN</td>
<td>Castings</td>
</tr>
<tr>
<td>R17</td>
<td>1</td>
<td>A 276 UNS S31254</td>
<td>Bars</td>
</tr>
<tr>
<td>R18</td>
<td>1</td>
<td>A 269 UNS S 31254</td>
<td>Tubes</td>
</tr>
</tbody>
</table>

### Austenitic Stainless Steel Type 316

<table>
<thead>
<tr>
<th>Code</th>
<th>Quantity</th>
<th>Material Code</th>
<th>Material Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>S01</td>
<td>1</td>
<td>A 312 Grade TP 316</td>
<td>Seamless &amp; welded pipes</td>
</tr>
<tr>
<td>S01</td>
<td>1</td>
<td>A 358 Grade 316</td>
<td>Welded pipes</td>
</tr>
<tr>
<td>S01</td>
<td>1</td>
<td>A 403 Grade WP 316</td>
<td>Wrought fittings</td>
</tr>
<tr>
<td>S01</td>
<td>1</td>
<td>A 182 Grade F 316</td>
<td>Forgings</td>
</tr>
<tr>
<td>S01</td>
<td>1</td>
<td>A 240 Grade 316</td>
<td>Plates</td>
</tr>
<tr>
<td>S02</td>
<td>1</td>
<td>A 351 Grade CF8M</td>
<td>Castings</td>
</tr>
<tr>
<td>S02</td>
<td>1</td>
<td>A 351 Grade CF3M</td>
<td>Castings</td>
</tr>
</tbody>
</table>

### Titanium Grade 2

<table>
<thead>
<tr>
<th>Code</th>
<th>Quantity</th>
<th>Material Code</th>
<th>Material Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>T01</td>
<td>1</td>
<td>B 337 Grade 2</td>
<td>Seamless &amp; welded pipes</td>
</tr>
<tr>
<td>T01</td>
<td>1</td>
<td>B 363 Grade WPT2/WPT2W</td>
<td>Wrought fittings</td>
</tr>
<tr>
<td>T01</td>
<td>1</td>
<td>B 381 Grade F2</td>
<td>Forgings</td>
</tr>
<tr>
<td>T02</td>
<td>1</td>
<td>B 367 Grade C2</td>
<td>Castings</td>
</tr>
<tr>
<td>T01</td>
<td>1</td>
<td>B 265 Grade 2</td>
<td>Plates</td>
</tr>
<tr>
<td>T01</td>
<td>1</td>
<td>B 348 Grade 2</td>
<td>Bars</td>
</tr>
<tr>
<td>T01</td>
<td>1</td>
<td>B 338 Grade 2</td>
<td>Tubes</td>
</tr>
</tbody>
</table>

### Low Alloy Steel Type AISI 4130

<table>
<thead>
<tr>
<th>Code</th>
<th>Quantity</th>
<th>Material Code</th>
<th>Material Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>X02</td>
<td>1</td>
<td>A 788 AISI 4140</td>
<td>Forgings</td>
</tr>
<tr>
<td>X03</td>
<td>1</td>
<td>A 487 Grade 2B, 2D</td>
<td>Castings</td>
</tr>
</tbody>
</table>
**MATERIAL DATA SHEET**

**MDS - C01, Rev. 1**

**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>-</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</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**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.

**MANUFACTURING PROCESS**

**HEAT TREATMENT/ DELIVERY CONDITION**

*Welded pipes to API 5L:*
Stress relieving when the nominal thickness $t \geq 19$ mm.

**CHEMICAL COMPOSITION**

$C \leq 0.22\%; Si \geq 0.10\%; Mn = 0.50 - 1.35\%; S \leq 0.025\%; P \leq 0.030\%; CE = C + \frac{Mn}{6} + 0.04 \leq 0.43.$

**TENSILE TESTING**

**EXTENT OF TESTING**

**TEST SAMPLING**

**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.*

**NON DESTRUCTIVE TESTING**

*Pipes to API 5L:
RT of weld seam or RT at ends and US/Eddy Current of the remaining weld.*

**SURFACE FINISH**

**REPAIR OF DEFECTS**

**CERTIFICATION**
EN 10 204 Type 3.1B
## MATERIAL DATA SHEET

MDS - C02, Rev. 1

### 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>Castings</td>
<td>ASTM A 216</td>
<td>WCB</td>
<td>-</td>
<td>S4, S5</td>
</tr>
</tbody>
</table>

### 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.

### MANUFACTURING PROCESS

### HEAT TREATMENT/DELIVERY CONDITION

### CHEMICAL COMPOSITION
C $\leq 0.22\%$ and CE $= C + \frac{Mn}{6} + 0.04 \leq 0.43$ for castings with butt weld ends.

### TENSILE TESTING

### HARDNESS

### IMPACT TESTING

### EXTENT OF TESTING

### TEST SAMPLING
For castings with weight 250 kg and above the test coupons shall be integrally cast with the casting.

### NON DESTRUCTIVE TESTING
*Magnetic particle examination:*
Supplementary requirement S4 shall apply to 10% of delivered castings in pressure class 150/300 psi and to 100% of delivered castings in pressure class 600 psi and above. All accessible surfaces, of the given percentage or minimum two off, of the castings from the same pattern and the same batch shall be examined.

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

*Radiographic examination:*
Supplementary requirement S5 shall apply to:
- critical areas as per ANSI B16.34 of the pilot cast of each pattern
- Class 600 and 900 psi; all butt weld ends
- Class 1500 psi and above; all critical areas according to ANSI B16.34.

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

### SURFACE FINISH

### REPAIR OF DEFECTS

### CERTIFICATION
EN 10 204 Type 3.1B
**MATERIAL DATA SHEET**

**MDS - C11, Rev. 1**

**TYPE OF MATERIAL:**
Carbon Steel Type 235LT

<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>S4</td>
</tr>
<tr>
<td>Welded pipes</td>
<td>ASTM A 671</td>
<td>CC60, CC70</td>
<td>t &lt;= 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>-</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>

**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.

**MANUFACTURING PROCESS**

**HEAT TREATMENT/ DELIVERY CONDITION**

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

**TENSILE TESTING**

**HARDNESS**

**IMPACT TESTING**
*Plates to A 516:*
Supplementary requirement S5 shall apply.
*Pipes to A 671:*
Supplementary requirement S2 shall apply.
*All products:*
The test temperature shall be -46 °C. 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.

**EXTENT OF TESTING**

**TEST SAMPLING**

**WELDING**

**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.
| **NON DESTRUCTIVE TESTING** | *Fittings to A 420:*  
Supplementary requirement S4, magnetic particle examination, shall apply to the weld area of 10% of all fittings. The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 6.  
*Forgings to A 350:*  
Supplementary Requirement S7.1, magnetic particle examination shall apply to 10% of all forgings with NPS > 2. The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 6. |
| **SURFACE FINISH** |  |
| **REPAIR OF DEFECTS** | Weld repair of base material is not acceptable. |
| **CERTIFICATION** | EN 10 204 Type 3.1B |
## MATERIAL DATA SHEET
### MDS - C12 Rev.1

**TYPE OF MATERIAL:**
Carbon Steel Type 235LT

<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 352</td>
<td>LCC</td>
<td>-</td>
<td>S4, S5</td>
</tr>
</tbody>
</table>

**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.

### MANUFACTURING PROCESS

**HEAT TREATMENT/DELIVERY CONDITION**

**CHEMICAL COMPOSITION**

C <= 0.22 %; S <= 0.025 %; P <= 0.030 %;
CE = C + Mn/6 + (Cr+Mo+V)/5 + (Cu+Ni)/15 <= 0.43

**TENSILE TESTING**

**HARDNESS**

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

**EXTENT OF TESTING**
If quenched and tempered heat treatment is applied, tensile and impact test is required for each melt and heat treatment load. Test blocks shall be heat treated with the castings they represents.

**TEST SAMPLING**
For castings with weight 250 kg and above the test coupons shall be integrally cast with the casting.

**NONDESTRUCTIVE TESTING**

*Magnetic Particle Examination:*
Supplementary requirement S4 shall apply to 10 % of delivered castings in pressure class 150/300 psi and to 100 % of delivered castings in pressure class 600 psi and above. All accessible surfaces, of the given percentage or minimum two off, of the castings from the same pattern and batch shall be examined. The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 7.

*Radiographic examination:*
Supplementary requirement S5 shall apply to:
- critical areas as per ANSI B16.34 of the pilot cast of each pattern
- Class 600 and 900 psi; all butt weld ends
- Class 1500 psi and above; all critical areas to ANSI B16.34. The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 7.

**SURFACE FINISH**

**REPAIR OF DEFECTS**

**CERTIFICATION**
EN 10 204 Type 3.1B
## MATERIAL DATA SHEET

MDS - C21, Rev. 1

### 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/Forgings</td>
<td>ASTM A 860</td>
<td>WPHY F52</td>
<td>Seamless and welded</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>ASTM A 694</td>
<td>F52</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 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.

### MANUFACTURING PROCESS

### HEAT TREATMENT/DELIVERY CONDITION

### CHEMICAL COMPOSITION
- **Forgings to A 694:**
  - 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 <= 0.07 %
  - CE = C + Mn/6 + (Cr+Mo+V)/5 + (Cu+Ni)/15 <= 0.43

### TENSILE TESTING

### 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.

### EXTENT OF TESTING
- **Forgings to A 694:** Impact tests shall be taken to the same frequency as tensile test.

### TEST SAMPLING
- **Forgings to A 694:** The test location shall be according to A 350 para 6.2.3.

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

### 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.

### NON DESTRUCTIVE TESTING
- **Fittings to A 860:** Supplementary requirement S4, magnetic particle examination, shall apply to the weld area to 10 % of all fittings.
- **Forgings to A 694:** 10 % of all forgings with NPS > 2 shall be magnetic particle examined according to ASME V Article 7.
- **All products:** The acceptance criteria shall be to ASME VIII Div. 1, Appendix 6.
**SURFACE FINISH**

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

**CERTIFICATION**  EN 10 204 Type 3.1B

---

### MATERIAL DATA SHEET

**MDS - C22, Rev. 1**

**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>Seamless pipes</td>
<td>API 5L</td>
<td>X52</td>
<td>-</td>
<td>t &gt; 25 mm : SR 4</td>
</tr>
</tbody>
</table>

**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.

**MANUFACTURING PROCESS**  Fine grain treatment shall be carried out.

**HEAT TREATMENT/DELIVERY CONDITION**  Normalised or Quenched and Tempered.

**CHEMICAL COMPOSITION**  

\[
\begin{align*}
C & \leq 0.16 \%; Mn = 0.90 - 1.60 \%; Si \leq 0.10-0.50 \%; S \leq 0.025 \%; P \leq 0.035 \%; Ti \leq 0.05 \%; Nb \leq 0.04 \%; Al \leq 0.06 \%; N \leq 0.015 \%; V+\text{Nb}+\text{Ti} \leq 0.07 \%; CE = C + Mn/6 + (Cr+Mo+V)/5 + (Cu+Ni)/15 \leq 0.43
\end{align*}
\]

**TENSILE TESTING**

**HARDNESS**

**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 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.

**EXTENT OF TESTING**

**TEST SAMPLING**

**NON DESTRUCTIVE TESTING**  Supplementary requirement SR 4 shall apply for thicknesses > 25 mm.

**SURFACE FINISH**  The surface finish shall comply with ASTM A 106 para. 18.3.2

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

**CERTIFICATION**  EN 10 204 Type 3.1B
### MATERIAL DATA SHEET

**MDS - D41, Rev. 1**

#### 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>Seamless pipes</td>
<td>ASTM A 790</td>
<td>UNS S31803</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

#### 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.

#### MANUFACTURING PROCESS
The steel melt shall be refined with AOD or equivalent.

#### HEAT TREATMENT / DELIVERY CONDITION

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

#### TENSILE TESTING
The hardness shall be measured and less than 28 HRC or alternatively 271 HB or 290 HV10.

#### 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 metal and 35 J single. Two sets, each 3 specimen, shall be carried out with notch located in weld metal and fusion line. Reduction factors for subsize specimens shall be: 7.5 mm - 5/6 and 5 mm - 2/3.

#### MICROGRAPHIC EXAMINATION
The micrographic examination shall cover the 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.

#### 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.

#### TEST SAMPLING

#### NON DESTRUCTIVE TESTING
White pickled.

#### SURFACE FINISH
Weld repair is not acceptable.

#### CERTIFICATION
EN 10 204 Type 3.1B
## MATERIAL DATA SHEET

**MDS - D42, Rev. 1**

### 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>Welded pipes</td>
<td>ASTM A 358</td>
<td>UNS S31803</td>
<td>Class 1, 3 and 5</td>
<td>S3</td>
</tr>
</tbody>
</table>

### 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.

### MANUFACTURING PROCESS
The steel melt shall be refined with AOD or equivalent.

### HEAT TREATMENT/DELIVERY CONDITION

<table>
<thead>
<tr>
<th>CHEMICAL COMPOSITION</th>
</tr>
</thead>
<tbody>
<tr>
<td>N = 0.14 - 0.20 %</td>
</tr>
</tbody>
</table>

### TENSILE TESTING
Base material properties: Rp0.2 >= 450 MPa; Rm >= 620 MPa; A >= 25%.

### HARDNESS
The hardness shall be measured and less than 28 HRC or alternatively 271 HB or 290 HV10.

### 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. Reduction factors for subsize specimens shall be: 7.5 mm - 5/6 and 5 mm - 2/3.

### MICROGRAPHIC EXAMINATION
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.

### EXTENT OF TESTING
Tensile, impact, hardness 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 a lot is defined as maximum 60 m of pipe of the same heat and size which are heat treated the same day.

### TEST SAMPLING

<table>
<thead>
<tr>
<th>WELDING</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NON DESTRUCTIVE TESTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eddy current examination according to ASTM A 450 is acceptable as replacement for radiography for wall thicknesses less than 4.0 mm. Supplementary requirement S3, penetrant examination, according to ASME V Article 6 shall apply to the weld area of 10% of the pipes delivered. Acceptance criteria shall be to ASME VIII, Div. 1 Appendix 7.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SURFACE FINISH</th>
</tr>
</thead>
<tbody>
<tr>
<td>White pickled.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>REPAIR OF DEFECTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weld repair of base material is not acceptable. For repair of welds same requirements to PQR/WPAR shall apply as for production welding.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CERTIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN 10 204 Type 3.1B</td>
</tr>
</tbody>
</table>
## MATERIAL DATA SHEET

### MDS - D43, Rev. 1

**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 S31803</td>
<td>WP-W, WP-S or WP-WX</td>
<td>S2, S7</td>
</tr>
</tbody>
</table>

**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.

**MANUFACTURING PROCESS**  
The steel melt shall be refined with AOD or equivalent.

**HEAT TREATMENT/ DELIVERY CONDITION**

<table>
<thead>
<tr>
<th>CHEMICAL COMPOSITION</th>
<th>N = 0.14 - 0.20 %</th>
</tr>
</thead>
</table>

**TENSILE TESTING**  
Supplementary requirement S2 shall apply.

**HARDNESS**  
The hardness shall be measured and less than 28 HRC or alternatively 271 HB or 290 HV10.

**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. 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.

**MICROGRAPHIC EXAMINATION**  
The micrographic examination shall cover the surface 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.

**EXTENT OF TESTING**  
Impact tensile, hardness testing, microstructure examination to the same extent as tensile testing defined in supplementary requirement S2 and for each heat treatment load.

**TEST SAMPLING**  
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.

**DIMENSIONAL TOLERANCES**  
Fitting with reference to MSS-SP-75 shall have maximum wall thickness under tolerance of 0,3 mm.

**NON DESTRUCTIVE TESTING**  
Supplementary requirement S7, liquid penetrant examination, shall apply to 10 % of all fittings above NPS 2. For welded fittings the examination shall cover the weld area only. The acceptance criteria shall be ASME VIII, Div. 1, Appendix 8.

**SURFACE FINISH**  
White pickled except for machined surfaces.

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

**CERTIFICATION**  
EN 10 204 Type 3.1B
MATERIAL DATA SHEET
MDS - D44, Rev. 1

**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>Forgings</td>
<td>ASTM A 182</td>
<td>F51</td>
<td>-</td>
<td>S5</td>
</tr>
</tbody>
</table>

**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.

**MANUFACTURING PROCESS**
The steel melt shall be refined with AOD or equivalent process. The Hot Isostatic Pressed (HIP) process is an acceptable alternative to forging.

**HEAT TREATMENT/ DELIVERY CONDITION**

**CHEMICAL COMPOSITION**
N = 0.14 - 0.20 %

**TENSILE TESTING**

**HARDNESS**
The hardness shall be measured and less than 28 HRC or alternatively 271 HB or 290 HV10.

**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.

**MICROGRAPHIC EXAMINATION**
The micrographic examination shall cover the 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.

**EXTENT OF TESTING**
Impact tensile, hardness testing, microstructure examination to the same extent as tensile testing defined in supplementary requirement S2 and for each heat treatment load.

**TEST SAMPLING**
For open die and ring rolled products all test samples shall be taken from a rough forging or a prolongation of the part. Separate test specimens is acceptable for products made by the HIP process.

**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.

**NON DESTRUCTIVE TESTING**
Supplementary requirement S5, liquid penetrant examination, shall apply to 10 % of forgings above NPS 2. The acceptance criteria shall be ASME VIII, Div. 1, Appendix 8.

**SURFACE FINISH**
White pickled except for machined surfaces.

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

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

**MDS - D45, Rev. 1**

**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 S31803</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**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.

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

**HEAT TREATMENT/ DELIVERY CONDITION**

**CHEMICAL COMPOSITION**
N = 0.14 - 0.20 %

**TENSILE TESTING**
The hardness shall be measured and less than 28 HRC or alternatively 271 HB or 290 HV10.

**HARDNESS**
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.

**IMPACT TESTING**
The micrographic examination shall cover the 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.

**MICROGRAPHIC EXAMINATION**
Impact tensile, hardness testing, micrographic examination shall be carried out for each heat, size and heat treatment load.

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

**TEST SAMPLING**

**NON DESTRUCTIVE TESTING**
White pickled.

**SURFACE FINISH**
Weld repair is not acceptable.

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

**MDS - D46, Rev. 1**

**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>Castings</td>
<td>ASTM A 890</td>
<td>UNS J92205</td>
<td>-</td>
<td>S2, S3, S33</td>
</tr>
</tbody>
</table>

**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.

**MANUFACTURING PROCESS**
The steel melt shall be with AOD or equivalent refining.

**HEAT TREATMENT/ DELIVERY CONDITION**

**CHEMICAL COMPOSITION**
N = 0.14 - 0.20 %

**TENSILE TESTING**

**HARDNESS**
The hardness shall be measured and less than 28 HRC or alternatively 271 HB or 290 HV10.

**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.

**MICROGRAPHIC EXAMINATION**
The micrographic examination shall cover the 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.

**EXTENT OF TESTING**
A full set of mechanical tests and microstructure examinations shall be made for each heat and heat treatment charge. The test blocks shall be heat treated with the casting they represent.

**TEST SAMPLING**
For castings with weight 250 kg and above the test coupons shall be integrally cast with the casting. All test blocks shall be treated together with the casting they represent.

**NON DESTRUCTIVE TESTING**

**Liquid penetrant examination:**
Supplementary requirement S3 shall apply to all accessible surfaces of all castings. The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 7.

**Radiographic examination:**
Supplementary requirement S5 shall apply to:
- Critical areas as per ANSI B16.34 of the pilot cast of each pattern.
- Class 600 and 900 psi; all butt weld ends
- Class 1500 psi and above; all critical areas to ANSI B16.34.

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

**SURFACE FINISH**
White pickled for machined surfaces.

**REPAIR OF DEFECTS**
Supplementary requirement S33 shall apply.
The repair welding procedure qualification shall include the following:
- qualified on a cast plate
- examination of microstructure and Charpy V-notch testing as specified above.

**CERTIFICATION**
EN 10 204 Type 3.1B
**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 S31803</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**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.

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

**HEAT TREATMENT/ DELIVERY CONDITION**

**CHEMICAL COMPOSITION**
N = 0.14 - 0.20 %

**TENSILE TESTING**

**HARDNESS**
The hardness shall be measured and less than 28 HRC or alternatively 271 HB or 290 HV10.

**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.

**MICROGRAPHIC EXAMINATION**
The micrographic examination shall cover the 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.

**EXTENT OF TESTING**

**TEST SAMPLING**

**NON DESTRUCTIVE TESTING**

**SURFACE FINISH**

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

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

**MDS - D48, Rev. 1**

**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 31803</td>
<td>-</td>
<td>S5</td>
</tr>
</tbody>
</table>

**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.

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

**HEAT TREATMENT/DELIVERY CONDITION**

**CHEMICAL COMPOSITION**
N = 0.14 - 0.20 %

**TENSILE TESTING**
The hardness shall be measured and less than 28 HRC or alternatively 271 HB or 290 HV10.

**IMPACT TESTING**

**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.

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

**TEST SAMPLING**

**NON DESTRUCTIVE TESTING**

**SURFACE FINISH**

**REPAIR OF DEFECTS**

**CERTIFICATION**
EN 10 204 Type 3.1B
# MATERIAL DATA SHEET

**MDS - D51, Rev. 1**

## 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>Seamless pipes</td>
<td>ASTM A 790</td>
<td>UNS S 32550, UNS S 32750, UNS S 32760</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**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.

**MANUFACTURING PROCESS**
The steel melt shall be refined with AOD or equivalent.

**HEAT TREATMENT/DELIVERY CONDITION**
The pipes shall be solution annealed followed by water quenching.

**CHEMICAL COMPOSITION**
PRE (% Cr + 3.3% Mo + 16% N) >= 40.0

**TENSILE TESTING**
Rp0.2 >= 550 MPa; Rm >= 750 MPa; A >= 15%

**HARDNESS**
The hardness shall be measured and shall be less than 28 HRC or alternatively 271 HB or 290 HV10.

**IMPACT TESTING**
Charpy V-notch testing is required according to ASTM A 370 at -46 °C. 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.

**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 be with the surface in the as-delivered condition. The test shall expose the external, internal and cross section surface in full wall thickness. No pitting is acceptable at 20 X magnification. The weight loss shall be less than 4.0 g/m.

**MICROGRAPHIC EXAMINATION**
The micrographic examination shall cover the surfaces 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.

**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.

**TEST SAMPLING**

**NON DESTRUCTIVE TESTING**

**SURFACE FINISH**
White pickled.

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

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

**MDS - D52, Rev. 1**

**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>
</table>
| Welded pipes       | ASTM A 358 | UNS S 32550  
UNS S 32750  
UNS S 32760 | Class 1, 3 and 5 | -            |

**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.

**MANUFACTURING PROCESS**
The steel melt shall be refined with AOD or equivalent.

**HEAT TREATMENT/ DELIVERY CONDITION**
Post weld solution annealing is not required of pipes manufactured out of solution annealed plate material as stated in chapter 5.3.2.2 of A 358.

**CHEMICAL COMPOSITION**
PRE (% Cr + 3.3% Mo + 16% N) >= 40.0

**TENSILE TESTING**
Rp0.2 >= 550 MPa; Rm >= 750 MPa; A >= 15%

**HARDNESS**
The hardness shall be measured and shall be less than 28 HRC or alternatively 271 HB or 290 HV10.

**IMPACT TESTING**
Charpy V-notch testing is required according to ASTM A 370 at - 46 °C. 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.

**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 be with the surface in the as-delivered condition. The test shall expose the external, internal and cross section surface in full wall thickness. No pitting is acceptable at 20 X magnification. The weight loss shall be less than 4.0 g/m.

**MICROGRAPHIC EXAMINATION**
The micrographic examination shall cover the surfaces and mid-thickness region. Both weld metal and 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.

**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 a lot is defined as maximum 60 m of pipe of the same hat and size and which are heat treated the same day.

**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 PQR/WPAR shall be carried out on the same material grade as shall be welded. Change of filler metal brand names required requalification.

**NON DESTRUCTIVE TESTING**
Eddy current examination according to ASTM A 450 is acceptable as replacement for radiography for wall thicknesses less than 4.0 mm. Supplementary requirement S3, penetrant examination, according to ASME V Article 6 shall apply to the weld area of 10% of the pipes delivered. Acceptance criteria shall be to ASME VIII, Div. 1 Appendix 7.
<table>
<thead>
<tr>
<th><strong>SURFACE FINISH</strong></th>
<th>White pickled.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>REPAIR OF DEFECTS</strong></td>
<td>Weld repair of base material is not acceptable. For repair of welds same requirements to PQR/WPAR shall apply as for production welding.</td>
</tr>
<tr>
<td><strong>CERTIFICATION</strong></td>
<td>EN 10 204 Type 3.1B</td>
</tr>
</tbody>
</table>
## MATERIAL DATA SHEET

**MDS - D53, Rev. 1**

**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>Wrought fittings</td>
<td>ASTM A 615</td>
<td>UNS S 32550</td>
<td>WP-S, WP-WX and WP-W</td>
<td>S2, S7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>UNS S 32750</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>UNS S 32760</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**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.

**MANUFACTURING PROCESS**
The steel melt shall be refined with AOD or equivalent.

**HEAT TREATMENT/DELIVERY CONDITION**
Solution annealing followed by water quenching.

**CHEMICAL COMPOSITION**
PRE (% Cr + 3.3% Mo + 16% N) >= 40.0

**TENSILE TESTING**
Base material properties: Rp0.2 >= 550 MPa; Rm >= 750 MPa; A >= 15%

**HARDNESS**
The hardness shall be measured and shall be less than 28 HRC or alternatively 271 HB or 290 HV10.

**IMPACT TESTING**
Charpy V-notch testing shall be carried out according to ASTM A 370 at -46 °C and the minimum absorbed energy shall be 45 J average / 35 J single. 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.

**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 be with the surface in the as-delivered condition. The test shall expose the external, internal and cross section surface including weld zone in full wall thickness. No pitting is acceptable at 20 X magnification. The weight loss shall be less than 4.0 g/m.

**MICROGRAPHIC EXAMINATION**
The micrographic examination shall cover the 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.

**EXTENT OF TESTING**
Tensile, impact, hardness, corrosion testing, microstructure examination to the same extent as tensile testing defined in supplementary requirement S2 except that all tests also shall be carried out for each heat treatment load.

**TEST SAMPLING**
According to supplementary requirement S2.

**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 PQR/WPAR shall be carried out on the same material grade as shall be welded. Change of filler metal brand names required requalification.
| NON DESTRUCTIVE TESTING | Supplementary requirements S7, penetrant examination, shall apply to 10% of all type of fittings above NPS 2. For welded fittings the examination shall cover the weld area only. The acceptance criteria shall be ASME VIII, Div. 1, Appendix 8. |
| SURFACE FINISH | White pickled. |
| REPAIR OF DEFECTS | Weld repair of base material is not acceptable. For repair of welds same requirements to PQR/WPAR shall apply as for production welding. |
| CERTIFICATION | EN 10 204 Type 3.1B |
**MATERIAL DATA SHEET**

**MDS - D54, Rev. 1**

**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>Forgings</td>
<td>ASTM A 182</td>
<td>UNS S 32550</td>
<td></td>
<td>S5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>UNS S 32750</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>UNS S 32760</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**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.

**MANUFACTURING PROCESS**

The steel melt shall be refined with AOD or equivalent process. The Hot Isostatic Pressed (HIP) process is an acceptable alternative to forging.

**HEAT TREATMENT/DELIVERY CONDITION**

Solution annealing followed by water quenching.

**CHEMICAL COMPOSITION**

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

**TENSILE TESTING**

Rp0.2 >= 550 MPa; Rm >= 750 MPa; A >= 15%.

**HARDNESS**

The hardness shall be measured and shall be less than 28 HRC or alternatively 271 HB or 290 HV10.

**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.

**MICROGRAPHIC EXAMINATION**

The micrographic examination shall cover the 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.

**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 be with the surface in the as-delivered condition. The test shall expose the external, internal and cross section surface in full wall thickness. No pitting is acceptable at 20 X magnification. The weight loss shall be less than 4.0 g/m².

**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.

**TEST SAMPLING**

All test samples shall be taken from a rough forging or prolongation of the part representing the heaviest wall thickness.

**NON DESTRUCTIVE TESTING**

Supplementary requirement S5, liquid penetrant examination, shall apply to 10 % of forgings above NPS 2. The acceptance criteria shall be ASME VIII, Div. 1, Appendix 8.

**SURFACE FINISH**

White pickled including machined sealing surfaces.

**REPAIR OF DEFECTS**

Weld repair.

**CERTIFICATION**

EN 10 204 Type 3.1B
**MATERIAL DATA SHEET**

**MDS - D55, Rev. 1**

**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>Plates</td>
<td>ASTM A 240</td>
<td>UNS S 32550</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>UNS S 32750</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>UNS S 32760</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**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.

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

**HEAT TREATMENT/Delivery Condition**
Solution annealing followed by water quenching.

**CHEMICAL COMPOSITION**
PRE (%Cr + 3.3% Mo + 16% N) >= 40.0.

**TENSILE TESTING**
Rp0.2 >= 550 MPa; Rm >= 750 MPa; A >= 15%.

**HARDNESS**
The hardness shall be measured and shall be less than 28 HRC or alternatively 271 HB or 290 HV10.

**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.

**MICROGRAPHIC EXAMINATION**
The micrographic examination shall cover the 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.

**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 be with the surface in the as-delivered condition. The test shall expose the external, internal and cross section surface in full wall thickness. No pitting is acceptable at 20 X magnification. The weight loss shall be less than 4.0 g/m².

**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.

**TEST SAMPLING**

**NON DESTRUCTIVE TESTING**

**SURFACE FINISH**
White pickled.

**REPAIR OF DEFECTS**
Repair welding is not acceptable.

**CERTIFICATION**
EN 10 204 Type 3.1B
MATERIAL DATA SHEET
MDS - D56, Rev. 1

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>Castings</td>
<td>ASTM A 890</td>
<td>UNS J93404</td>
<td>-</td>
<td>S2, S3, S33</td>
</tr>
<tr>
<td></td>
<td></td>
<td>UNS J93380</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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.

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

HEAT TREATMENT/ DELIVERY CONDITION
According to Grade 5A (UNS J93404).

CHEMICAL COMPOSITION
PRE (\%Cr + 3.3\% Mo + 16\% N) >= 40.0.

TENSILE TESTING
Rp0.2 >= 450 MPa; Rm >= 700 MPa; A >= 15%.

HARDNESS
The hardness shall be measured and shall be less than 28 HRC or alternatively 271 HB or 290 HV10.

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.

MICROGRAPHIC EXAMINATION
The micrographic examination shall cover the surface and mid-thickness region of the test blocks. On WPQ's both the weld and the 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.

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 be with the surface in the as-delivered condition. The test shall expose the external, internal and cross section surface in full wall thickness. No pitting is acceptable at 20 X magnification. The weight loss shall be less than 4.0 g/m².

EXTENT OF TESTING
A full set of mechanical and corrosion tests and microstructure examinations shall be made for each heat and heat treatment charge.

TEST SAMPLING
For castings with weight 250 kg and above the test coupons shall be integrally cast with the casting. All test blocks shall be heat treated together with the castings they represent.
| **NON DESTRUCTIVE TESTING** | *Liquid penetrant examination:*
Supplementary requirement S3 shall apply to all accessible surfaces of all castings in machined condition. The acceptance criteria shall be ASME VIII, Div. 1, Appendix 7.  
*Radiographic examination (RT):*
Supplementary requirement S5 shall apply to:
- Critical areas as per ANSI B16.34 of the pilot cast of each pattern.
- Class 600 and 900 psi; all butt weld ends
- Class 1500 psi and above; all critical areas to ANSI B16.34.
The acceptance criteria shall be to ASME VIII, Div. 1 Appendix 7. |
| **SURFACE FINISH** | White pickled shall be carried out after any blasting and shall include finished machined sealing surfaces. |
| **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 material grade
- change of filler metal brand names requires requalification
- examination of microstructure
- corrosion and Charpy V-notch testing as specified above. |
<p>| <strong>CERTIFICATION</strong> | EN 10 204 Type 3.1B |</p>
<table>
<thead>
<tr>
<th><strong>MATERIAL DATA SHEET</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MDS - D57, Rev. 1</strong></td>
</tr>
<tr>
<td><strong>TYPE OF MATERIAL:</strong></td>
</tr>
<tr>
<td>Ferritic/Austenitic Stainless Steel, Type 25Cr duplex</td>
</tr>
<tr>
<td><strong>PRODUCT</strong></td>
</tr>
<tr>
<td>Bars</td>
</tr>
</tbody>
</table>

**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.

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

**HEAT TREATMENT/DELIVERY CONDITION**
Solution annealing followed by water quenching.

**CHEMICAL COMPOSITION**
PRE (%Cr + 3.3% Mo + 16% N) >= 40.0.

**TENSILE TESTING**
Rp0.2 >= 550 MPa; Rm >= 750 MPa; A >= 15%.

**HARDNESS**
The hardness shall be measured and shall be less than 28 HRC or alternatively 2715 HB or 290 HV10.

**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.

**MICROGRAPHIC EXAMINATION**
The micrographic examination shall cover the 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.

**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 be with the surface in the as-delivered condition. The test shall expose the external, internal and cross section surface in full wall thickness. No pitting is acceptable at 20 X magnification. The weight loss shall be less than 4.0 g/m².

**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.

**TEST SAMPLING**

**NON DESTRUCTIVE TESTING**

**SURFACE FINISH**
Finished product shall be white pickled.

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

**CERTIFICATION**
EN 10 204 Type 3.1B
MATERIAL DATA SHEET
MDS - N01, Rev. 1

**TYPE OF MATERIAL:**
Nickel alloy Type 625

<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 B 366</td>
<td>UNS N06625</td>
<td>-</td>
<td>S3</td>
</tr>
<tr>
<td>Pipes</td>
<td>ASTM B 775</td>
<td>UNS N06625</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Forgings</td>
<td>ASTM B 564</td>
<td>UNS N06625</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Plates</td>
<td>ASTM B 443</td>
<td>UNS N06625</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Bars</td>
<td>ASTM B 446</td>
<td>UNS N06625</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**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.

**MANUFACTURING PROCESS**

| HEAT TREATMENT/ DELIVERY CONDITION | Annealed. |

**CHEMICAL COMPOSITION**

| TENSILE TESTING |

| EXTENT OF TESTING |

| TEST SAMPLING |

| FORMING |

| NON DESTRUCTIVE EXAMINATION (NDE) |

Fittings to B 366:
Supplementary requirement S3, liquid penetrant, shall apply to the weld area at 10% of all fittings above NPS2, or 2 off of all fittings of each type.
The acceptance criteria shall be ASME VIII, Div. 1, Appendix 6.

Forgings to B 564:
Liquid penetrant examination shall be performed at 10% of forgings above NPS 2.
The acceptance criteria shall be ASME VIII, Div. 1, Appendix 6.

| SURFACE FINISH |

Bright annealed or descaled.

| REPAIR OF DEFECTS |

Weld repair is not acceptable.

| CERTIFICATION |

EN 10 204 Type 3.1B
**MATERIAL DATA SHEET MDS - N02, Rev. 1**

**TYPE OF MATERIAL:**
Nickel alloy Type 625

<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>CW-6MC</td>
<td>Class 1</td>
<td>S2, S3</td>
</tr>
</tbody>
</table>

**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.

**MANUFACTURING PROCESS**
- 

**HEAT TREATMENT/ DELIVERY CONDITION**
- 

**CHEMICAL COMPOSITION**
- 

**TENSILE TESTING**
The specimen shall be taken on a crosssection from surface to mid-thickness. The microstructure, as examined at 200 X magnification on a suitably etched specimen, shall be free from grain boundary carbides and intermetallic phases.

**EXTENT OF TESTING**
Tensile test and micrographic examination for each melt and heat treatment load.

**TEST SAMPLING**
For castings with weight 250 kg and above the test coupons shall be integrally cast.

**NON DESTRUCTIVE EXAMINATION (NDE)**
- Liquid penetrant examination:
  Supplementary requirement S3 shall apply to all accessible surfaces of all castings.
  The acceptance criteria shall be ASME VIII, Div.1, Appendix 7.
- Radiographic examination (RT):
  Supplementary requirement S2 shall apply to:
  - Critical areas as per ANSI B 16.34 of the pilot cast of each pattern.
  - Class 600 and 900 psi; all butt weld ends.
  - Class 1500 psi and above; all critical areas to ANSI B 16.34.
  The acceptance criteria shall be ASME VIII, Div. 1, Appendix 7.

**SURFACE FINISH**
White pickled and passivated. Shall be carried out after any blasting.

**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 and this MDS.
- A cast plate shall be used for the test welding.
- A macro examination shall be carried out.
- Change of filler metal brand name require requalification.
All casting with major repairs shall be given a solution heat treatment after welding.

**CERTIFICATION**
EN 10 204 Type 3.1B
# MATERIAL DATA SHEET

**MDS P01, Rev. 1**

## TYPE OF MATERIAL:
Glassfibre Reinforced Plastics (GRP)

<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>

## 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.

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

## RESIN/HARDENER TYPE
Preferred resins are bisphenol A epoxies with aromatic or cycloaliphatic curing agents or vinylester.

## 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.

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

- **Pressure 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:**

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 (Tg) 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.

**Chemical Resistance.** *(Delete section 2.2.5 and replace with)*: 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 Tg1 (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.

<table>
<thead>
<tr>
<th>ELECTRIC CONDUCTIVITY</th>
<th>If conductive components are specified, the conductivity in the structural layers shall not be accomplished by adding carbon black to the resin.</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRODUCTION TESTING</td>
<td>Production testing shall be performed according to UKOOA document, Part 2, Chapter 4 with the following additional requirements.</td>
</tr>
<tr>
<td></td>
<td><strong>Hydrostatic Mill Test</strong> (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.</td>
</tr>
<tr>
<td></td>
<td><strong>Degree of Cure</strong> (Section 4.3.2, Add following sentences after last paragraph):</td>
</tr>
<tr>
<td></td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td>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.</td>
</tr>
<tr>
<td>FLANGES</td>
<td>Allowable bolt torque and flange mis-alignment shall be defined by manufacturer.</td>
</tr>
<tr>
<td>NDT/VISUAL TESTING</td>
<td>According to UKOOA, Part 4 or BS 7159.</td>
</tr>
<tr>
<td>CERTIFICATION</td>
<td>EN 10 204 Type 3.1B containing:</td>
</tr>
<tr>
<td></td>
<td>- Hydrostatic mill test</td>
</tr>
<tr>
<td></td>
<td>- Degree of cure</td>
</tr>
<tr>
<td></td>
<td>- Short time failure pressure</td>
</tr>
<tr>
<td></td>
<td>- Glass content</td>
</tr>
<tr>
<td></td>
<td>- Visual inspection</td>
</tr>
<tr>
<td></td>
<td>- Wall thickness</td>
</tr>
<tr>
<td></td>
<td>- Resistivity (If conductive pipe is specified)</td>
</tr>
</tbody>
</table>
MATERIAL DATA SHEET

MDS - R11, Rev. 1

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>

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.

MANUFACTURING PROCESS
The steel melt shall be refined by AOD or equivalent treatment.

HEAT TREATMENT/
DELIVERY CONDITION

CHEMICAL COMPOSITION

TENSILE TESTING

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 be with the surfaces in the as-delivered condition. The test shall expose the external and internal surface and a cross section surface in full wall thickness. No pitting is acceptable at internal and external surfaces at 20 X magnification. The weight loss shall be < 4,0 g/m².

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

TEST SAMPLING

NON DESTRUCTIVE TESTING

SURFACE FINISH
White pickled.

REPAIR OF DEFECTS
Weld repair is not acceptable.

CERTIFICATION
EN 10 204 Type 3.1B
MATERIAL DATA SHEET
MDS - R12, Rev. 1

**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</td>
<td>Class 1, 3 and 5.</td>
<td>S3</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>

**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.

**MANUFACTURING PROCESS**
Steel making in electric furnace with AOD or equivalent refining.

**HEAT TREATMENT/Delivery Condition**
Post weld solution annealing is not required of pipes manufactured out of solution annealed plate material as stated in chapter 5.3.2.2 of A 358.

**CHEMICAL COMPOSITION**

**TENSILE TESTING**

**HARDNESS**

**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 be with the surfaces in the as-delivered condition. The test shall expose the external and internal surface and a cross section surface including weld zone in full wall thickness. No pitting is acceptable at internal and external surfaces at 20 X magnification. The weight loss shall be < 4,0 g/m².

**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.

**TEST SAMPLING**

**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.

**NON DESTRUCTIVE TESTING**
Eddy current examination according to ASTM A 450 is acceptable as replacement for radiography for wall thicknesses less than 4.0 mm. Supplementary requirement S3, penetrant examination, shall apply according to ASME V Article 6, to the weld area of 10 % of the pipes. Acceptance criteria shall be to ASME VIII Div. 1 Appendix 8.

**SURFACE FINISH**
White pickled.

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

**CERTIFICATION**
EN 10 204 Type 3.1B
MATERIAL DATA SHEET
MDS - R13, Rev. 1

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>

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.

MANUFACTURING PROCESS
Steel making in electric furnace with AOD or equivalent refining.

HEAT TREATMENT/DELIVERY CONDITION

CHEMICAL COMPOSITION

TENSILE TESTING

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 be with the surfaces in the as-delivered condition. The test shall expose the external and internal surfaces and a cross section surface including weld zone in full wall thickness. No pitting is acceptable at internal and external surfaces at 20 X magnification. The weight loss shall be < 4,0 g/m².

EXTENT OF TESTING
Corrosion testing shall be performed for each type, size, wall thickness, heat of material and heat treatment load.

TEST SAMPLING

WELDING
The weld repair 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.

DIMENSIONAL TOLERANCES
Fittings with reference to MSS-SP-75 shall have maximum wall thickness under tolerance of 0,3 mm.

NON DESTRUCTIVE TESTING
Supplementary requirement S7, liquid penetrant examination, shall apply to the weld area at 10 % of all fittings above NPS 2. The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 8.

SURFACE FINISH
White pickled.

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

CERTIFICATION
EN 10 204 Type 3.1B
### MATERIAL DATA SHEET

**MDS - R14, Rev. 1**

**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>Forgings</td>
<td>ASTM A 182</td>
<td>F44</td>
<td>-</td>
<td>S5</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>

**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.

**MANUFACTURING PROCESS**
The steel melt shall be refined with AOD or equivalent. The Hot Isostatic Pressed (HIP) process is an acceptable alternative to forging.

**HEAT TREATMENT/DELIVERY CONDITION**

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

**TENSILE TESTING**

**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 be with the surface in the as-delivered condition. Test samples shall be taken from the thickest part of the product. For products with NPS <= 4 the samples shall cover external/internal surface and full wall section. For products with NPS > 4 the samples shall cover at least one external/internal surface and a cross section to the mid-thickness. No pitting is acceptable at internal and external surfaces at 20 X magnification. The weight loss shall be < 4.0 g/m².

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

**TEST SAMPLING**
For open die and ring rolled products all test samples shall be taken from a rough forging or prolongation of the part. Separate test specimens is acceptable for products made by the HIP process.

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

**NON DESTRUCTIVE TESTING**
Supplementary requirement S5, liquid penetrant examination, shall apply to 10 % of all fittings above NPS 2. The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 8.

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

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

**CERTIFICATION**
EN 10 204 Type 3.1B
**MATERIAL DATA SHEET**
**MDS - R15, Rev. 1**

**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>Plates</td>
<td>ASTM A 240</td>
<td>UNS S31254, UNS N08367, UNS N08925, UNS N08926</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**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.

**MANUFACTURING PROCESS**
The steel melt shall be refined with AOD or equivalent.

**HEAT TREATMENT/ DELIVERY CONDITION**

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

**TENSILE TESTING**

**HARDNESS**

**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 be with the surfaces in the as-delivered condition. The test shall expose the external and internal surface and a cross section surface in full wall thickness. No pitting is acceptable internal and external surfaces at 20 X magnification. The weight loss shall be < 4.0 g/m².

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

**TEST SAMPLING**

**NON DESTRUCTIVE TESTING**

**SURFACE FINISH**
White pickled.

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

**CERTIFICATION**
EN 10 204 Type 3.1B
### MATERIAL DATA SHEET

**MDS - R16, Rev. 1**

**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>Castings</td>
<td>ASTM A 351</td>
<td>CK-3MCuN CN-3MN</td>
<td>-</td>
<td>S5, S6</td>
</tr>
</tbody>
</table>

**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.

**MANUFACTURING PROCESS**
The steel melt shall be refined with AOD or equivalent process. Remelting of AOD or VOD steel in an electric furnace is acceptable.

**HEAT TREATMENT/DELIVERY CONDITION**
Solution annealed at temperature $\geq 1225 \, ^\circ C$.

**CHEMICAL COMPOSITION**
P $\leq 0.030 \%$

**TENSILE TESTING**
Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 $^\circ C$ and the exposure time 24 hours. Test specimens shall be with the surfaces in the as-delivered condition. The test shall expose the external and internal surface and a cross section surface in full wall thickness. No pitting is acceptable at internal and external surfaces at 20 X magnification. The weight loss shall be $< 4.0 \, g/m^2$.

**EXTENT OF TESTING**
Tensile test and corrosion test for each melt and heat treatment load. The test blocks shall be heat treated with the castings they represents.

**TEST SAMPLING**
For castings with weight 250 kg and above the test coupons shall be integrally cast.

**NON DESTRUCTIVE TESTING**
*Liquid penetrant examination:* Supplementary requirement S6 shall apply to all accessible surfaces of all castings in machined condition. The acceptance criteria shall be ASME VIII, Div.1, Appendix 7.
*Radiographic examination:* Supplementary requirement S5 shall apply to:
- critical areas as per ANSI B 16.34 of the pilot cast of each pattern
- Class 600 and 900 psi; all butt weld ends
- Class 1500 psi and above; all critical areas to ANSI B16.34. The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 7.

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

**REPAIR OF DEFECTS**
Repair welding shall be carried out with Ni-based consumables with alloying content: Mo $\geq 8.0 \%$; Cr $\geq 15.0 \%$; (Mo + Cr) $\geq 28 \%$; C $\leq 0.030 \%$; S $\leq 0.015 \%$; Nb $< 0.5 \%$. 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 of filler metal brand name require requalification.
All casting with major repairs shall be given a solution heat treatment after welding.

**CERTIFICATION**
EN 10 204 Type 3.1B
## MATERIAL DATA SHEET

**MDS - R17, Rev. 1**

### 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>Bars</td>
<td>ASTM A 276</td>
<td>UNS S31254, UNS N08367, UNS N08925, UNS N08926</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

### 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.

### MANUFACTURING PROCESS

### HEAT TREATMENT/DELIVERY CONDITION

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

### TENSILE 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 be with the surfaces in the as-delivered condition. The test shall expose the external and internal surface and a cross section surface in full wall thickness. No pitting is acceptable at internal and external surfaces at 20 X magnification. The weight loss shall be < 4.0 g/m².

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

### TEST SAMPLING

### NON Destructive TESTING

### SURFACE FINISH
Finished product shall be white pickled.

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

### CERTIFICATION
EN 10 204 Type 3.1B
**MATERIAL DATA SHEET**

**MDS - R18, Rev. 1**

**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>Tubes</td>
<td>ASTM A 269</td>
<td>UNS S31254UNS N08367UNS N08925UNS N08926</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**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.

**MANUFACTURING PROCESS**
The steel melt shall be refined by AOD or equivalent treatment.

**HEAT TREATMENT/DELIVERY CONDITION**

**CHEMICAL COMPOSITION**

**TENSILE 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 be with the surfaces in an as-delivered condition. The specimen shall include the full wall thickness. No pitting is acceptable at internal and external surfaces at 20 X magnification. The weight loss shall be < 4.0 g/m².

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

**TEST SAMPLING**

**FORMING**

**NON DESTRUCTIVE TESTING**

**SURFACE FINISH**
White pickled.

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

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

MDS - S01, Rev. 1

TYPE OF MATERIAL:
Austenitic Stainless Steel, Type 316

<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 Welded pipesSeaml. &amp; welded pipesForgingsPlates</td>
<td>ASTM A 403</td>
<td>WP 316</td>
<td>W/S/WX</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>ASTM A 358</td>
<td>316</td>
<td>Class 1, 3, 4 or 5</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>ASTM A 312</td>
<td>TP 316</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>ASTM A 182</td>
<td>F 316</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>ASTM A 240</td>
<td>316</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

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.

MANUFACTURING PROCESS

HEAT TREATMENT/DELIVERY CONDITION

CHEMICAL COMPOSITION
C $\leq 0.035\%$

Plates to A 240:
S $\leq 0.015\%$

TENSILE TESTING
Grade 316L with Rp_{0.2}$\geq 205$ MPa and Rm$\geq 515$ MPa is acceptable.

EXTENT OF TESTING

TEST SAMPLING

FORMING

WELDING

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

NONDESTRUCTIVE TESTING
Pipes to A 358:
Eddy current examination according to ASTM A 450 is acceptable as replacement for radiography for wall thicknesses less than 4.0 mm.

SURFACE FINISH
White pickled except for machined surfaces.

REPAIR OF DEFECTS
Weld repair of base material is not acceptable

CERTIFICATION
EN 10 204 Type 3.1B
## MATERIAL DATA SHEET

**MDS - S02, Rev. 1**

### TYPE OF MATERIAL:
Austenitic Stainless Steel Castings

<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 351</td>
<td>CF8M</td>
<td>- -</td>
<td>S5, S6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CF3M</td>
<td></td>
<td>S5, S6</td>
</tr>
</tbody>
</table>

### 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.

### MANUFACTURING PROCESS

### HEAT TREATMENT/DELIVERY CONDITION

### CHEMICAL COMPOSITION

### TENSILE TESTING
**Extent of Testing**
Tensile test for each melt and heat treatment load. The test blocks shall be heat treated with the castings they represents.

**Test Sampling**
For castings with weight 250 kg and above the test coupons shall be integrally cast.

### NON DESTRUCTIVE TESTING

- **Liquid penetrant examination:**
  Supplementary requirement S6 shall apply to 10 % of castings with pressure rating 150/300 psi and 100 % to castings with pressure rating 600 psi and above. All accessible surfaces of the given percentage or minimum two off, of the castings from the same pattern and batch shall be examined.
  The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 7.

- **Radiographic examination:**
  Supplementary requirement S5 shall apply to:
  - critical areas as per ANSI B 16.34 of the pilot cast of each pattern- Class 600 and 900 psi; all butt welds
  - Class 1500 psi and above; all critical areas to ANSI B16.34.
  The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 7.

### SURFACE FINISH

### REPAIR OF DEFECTS

### CERTIFICATION
EN 10 204 Type 3.1B
## TYPE OF MATERIAL:
Titanium Grade 2

<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>Pipes</td>
<td>ASTM B 337</td>
<td>2</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Wrought fittings</td>
<td>ASTM B 363</td>
<td>WPT2/WPT2W</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Forgings</td>
<td>ASTM B 381</td>
<td>F</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Plates</td>
<td>ASTM B 265</td>
<td>2</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Bars</td>
<td>ASTM B 348</td>
<td>2</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Tubes</td>
<td>ASTM B 338</td>
<td>2</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

### 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.

### MANUFACTURING PROCESS

#### HEAT TREATMENT/DELIVERY CONDITION

- **All products:** Shall be supplied in annealed condition.
- **Welded products:** Acceptable as welded from annealed plates.

### CHEMICAL COMPOSITION

### TENSILE TESTING

#### EXTENT OF TESTING

Forgings to B 381:
Tensile test specimen shall be taken from each lot. A lot is defined as all products of the same nominal size and wall thickness produced from the same heat and subject to the same finishing operation.

### TEST SAMPLING

### WELDING

- **Welded pipes to B 337:** Welding procedures shall be qualified in accordance with ASME IX.

### DIMENSIONAL TOLERANCE

- **Flanges to B 381:** Flanges to MSS SP
  - 44

  shall have maximum wall thickness under tolerance of 0.3 mm at the welding end.

### NON DESTRUCTIVE TESTING

- **Pipes to B 337:** Eddy current examination according to ASTM A 450 is acceptable as replacement for radiography for welded pipes with wall thickness less than 4.0 mm.

### SURFACE FINISH

### REPAIR OF DEFECTS

### CERTIFICATION

EN 10 204 Type 3.1B
MATERIAL DATA SHEET

MDS - T02, Rev. 1

TYPE OF MATERIAL:
Titanium Grade 2

<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 B 367</td>
<td>C2</td>
<td>-</td>
<td>S1, S2</td>
</tr>
</tbody>
</table>

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.

MANUFACTURING PROCESS

HEAT TREATMENT/DELIVERY CONDITION

CHEMICAL COMPOSITION

TENSILE TESTING

EXTENT OF TESTING
For castings with weight 250 kg and above the test coupons shall be integrally cast.

TEST SAMPLING

NON DESTRUCTIVE TESTING
Liquid penetrant examination:
Supplementary requirement S2 shall apply to all accessible surfaces of all castings.
The acceptance criteria shall be to ANSI B16.34 except no cracks are acceptable.
Radiographic examination:
Supplementary requirement S5 shall apply to:
- critical areas as per ANSI B 16.34 of the pilot cast of each pattern
- Class 600 and 900 psi; all butt welds
- Class 1500 psi and above; all critical areas to ANSI B16.34.
The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 7.

SURFACE FINISH

REPAIR OF DEFECTS

CERTIFICATION
EN 10 204 Type 3.1B
### MATERIAL DATA SHEET

**MDS - X02, Rev. 1**

#### TYPE OF MATERIAL:
High Strength Low Alloy Steel

<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 788</td>
<td>AISI 4140</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### 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.

#### MANUFACTURING PROCESS
Forgings to be finished hot-worked.

#### HEAT TREATMENT/DELIVERY CONDITION
Forgings shall be austenitised, liquid quenched and tempered.

#### CHEMICAL COMPOSITION
According to ASTM A 29, AISI 4140.

#### TENSILE TESTING
- Minimum yield strength: $R_{y} \geq 620$ Mpa
- Minimum tensile strength: $R_{m} \geq 850$ Mpa
- Minimum elongation: $A_{5} \geq 15\%$

#### HARDNESS

#### IMPACT TESTING
Charpy V-notch testing is required according to ASTM A 370 at -30 °C. The notch shall be perpendicular to the surface. Acceptable absorbed energy values:
- Min. average of 3 specimens: 42 Joules; specimen size 10x10mm
- Min. single value: 30 Joules

#### EXTENT OF TESTING
One set of tensile and impact tests shall be taken from each melt, section thickness ± 25 % and heat treatment load.

#### TEST SAMPLING
According to ASTM A 350.

#### NON DESTRUCTIVE TESTING
Supplementary requirement S18, magnetic particle examination, shall apply to 10 % of all forgings.

#### SURFACE FINISH

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

#### CERTIFICATION
EN 10 204 Type 3.1B
### MATERIAL DATA SHEET

**MDS - X03, Rev. 1**

#### TYPE OF MATERIAL:
High Strength Low Alloy Steel

<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, 2D</td>
<td>-</td>
<td>S4, S5</td>
</tr>
</tbody>
</table>

#### 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.

#### HEAT TREATMENT/DELIVERY CONDITION

#### HARDNESS

**IMPACT TESTING**
Charpy V-notch testing is required according to ASTM A 370 at -30 °C. The notch shall be perpendicular to the surface. Acceptable absorbed energy values:
- Min. average of 3 specimens: 42 Joules; specimen size 10x10mm
- Min. single value: 30 Joules

**EXTENT OF TESTING**
One set of tensile and impact tests shall be carried out for each heat and heat treatment load.

**TEST SAMPLING**
For castings with weight 250 kg and above the test coupons shall be integrally cast with the casting. All test blocks shall be heat treated together with the casting they represent.

**NON DESTRUCTIVE TESTING**
The testing shall be carried out after final heat treatment, including PWHT after repair. Radiography may be carried out prior to PWHT.
- Magnetic Particle Examination: 100 % according to ASME VIII, Div. 1, Appendix 7.
- Radiographic examination:
  - Critical sections, as defined by ANSI B16.34 shall be 100 % tested on the first two castings of each pattern. Provided these two castings fulfil the requirements, radiography may be omitted on the rest of the castings of the same pattern. Otherwise, radiography shall be carried out until 2 successive castings satisfy the specified requirements. All butt weld ends shall be 100 % tested. The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 7.

**REPAIR OF DEFECTS**
All weld repairs shall be post weld heat treated. The repair welding procedure qualification shall include the following:
- qualified on a casting of the same material grade.
- one set of impact tests, 3 specimens, shall be taken from weld metal, fusion line.

**CERTIFICATION**
EN 10 204 Type 3.1B