PDHonline Course M184 (3 PDH)

Material Data Sheets for the Construction of Piping Systems

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NORSOK STANDARD M-630

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Material data sheets for piping

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Foreword

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

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 Subject to development and publication of international standards, the relevant NORSOK standard will be withdrawn.

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

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

Introduction

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

MINOR DEVIATIONS FROM ASME B31.1 CODE REQUIREMENTS

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

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

In general, the MDS have supplementary requirement beyond the ASTM standard to ensure a proper safety level.

1 Scope

This standard includes material requirement in a collection of Piping Material Data Sheets (MDS) for use in piping systems, selected according to NORSOK L-001, Piping and Valves.

2 Normative references

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

3 Definitions

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

3.1.2
carbon steel type 235
carbon steel with SMYS ≥ 220MPa and not impact tested

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

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

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

3.1.6
MDS
material data sheet

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

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

3.1.9
SMYS
specified minimum yield strength

3.1.10
stainless steel type 316
alloys with approx. 2.5 % Mo of type AISI 316

3.1.11
stainless steel type 6Mo
alloys with 6 % Mo and PRE > 40

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

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

4 Collection of material data sheets

4.1 General

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

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

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

The actual types of materials covered are as follow:

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

Note: Welded products according to MDS D42, D43, D52, D53, R12, R13, S01 and T01 have acceptance classes which give welding factors 0.8 and 1.0. The correct class is specified on the piping class sheet. The order shall include acceptable classes

Table 1 – Material Selection Menu for Piping Systems

Product	Carbon steel Type 235 [1)]	Carbon steel Type 235LT impact tested	Carbon steel Type 360LT impact tested	Stainless steel Type 316	Stainless steel Type 22Cr Duplex	Stainless steel Type 25Cr Duplex	Stainless steel Type 6Mo[2)]	Cu/Ni 90/10 and other copper alloys	Nickel alloy	Titanium Grade 2 [3)]	High strength low alloyed steel
Pipes Seamless	A106 Grade B	A333 Grade 6	API 5L Grade X52	A312 Grade TP 316	A790 UNS S31803	A790 UNS S32550, UNS S32750, UNS S32760	A312 UNS S31354, UNS N08367, UNS N08925, UNS N08926	B466 UNS C 70600	B705 UNS UNS N06625	B861 Gr 2	A519 AISI 4130
Pipes Welded	API 5L Grade B ASTM A672 CC60, CC70 Class 12, 22	A671 Grade CC60, CC70 Class 12, 22	A671 Grade CC70 Class 12, 22	A312 Grade TP316 A358 Grade 316 Class 1, 3, 4	A928 UNS S31803 Class 1, 3, 5	A928 UNS S32550, UNS S32750, UNS S32760, Class 1, 3 and 5	A358 UNS S31254, UNS N08367, UNS N08925, UNS N08926 Class 1, 3, 5	B467 UNS C 70600	B705 UNS UNS N06625	B862 Gr 2	
Fittings	A234 Grade WPB	A420 Grade WPL 6	A860 Grade WPHY 52	A403 Grade WP 316 Class S, W, WX	A815 UNS S31803 Class S, W, WX	A815 UNS S32550, UNS S32750, UNS S32760, Class S, W, WX	A403 WP S31254, UNS N08367, UNS N08925, UNS N08926 Class S, W, WX	- UNS C 70600	B366 UNS UNS N06625	B363 Grade WPT2 / WPT2W	A234 AISI 4130
Forgings	A105	A350 Grade LF2	A694 Grade F52	A182 Grade F316	A182 Grade F51	A182 UNS S32550, F53 (UNS S32750), F55 (UNS S32760)	A182 Grade F44, UNS N08367, UNS N08925, UNS N08926	- UNS C 70600	B564 UNS UNS N06625	B381 Grade F2	ASTM A 788 AISI 4140 API 6A 60K (AISI 4130) A182 F22
Plate	A516 Grade 60, 70	A516 Grade 70	A516 Grade 70,	A240 Grade 316	A240 UNS S31803	A240 UNS S32550, UNS S32750, UNS S 32760	A 240 UNS S31254, UNS N08367, UNS N08925, UNS N08926	B171 UNS C 70600	B443 UNS UNS N06625	B265 Grade 2	

Castings	A216 Grade WCB	A352 Grade LCC	A352 Grade LCC	A351 Grade CF8M or CF3M	A890 UNS Grade 4 (J92205)	A890 UNS J93404, UNS J93380	A 351 CK-3MCuN, CN-3MN	B148 UNS C 95800	B494 Grade CW-6MC (UNS N06625) Grade CX2MW (UNS N26022)	B367 Grade C2	ASTM A 487 Gr 2B ASTM A 487 Gr 2B (÷46°C)
Bars					A276 UNS S 31803	A276 UNS S 32550 UNS S 32750 UNS S 32960	A276 UNS S 31259 UNS N08367 UNS N08925 UNS N08926		B446 UNS N06625	B348 Gr 2	
Tubes				A269 316	A789 UNS S 31803	A789 UNS S32550 UNS S 32750 UNS S 32760	A269 UNS S 31259 UNS N08367 UNS N08925 UNS N08926		B444 UNS N06625	B338 Gr 2	

NOTE 1) Type 235 should be used in piping systems with minimum design temperature above or equal to -15 $^{\circ}$C and thicknesses less than approx.15 mm.
NOTE 2) The grades UNS N08367, N08925 and N08926 are considered equivalent to UNS S31254. The grade CN-3 MN is considered equivalent to CK-3MCuN.
NOTE 3) GOST VT-1-0 is considered equivalent.

4.2 Referenced Standards and Corresponding MDS

MDS No.	Rev. No.	Standard and Grade (Note 1)	Products
		Carbon Steel Type 235	
C01	2	A 106 Grade B (1995)	Seamless pipes
C01	2	API 5L Grade B (1995)	Welded pipes
C01	2	A 672 Grade CC60,CC70 (1994)	Welded pipes
C01	2	A 234 Grade WPB (1996)	Wrought fittings
C01	2	A 105 (1995)	Forgings
C01	2	A 516 Grade 60 (1990)	Plates
C02	2	A 216 Grade WCB (1993)	Castings
		Carbon Steel Type 235LT	
C11	2	A 333 Grade 6 (1994)	Seamless pipes
C11	2	A 671 Grade CC60, CC70 (1994)	Welded pipes
C11	2	A 420 Grade WPL 6 (1996)	Wrought fittings
C11	2	A 350 Grade LF 2 (1996)	Forgings
C11	2	A 516 Grade 70 (1990)	Plates
C12	2	A 352 Grade LCC (1993)	Castings
		Carbon Steel Type 360LT	
C21	2	A 694 Grade 52 (1995)	Forgings
C21	2	A 860 WPHY 52 (1996)	Wrought fittings
C22	2	API 5L Grade X52 (1995)	Seamless pipes
		Ferritic/Austenitic Stainless Steel Type 22Cr Duplex	
D41	2	A 790 UNS S31803 (1995)	Seamless pipes
D42	2	A 928 UNS S31803 (1994)	Welded pipes
D43	2	A 815 UNS S31803 (1996)	Wrought fittings
D44	2	A 182 Grade F51 (1996)	Forgings
D45	2	A 240 UNS S31803 (1996)	Plates
D46	2	A 890 Grade 4 (UNS J92205) (1994)	Castings
D47	2	A 276 UNS S31803 (1996)	Bars
D48	2	A 789 UNS S31803 (1994)	Tubes
		Ferritic/Austenitic Stainless Steel Type 25Cr Duplex	
D51	2	A 790 UNS S32550 (1995) A 790 UNS S32750 (1995) A 790 UNS S32760 (1995)	Seamless pipes
D52	2	A 928 UNS S32550 (1994)	Welded pipes

MDS No.	Rev. No.	Standard and Grade	Products
		A 928 UNS S32750 (1994)	
D53	2	A 928 UNS S32760 (1994)	Wrought fittings
		A 815 UNS S32550 (1996)	
		A 815 UNS S32750 (1996)	
		A 815 UNS S32760 (1996)	
D54	2	A 182 UNS S32550 (1996)	Forgings
		A 182 Grade F53 (UNS S32750) (1996)	
		A 182 Grade F55 (UNS S32760) (1996)	
D55	2	A 240 UNS S32550 (1996)	Plates
		A 240 UNS S32750 (1996)	
		A 240 UNS S32760 (1996)	
D56	2	A 890 UNS J93380 (1994)	Castings
		A 890 UNS J93404 (1994)	
D57	2	A 276 UNS S32550 (1996)	Bars
		A 276 UNS S32750 (1996)	
		A 276 UNS S32760 (1996)	
D58	1	A 789 UNS S32550 (1995)	Tubes
		A 789 UNS S32750 (1995)	
		A 789 UNS S32760 (1995)	
		Copper/Nickel 90/10	
K01	1	B 466 UNS C 70600 (1992)	Seaml. pipes & tubes
		B 467 UNS C 70600 (1988)	Welded pipes
		B 151 UNS C 70600 (1994)	Rod & bar
		B 171 UNS C 70600 (1995)	Plates & sheets
		- UNS C 70600 (1995)	Fittings
		- UNS C 70600 (1995)	Flanges
		Aluminium - Bronze Sand Castings	
K02	1	B 148 UNS C 9580 (1993)	Castings
		Nickel Alloy Type 625	
N01	2	B 366 UNS N06625 (1996)	Wrought fittings
N01	2	B 705 UNS N06625 (1995)	Pipes
N01	2	B 564 UNS N06625 (1996)	Forgings
N01	2	B 443 UNS N06625 (1993)	Plates
N01	2	B 446 UNS N06625 (1993)	Bars
N01	2	B 444 UNS N06625 (1995)	Pipes and tubes
N02	2	A 494 Grade CW-6MC (1993)	Castings
N02	2	A 494 Grade CX 2MW (1993)	
		Polymers including fibre reinforced	
P01	1	UK00A	GRP pipes and fittings
P11	1	Hudrogenated Nitrile (HNBR)	O-ring
P12	1	Fluorocarbon terpolymer (FKM)	O-ring
P13	1	Fluorocarbon low T terpolymer (FKM GLT)	O-ring
P14	1	Nitrile	O-ring
P21	1	PEEK (Poly-ether-ether-ketone)	Back-up rings and seal inserts
P22	1	PTFE (Poly-tetra-fluoro-ethylene)	Lipseals,back-up rings and seal inserts
P23	1	PEEK (Poly-ether-ether-ketone) with PTFE added	Seal inserts

		Austenitic Stainless Steel Type 6Mo	
R11	2	A 312 UNS S31254 (1995)	Seamless pipes
R12	2	A 358 UNS S31254 (1995)	Welded pipes
R13	2	A 403 UNS S31254 (1996)	Wrought fittings
R14	2	A 182 Grade F44 (1996)	Forgings
R15	2	A 240 UNS S31254 (1996)	Plates
R16	2	A 351 Grade CK-3McuN (1994)	Castings
R17	2	A 276 UNS S31254 (1996)	Bars
R18	2	A 269 UNS S 31254 (1996)	Tubes
		Austenitic Stainless Steel Type 316	
S01	2	A 312 Grade TP 316 (1995)	Seamless & welded pipes
S01	2	A 358 Grade 316 (1995)	Welded pipes
S01	2	A 403 Grade WP 316 (1996)	Wrought fittings
S01	2	A 182 Grade F 316 (1996)	Forgings
S01	2	A 240 Grade 316 (1996)	Plates
S02	2	A 351 Grade CF8M (1994)	Castings
S02	2	A 351 Grade CF3M (1994)	Castings
		Titanium Grade 2	
T01	2	B 861 Grade 2 (1995)	Seamless pipes
T01	2	B 862 Grade 2 (1995)	Welded pipes
T01	2	B 363 Grade WPT2/WPT2W (1995)	Wrought fittings
T01	2	B 381 Grade F2 (1995)	Forgings
T01	2	B 265 Grade 2 (1995)	Plates
T01	2	B 348 Grade 2 (1995)	Bars
T01	2	B 338 Grade 2 (1995)	Tubes
T02	2	B 367 Grade C2 (1993)	Castings
		High Strength Low Alloy Steel	
X01	1	A 519 AISI 4130 (1994) A 234 AISI 4130 (1996)	Seamless pipes Wrought fittings (seamless)
X02	2	A 788 AISI 4140 (1994)	Forgings
X03	2	A 487 Grade 2B (1993)	Castings
X04	1	API 6A 60K (AISI 4130) (1996)	Forgings
X05	1	A 182 F22 (1996)	Forgings
X06	1	A 487 Grade 2B (-46 °C) (1993)	Castings

Note 1: The current year of issue of standards referenced is shown for guidance only. The latest year of issue shall be used unless otherwise specifically agreed.

MATERIAL DATA SHEET	**MDS - C01**			**Rev. 2**
TYPE OF MATERIAL: Carbon Steel Type 235				**Page 1 of 1**
PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Wrought fittings	ASTM A 234	WPB	-	-
Welded pipes	API 5L	B	-	-
	ASTM A 672	CC60, CC70	t ≤ 19 mm: Class 12	-
			t > 19 mm: Class 22	-
Seamless pipes	ASTM A 106	B	-	-
Forgings	ASTM A 105	-	-	-
Plates	ASTM A 516	60, 70	-	-

1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.	
2. MANUFACTURING PROCESS	*Welded pipes to API 5L:* Electric resistance welded pipes are not acceptable.	
2. HEAT TREATMENT	*Welded pipes to API 5L:* Stress relieving when the nominal thickness t ≥ 19 mm.	
3. CHEMICAL COMPOSITION	C ≤ 0.22 %; Si ≥ 0.10 %; Mn = 0.50 - 1.35%; S ≤ 0.025 %; P ≤ 0.030 %; CE = C + Mn/6 + 0.04 ≤ 0.43.	
4. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual component.	
5.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.
6. NON DESTRUCTIVE TESTING	*Pipes to API 5L*:	RT of weld seam or RT at ends and US/Eddy Current of the remaining weld.
	Fittings to A 234:	UT is not acceptable as replacement of RT.
7. CERTIFICATION	EN 10 204 Type 3.1B	

MATERIAL DATA SHEET	**MDS - C02**			**Rev. 2**
TYPE OF MATERIAL: Carbon Steel Type 235				**Page 1 of 1**
PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Castings	ASTM A 216	WCB	-	S4, S5

1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.
2. CHEMICAL COMPOSITION	C ≤ 0.22 % and CE = C + Mn/6 + 0.04 ≤ 0.43 for castings with butt weld ends.
3. EXTENT OF TESTING	One set of tensile test is required for each melt and heat treatment load.
4. TEST SAMPLING	Samples for mechanical testing shall realistically reflect the properties in the actual components. For castings with weight 250 kg and above the test blocks shall be integrally cast with the casting. The test blocks shall be heat treated together with the castings they represents.
5. NON DESTRUCTIVE TESTING	*Magnetic particle testing:* Supplementary requirement S4 shall apply to all accessible surfaces of all castings. The examination shall be carried out after final machining.The acceptance criterias shall be ASME VIII, Div.1, Appendix 7. *Radiographic testing:* Supplementary requirement S5 shall apply to: - Critical areas as per ANSI B16.34 of the pilot cast of each pattern - All butt weld ends of each casting. - Class 1500 psi and above; all critical areas according to ANSI B16.34 of each casting. The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 7.
6. CERTIFICATION	EN 10 204 Type 3.1B.

MATERIAL DATA SHEET MDS - C11 Rev. 2

TYPE OF MATERIAL: Carbon Steel Type 235LT

PRODUCT	*STANDARD*	*GRADE*	*ACCEPT. CLASS*	*SUPPL. REQ.*
Wrought fittings	ASTM A 420	WPL 6	-	*S2*,S4
Welded pipes	ASTM A 671	CC60, CC70	t ≤ 19 mm: Class 12	S2, S7
			t > 19 mm: Class 22	S2, S7
Seamless pipes	ASTM A 333	6	-	-
Forgings	ASTM A 350	LF2	Class 1	S7
Plates	ASTM A 516	70		S5

1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.
2. CHEMICAL COMPOSITION	C ≤ 0.22 %; Mn = 0.50 - 1.35 %; S ≤ 0.025 %; P ≤ 0.030 %; CE = C + Mn/6 + 0.04 ≤ 0.43.
3. IMPACT TESTING	Charpy V-notch testing at - 46°C is required for the thicknesses ≥ 6 mm. For flanges apply the thickness at the weld neck. The minimum absorbed energy for full size specimens shall be 27 J average and 20 J single. Reduction factors for subsize specimens shall be: 7.5mm - 5/6 and 5 mm - 2/3.
4. EXTENT OF TESTING	*Fittings to A 420:* Supplementary requirement S2 shall apply. Impact testing shall be carried out to the same extent as tensile testing (S2). *Pipes to A 671:* Supplementary requirement S2 shall apply to the same extent as tensile testing. *Forgings to A 350:* One set of tensile and impact testing shall be carried out for each heat and heat treatment load. A test lot shall not exceed 2000 kg for forgings with as forged weight ≤ 50 kg, and 5000 kg for forgings with as forged weight > 50 kg.
5. TEST SAMPLING	*All products:* Samples for production testing shall realistically reflect the properties in the actual component. *Fittings to A 420:* Supplementary requirement S2 shall apply. *Forgings to A350:* Sketches shall be established showing type, size and location of test samples and extraction of test specimens.
6. DIMENSIONAL TOLERANCES	*Fittings to A 420:* Fittings with reference to MSS SP-75 shall have maximum wall thickness under tolerance of 0.3 mm in accordance with standard. *Flanges to A 350:* Flanges to MSS SP-44 shall have a maximum wall thickness under tolerance of 0.3 mm for the hub at the welding end.

MATERIAL DATA SHEET	**MDS - C11**			**Rev. 2**
TYPE OF MATERIAL: Carbon Steel Type 235LT				**Page 2 of 2**
PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Wrought fittings	ASTM A 420	WPL 6	-	*S2*,S4
Welded pipes	ASTM A 671	CC60, CC70	t ≤ 19 mm: Class 12	S2, S7
			t > 19 mm: Class 22	S2, S7
Seamless pipes	ASTM A 333	6	-	-
Forgings	ASTM A 350	LF2	*Class 1*	S7
Plates	ASTM A 516	70		S5

7. NON DESTRUCTIVE TESTING	*Fittings to A 420:* Ultrasonic testing is not acceptable as replacement of radiographic testing. Supplementary requirement S4, magnetic particle testing, shall apply to 10 % of all fittings (same test lot as defined for mechanical testing) for nominal thicknesses < 12.7mm and 100 % of all fittings for nominal thicknesses ≥ 12.7 mm. The testing shall be carried out after calibration. The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 6. *Forgings to A 350:* Supplementary Requirement S7.1, magnetic particle testing shall apply to 10 % of all forgings (same test lot as defined for mechanical testing) with NPS > 2. The testing shall be carried out after final machining. The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 6.
8. REPAIR OF DEFECTS	Weld repair of base material is not acceptable.
9. MARKING	Heat treatment load number shall be permanently marked on the component where testing is required per. heat treatment load.
10. CERTIFICATION	EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET MDS - C12 Rev. 2

TYPE OF MATERIAL: Carbon Steel Type 235LT **Page 1 of 1**

PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Castings	ASTM A 352	LCC	-	S4, S5

1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.
2. CHEMICAL COMPOSITION	$C \leq 0.22$ % ; $S \leq 0.025$ %; $P \leq 0.030$ %; $CE = C + Mn/6 + (Cr+Mo+V)/5 + (Cu+Ni)/15 \leq 0.43$
3. IMPACT TESTING	The minimum absorbed energy for full size specimens shall be 27 J average and 20 J single.
4. EXTENT OF TESTING	One set of tensile and impact test is required for each melt and heat treatment load. A test lot shall not exceed 5 000 kg.
5. TEST SAMPLING	Samples for mechanical testing shall realistically reflect the properties in the actual components. Thickness of the test block shall be equal to the thickness of the actual components as heat treated up to a maximum thickness of 100 mm. For flanged components the largest flange thickness apply. Test specimens shall be cut from the 1/4 T location from the surface where T is the thickness of the test block. Test block shall be integrally cast or gated onto the castings and shall not be removed from the castings until after the final quality heat treatment.
6. NON DESTRUCTIVE TESTING	*Magnetic Particle testing:* Supplementary requirement S4 shall apply to all accessible surfaces of all castings. The testing shall be carried out after final machining. The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 7. *Radiographic testing:* Supplementary requirement S5 shall apply to: - Critical areas as per ANSI B16.34 of the pilot cast of each pattern - All butt weld ends of each casting. - Class 1500 psi and above; all critical areas to ANSI B16.34 of each casting. The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 7.
7. REPAIR OF DEFECTS.	A cast plate shall be used in the qualification of the repair welding procedure.
8. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.
9. CERTIFICATION	EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium shall be stated in the certificate.

MATERIAL DATA SHEET MDS - C21 Rev. 2

TYPE OF MATERIAL: Carbon Steel Type 360LT

PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Wrought fittings Forgings	ASTM A 860 ASTM A 694	WPHY 52 F52	Seamless and welded -	

1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.
2. CHEMICAL COMPOSITION	C ≤ 0.20 %; Mn = 0.90 - 1.60 %; Si= 0.10-0.50 %; S ≤ 0.025 %; P ≤ 0.035 %; Ti ≤0.05 %; Nb ≤ 0.04 %; Al ≤ 0.06 %; N ≤ 0.015 %; V+Nb+Ti ≤ 0.10 %; V+Nb ≤ 0.07; CE = C + Mn/6 + (Cr+Mo+V)/5 + (Cu+Ni)/15 ≤ 0.43 .
3. IMPACT TESTING	Charpy V-notch testing according to ASTM A 370 at - 46 °C is required for the thicknesses ≥ 6 mm. The minimum absorbed energy for full size specimen shall be 40 J average and 30 J single. Reduction factors for subsize specimens shall be: 7.5 mm - 5/6 and 5 mm - 2/3.
4. EXTENT OF TESTING	*Forgings to A 694:* One set of tensile and impact testing shall be carried ou for each heat and heat treatment load. A test lot shall not exceed 2000 kg for forgings with as forged weigth ≤ 50 kg, and 5000 kg for forgings with as forged weigth > 50 kg.
5. TEST SAMPLING	*All products:* Samples for production testing shall realistically reflect the properties in the actual component. *Forgings to A694:* Test samples shall be from prolongations on actual components. Sacrificial forgings shall be used for die forged components. However, special agreements may be made for die forged components with as forged weight exceeding 50 kg. Test specimens shall be cut at the 1/4 T location from the surface where T is the thickness of the test samples as heat treated. Sketches shall be established showing type, size and location of test samples and extraction of test specimens.
6. WELDING	*Fittings to A 860:* The WPQ shall be qualified in accordance with ASME IX or EN 288-3.
7. DIMENSIONAL TOLERANCES	*Fittings to A 860:* Fittings with reference to MSS-SP-75 shall have maximum wall thickness under tolerance of 0.3 mm. Flanges to A 694: Flanges to MSS-SP-44 shall have a maximum wall thickness under tolerance of 0.3 mm for the hub at the welding end.
8. NON DESTRUCTIVE TESTING	*Fittings to A 860:* Supplementary requirement S4, magnetic particle testing, shall apply to 10 % of all fittings (same test lot as defined for mechanical testing) for nominal thicknesses < 12.7 mm and 100 % of all fittings for nominal thicknesses ≥ 12.7 mm. The testing shall be carried out after calibration. *Forgings to A 694:* 10 % of all forgings with NPS > 2 (same test lot as defiend for mechanical testing) shall be magnetic particle testing according to ASME V Article 7. The testing shall be carried out after final machining. *All products:* The acceptance criteria shall be to ASME VIII Div. 1, Appendix 6.

MATERIAL DATA SHEET	**MDS - C21**			**Rev. 2**
TYPE OF MATERIAL: Carbon Steel Type 360LT				**Page 2 of 2**
PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Wrought fittings Forgings	ASTM A 860 ASTM A 694	WPHY 52 F52	Seamless and welded -	
9. REPAIR OF DEFECTS	Weld repair of base material is not acceptable.			
10. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.			
11. CERTIFICATION	EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.			

MATERIAL DATA SHEET MDS - C22 Rev. 2

TYPE OF MATERIAL: Carbon Steel Type 360LT **Page 1 of 1**

PRODUCT	*STANDARD*	*GRADE*	*ACCEPT. CLASS*	*SUPPL. REQ.*
Seamless pipes	API 5L	X52	-	SR 4.3

1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.
2. STEEL MAKING	Fine grain treatment shall be carried out.
3. HEAT TREATMENT/ DELIVERY CONDITION	Normalised or Quenched and Tempered.
4. CHEMICAL COMPOSITION	C ≤ 0.16 %; Mn = 0.90 - 1.60 %; Si= 0.10-0.50 %; S ≤ 0.025 %; P ≤ 0.035 %; Ti ≤ 0.05 %; Nb ≤ 0.04 %; Al ≤ 0.06 %; N ≤ 0.015 %; V+Nb+Ti ≤ 0.10 %; V+Nb ≤ 0.07 %; CE = C + Mn/6 + (Cr+Mo+V)/5 + (Cu+Ni)/15 ≤ 0.43
5. 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.
6. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual component.
7. NON DESTRUCTIVE TESTING	Supplementary requirement SR 4.3 with notch calibration of 5 % of the nominal wall thickness shall apply for all thicknesses.
8. SURFACE FINISH	The surface finish shall comply with ASTM A 106 para. 18.3.2.
9. REPAIR OF DEFECTS	Weld repair is not acceptable.
10. CERTIFICATION	EN 10 204 Type 3.1B

MATERIAL DATA SHEET MDS - D41 Rev. 2

TYPE OF MATERIAL: Ferritic / Austenitic Stainless Steel, Type 22Cr duplex **Page 1 of 1**

PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Seamless pipes	ASTM A 790	UNS S 31803	-	-

1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.
2. QUALIFICATION	Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.
3. STEEL MAKING	The steel melt shall be refined with AOD or equivalent.
4. CHEMICAL COMPOSITION	N = 0.14 - 0.20 %
5. HARDNESS	The hardness shall be maximum 28 HRC or alternatively 271 HB or 290 HV10.
6. IMPACT TESTING	Charpy V-notch testing (3 specimens) according to ASTM A 370 at - 46 °C is required for the thicknesses ≥ 6 mm. The minimum absorbed energy shall be 45 J average / 35 J single. Reduction factors for subsize specimens shall be: 7.5 mm - 5/6 and 5 mm - 2/3.
7. MICROGRAPHIC EXAMINATION	The micrographic examination shall cover the near surfaces and mid-thickness region of the pipe. The ferrite content shall be determined according to ASTM E 562 or equivalent and shall be within 35-55 %. The microstructure, as examined at 400 X magnification on a suitably etched specimen, shall be free from intermetallic phases and precipitates.
8. EXTENT OF TESTING	Charpy V-notch impact, microstructure, hardness and tensile testing shall be carried out for each lot as defined in the referred standard. For batch furnace charges the specified tests shall be carried out for each heat treatment charge.
9. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual components.
10. SURFACE FINISH	White pickled.
11. REPAIR OF DEFECTS	Weld repair is not acceptable.
12. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.
13. CERTIFICATION	EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET MDS - D42 Rev. 2

TYPE OF MATERIAL: Ferritic/Austenitic Stainless Steel, Type 22Cr duplex **Page 1 of 2**

PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Welded pipes	ASTM A 928	UNS S31803	Class 1, 3 and 5	S3

1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.
2. QUALIFICATION	Manufacturers of product to this MDS shall comply with the requirement of NORSOK standard M-650.
3. STEEL MAKING	The steel melt shall be refined with AOD or equivalent.
4. HEAT TREATMENT	The pipes shall be solution annealed followed by water quenching.
5. CHEMICAL COMPOSITION	N = 0.14 - 0.20 %
6. TENSILE TESTING	Base material properties: $R_{p0.2} \geq 450$ MPa; $R_m \geq 620$ MPa; $A \geq 25$ %.
7. HARDNESS	The hardness shall be maximum 28 HRC or alternatively 271 HB or 290 HV10 for base material, HAZ and weld metal..
8. IMPACT TESTING	Charpy V-notch testing according to ASTM A 370 at - 46 °C is required for the thicknesses ≥ 6 mm. The minimum absorbed energy shall be 45 J average and 35 J single. Two sets, each 3 specimen, shall be carried out with notch located in weld metal and fusion line, respectively. Reduction factors for subsize specimens shall be: 7.5 mm - 5/6 and 5 mm - 2/3.
9. MICROGRAPHIC EXAMINATION	The micrographic examination shall cover the near surfaces and mid-thickness region of the pipe including the weld zone. The ferrite content shall be determined according to ASTM E 562 or equivalent and shall be within 35-55 % for base material and 25-60 % for weld metal. The microstructure, as examined at 400 X magnification on a suitably etched specimen, shall be free from intermetallic phases and precipitates.
10. EXTENT OF TESTING	Tensile test, impact test, hardness test and microstructure examination shall be carried out for each lot. The lot is defined as follows: - For batch furnace a lot is defined as maximum 60 m of pipe of the same heat, size and heat treatment charge. - For continuous heat treatment furnace the lot definition in para 8.1 of the ASTM standard apply
11. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual components.
12. WELDING	The PQR/WPAR shall be qualified in accordance with ASME IX or EN 288-3 and shall include the same examinations as for the production testing. The qualification shall be carried out on the same material grade (UNS number) as used in production. Change of specific make (brand name) of welding consumables requires requalification.
13. TOLERANCES	The pipes shall have a max. undertolerance of 0.3 mm.
14. NON DESTRUCTIVE TESTING	Eddy current testing according to ASTM A 450 is acceptable as replacement for spot radiography for wall thicknesses less than 4.0 mm. Supplementary requirement S3, penetrant testing, according to ASME V Article 6 shall apply to the weld area of 10 % of the pipes (same test lot as defined for mechanical testing) delivered. The testing shall be carried out after calibration and pickling. Acceptance criteria shall be to ASME VIII, Div. 1 Appendix 8.

MATERIAL DATA SHEET	**MDS - D42**			**Rev. 2**
TYPE OF MATERIAL: Ferritic/Austenitic Stainless Steel, Type 22Cr duplex				**Page 2 of 2**
PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Welded pipes	ASTM A 928	UNS S31803	Class 1, 3 and 5	S3

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

MATERIAL DATA SHEET	**MDS - D43**			**Rev. 2**
TYPE OF MATERIAL: Ferritic / Austenitic Stainless Steel, Type 22Cr duplex				**Page 1 of 2**
PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Wrought fittings	ASTM A 815	UNS S 31803	WP-W, WP-S or WP-WX	S7

1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.
2. QUALIFICATION	Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.
3. STEEL MAKING	The steel melt shall be refined with AOD or equivalent.
4. HEAT TREATMENT	The fittings shall be solution annealed followed by water quenching.
5. CHEMICAL COMPOSITION	N = 0.14 - 0.20 %
6. HARDNESS	The hardness shall be maximum 28 HRC or alternatively 271 HB or 290 HV10 for base material, HAZ and weld metal.
7. IMPACT TESTING	Charpy V-notch testing according to ASTM A 370 at - 46 °C is required for the thicknesses ≥ 6 mm. The minimum absorbed energy shall be 45 J 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.
8. MICROGRAPHIC EXAMINATION	The micrographic examination shall cover the near surfaces and mid-thickness region of the fittings including the weld zone. The ferrite content shall be determined according to ASTM E 562 or equivalent and shall be within 35 - 55 % for base material and 25 - 60 % for weld metal. The microstructure, as examined at 400 X magnification on a suitably etched specimen, shall be free from intermetallic phases and precipitates.
9. EXTENT OF TESTING	Tensile test, impact test hardness test and microstructure examination shall be carried out for each heat, heat treatment load within a wall thickness range of 5 mm and welded with the same WPS.
10. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual components.
11. WELDING	The PQR/WPAR shall be qualified in accordance with ASME IX or EN 288-3 and shall include the same examinations as for the production testing. The qualification shall be carried out on the same material grade (UNS number) as used in production. Change of specific make of welding consumables requires requalification.
12. DIMENSIONAL TOLERANCES	Fitting with reference to MSS-SP-75 shall have maximum wall thickness under tolerance of 0.3 mm.
13. NON DESTRUCTIVE TESTING	Supplementary requirement S7, liquid penetrant testing, shall apply to 10 % of seamless (from the test lot as defined above) and 100 % of welded fittings above NPS 2. The testing shall be carried out after calibration and pickling. For welded fittings the testing shall cover the weld only. The acceptance criteria shall be ASME VIII, Div. 1, Appendix 8.

MATERIAL DATA SHEET	**MDS - D43**			**Rev. 2**
TYPE OF MATERIAL: Ferritic / Austenitic Stainless Steel, Type 22Cr duplex				**Page 2 of 2**
PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Wrought fittings	ASTM A 815	UNS S31803	WP-W, WP-S or WP-WX	S7

14. SURFACE FINISH	White pickled. Machined surfaces do not require pickling.
15. REPAIR OF DEFECTS	Weld repair of base material is not acceptable. For repair of welds the same requirements to PQR/WPAR shall apply as for production welding.
16. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.
17. CERTIFICATION	EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET MDS - D44 Rev. 2

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

PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Forgings	ASTM A 182	F51	-	S5

1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.
2. QUALIFICATION	Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.
3. STEEL MAKING	The steel melt shall be refined with AOD or equivalent.
4. MANUFACTURING PROCESS	The Hot Isostatic Pressed (HIP) process is an acceptable alternative to forging.
5. HEAT TREATMENT	The forgings shall be solution annealed followed by water quenching.
6. CHEMICAL COMPOSITION	N = 0.14 - 0.20 %
7. HARDNESS	The hardness shall be less than 28 HRC (or alternatively 271 HB or 290 HV10).
8. IMPACT TESTING	Charpy V-notch testing according to ASTM A 370 at - 46 °C is required for the thicknesses ≥ 6 mm (thickness at the weld neck). The minimum absorbed energy shall satisfy 45 J average and 35 J single. Reduction factors for subsize specimens shall be: 7.5 mm - 5/6 and 5 mm - 2/3.
9. MICROGRAPHIC EXAMINATION	The micrographic examination shall be carried out at the same area as location of specimens for mechanical. The area shall be minimum 10 x 10 mm. The ferrite content shall be determined according to ASTM E 562 or equivalent and shall be within 35 - 55 %. The microstructure, as examined at 400 X magnification on a suitably etched specimen, shall be free from intermetallic phases and precipitates.
10. EXTENT OF TESTING	One set of impact test, tensile test, hardness test and microstructure examination shall be carried out for each heat and heat treatment load. A test lot shall not exceed 2000 kg for forgings with as forged weight ≤ 50 kg, and 5000 kg for forgings with as forged weight > 50 kg.
11. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual components. Test samples shall be from prolongations on actual component. Sacrificial forgings shall be used for die forged components. However, special agreements may be made for die forged components with as forged weight exceeding 50 kg. Integrated test blocks shall be used for HIP. Test specimens shall be cut at the 1/4 T location from the surface where T is the thickness of the test samples as heat treated. Sketches shall be established showing type, size and location of test samples and extraction of test specimens.
12. DIMENSIONAL TOLERANCES	Flanges to MSS SP-44 shall have maximum wall thickness under tolerance of 0.3 mm for the hub at the welding end.

MATERIAL DATA SHEET	**MDS - D44**			**Rev. 2**
TYPE OF MATERIAL: Ferritic / Austenitic Stainless Steel, Type 22Cr duplex				**Page 2 of 2**
PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Forgings	ASTM A 182	F51	-	S5

13. NON DESTRUCTIVE TESTING	Supplementary requirement S5, liquid penetrant testing, shall apply to 10 % of forgings (from the lot as defined for mechinical testing) above NPS 2. The testing shall be carried out after final machining. Non-machined surfaces shall be pickled prior to the testing. The acceptance criteria shall be ASME VIII, Div. 1, Appendix 8.
14. SURFACE FINISH	White pickled. Machined surfaces do not require pickling.
15. REPAIR OF DEFECTS	Weld repair is not acceptable.
16. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.
17. CERTIFICATION	EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET	**MDS - D45**			**Rev. 2**
TYPE OF MATERIAL: Ferritic / Austenitic Stainless Steel, Type 22Cr duplex				**Page 1 of 1**
PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Plates	ASTM A 240	UNS S 31803	-	-

1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.
2. QUALIFICATION	Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.
3. STEEL MAKING	The steel melt shall be refined with AOD or equivalent.
4. HEAT TREATMENT	The plates shall be solution annealed followed by water quenching.
5. CHEMICAL COMPOSITION	N = 0.14 - 0.20 %
6. HARDNESS	The hardness shall be maximum 28 HRC or alternatively 271 HB or 290 HV10.
7. IMPACT TESTING	Charpy V-notch testing according to ASTM A 370 at - 46 °C is required for the thicknesses ≥ 6 mm. The minimum absorbed energy shall satisfy 45 J average and 35 J single. Reduction factors for subsize specimens shall be: 7.5 mm - 5/6 and 5 mm - 2/3.
8. MICROGRAPHIC EXAMINATION	The micrographic examination shall cover the near surface and mid-thickness region. The ferrite content shall be determined according to ASTM E 562 or equivalent and shall be within 35 -55 %. The microstructure, as examined at 400 X magnification on a suitably etched specimen, shall be free from intermetallic phases and precipitates.
9. EXTENT OF TESTING	Impact test, tensile test, hardness test and micrographic examination shall be carried out for each heat, size and heat treatment load.
10. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual components.
11. SURFACE FINISH	White pickled.
13. REPAIR OF DEFECTS	Weld repair is not acceptable.
14. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.
15. CERTIFICATION	EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET MDS - D46 Rev. 2

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

PRODUCT	*STANDARD*	*GRADE*	*ACCEPT. CLASS*	*SUPPL. REQ.*
Castings	ASTM A 890	4 (UNS J9225)	-	S2, S3, S33

1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.
2. QUALIFICATION	Manufacturers of product to this MDS shall comply with the requirement of NORSOK standard M-650.
3. STEEL MAKING	The steel melt shall be with AOD or equivalent refining.
4. HEAT TREATMENT	The castings shall be solution annealed followed by water quenching.
5. CHEMICAL COMPOSITION	N = 0.14 - 0.20 %
6. HARDNESS	The hardness shall be maximum 28 HRC or alternatively 271 HB or 290 HV10.
7. IMPACT TESTING	Charpy V-notch testing is required according to ASTM A 370 at - 46 °C. The minimum absorbed energy shall satisfy 45 J average and 35 J single.
8. MICROGRAPHIC EXAMINATION	The micrographic examination shall be carried out at the same area as location of specimens for mechanical testing. The area shall be minimum 10 x 10 mm. The ferrite content shall be determined according to ASTM E 562 or equivalent and shall be within 35 -55 %. The microstructure, as examined at 200 X and 400 X magnification on a suitably etched specimen, shall be free from intermetallic phases and precipitates.
9. EXTENT OF TESTING	A full set of mechanical tests and microstructure examinations shall be made for each heat and heat treatment load. A test lot shall not exceed 5 000 kg.
10. TEST SAMPLING	Samples for mechanical testing shall realistically reflect the properties in the actual components. Thickness of the test block shall be equal to the thickness of the actual components up to a maximum thickness of 100 mm. For flanged components the largest flange thickness shall apply. Test specimens shall be cut from the1/4 T location from the surface where T is the thickness of the test block. Test block shall be integrally cast or gated onto the castings and shall not be removed from the castings until after the final quality heat treatment.
12. NON DESTRUCTIVE TESTING	*Liquid penetrant testing:* Supplementary requirement S3 shall apply to all accessible surfaces of all castings. The examination shall be carried out after final machining. Non-machined surfaces shall be pickled prior to the testing. The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 7. *Radiographic testing:* Supplementary requirement S2 shall apply to: - Critical areas as per ANSI B16.34 of the pilot cast of each pattern. - All butt weld ends of each casting - Class 1500 psi and above; all critical areas to ANSI B16.34 of each casting.. The acceptance criteria shall be to ASME VIII, Div. 1 Appendix 7.

MATERIAL DATA SHEET	**MDS - D46**			**Rev. 2**
TYPE OF MATERIAL: Ferritic / Austenitic Stainless Steel, Type 22Cr duplex				**Page 2 of 2**
PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Castings	ASTM A 890	4 (UNS J9225)	-	S2, S3, S33
13. SURFACE FINISH	White pickled. Machined surfaces do not require pickling.			
14. REPAIR OF DEFECTS	Supplementary requirement S33 shall apply. The repair welding procedure qualification shall include the following: - qualified on a cast plate of the same grade (UNS-number) which shall be welded - change of specific make of filler metal (brand name) requires re-qualification - examination of microstructure of base material and weld zone. The ferrite content shall be 35-55 % for the base material and 25-60 % for the weld metal. - Charpy V-notch testing as specified above, with two sets each 3 specimens, with notch located in weld metal and fusion line, respectively.			
15. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.			
16. CERTIFICATION	EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.			

MATERIAL DATA SHEET MDS - D47 Rev. 2

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

PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Bars	ASTM A 276	UNS S 31803	-	-

1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.
2. QUALIFICATION	Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.
3. STEEL MAKING	The steel melt shall be refined with AOD or equivalent.
4. HEAT TREATMENT	The bars shall be solution annealed followed by water quenching.
5. CHEMICAL COMPOSITION	N = 0.14 - 0.20 %
6. HARDNESS	The hardness shall be maximum 28 HRC or alternatively 271 HB or 290 HV10.
7. IMPACT TESTING	Charpy V-notch testing is required according to ASTM A 370 at - 46 °C. The minimum absorbed energy shall satisfy 45 J average and 35 J single.
8. MICROGRAPHIC EXAMINATION	The micrographic examination shall be carried out at the same area as location of speciemns for mechanical testing. The area shall be minimum 10 x 10 mm. The ferrite content shall be determined according to ASTM E 562 or equivalent and shall be within 35 - 55 %. The microstructure, as examined at 400 X magnification on a suitably etched specimen, shall be free from intermetallic phases and precipitates.
9. EXTENT OF TESTING	Impact test, hardness test and micrographic examination shall be carried out to the same extent as tensile test.
10. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual components.
11. SURFACE FINISH	White pickled. Machined surfaces do not require pickling.
12. REPAIR OF DEFECTS	Weld repair is not acceptable.
13. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.
14. CERTIFICATION	EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET MDS - D48 Rev. 2

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

PRODUCT	*STANDARD*	*GRADE*	*ACCEPT. CLASS*	*SUPPL. REQ.*
Tubes	ASTM A 789	UNS S 31803	-	-

1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.
2. QUALIFICATION	Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.
3. STEEL MAKING	The steel melt shall be refined with AOD or equivalent.
4. HEAT TREATMENT	The tubes shall be solution annealed followed by water quenching.
5. CHEMICAL COMPOSITION	N = 0.14 - 0.20 %
6. HARDNESS	The hardness shall be maximum 28 HRC or alternatively 271 HB or 290 HV10.
7. IMPACT TESTING	Charpy V-notch testing (3 specimens) according to ASTM A 370 at - 46 °C is required for the thicknesses ≥ 6 mm. The minimum absorbed energy shall be 45 J average / 35 J single. Reduction factors for subsize specimens shall be: 7.5 mm - 5/6 and 5 mm - 2/3.
8. MICROGRAPHIC EXAMINATION	The ferrite content shall be determined according to ASTM E 562 or equivalent and shall be within 35-55 %. The microstructure, as examined at 400 X magnification on a suitably etched specimen, shall be free from intermetallic phases and precipitates.
9. EXTENT OF TESTING	Microstructure, hardness and tensile testing shall be carried out for each lot as defined in the referred standard.
10. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual components.
11. SURFACE FINISH	White pickled.
12. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.
13. CERTIFICATION	EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET	**MDS - D51**			**Rev. 2**
TYPE OF MATERIAL: Ferritic / Austenitic Stainless Steel, Type 25Cr duplex				**Page 1 of 2**
PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Seamless pipes	ASTM A 790	UNS S 32550 UNS S 32750 UNS S 32760	-	-

1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard. This MDS is based on the mechanical properties of UNS S 32750 which is the only Type 25 Cr duplex listed in ASME B31.3.
2. QUALIFICATION	Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.
3. STEEL MAKING	The steel melt shall be refined with AOD or equivalent.
4. HEAT TREATMENT	The pipes shall be solution annealed followed by water quenching.
5. CHEMICAL COMPOSITION	PRE (% Cr + 3.3 % Mo + 16 % N) ≥ 40.0
6. TENSILE TESTING	$R_{p0.2} \geq 550$ MPa; $R_m \geq 800$ MPa;
7. HARDNESS	The harness shall be max. 32 HRC (or alternatively 301 HB or 330 HV 10).
8. IMPACT TESTING	Charpy V-notch testing (3 specimen) according to ASTM A 370 at - 46 °C is required for thicknesses ≥ 6 mm. The minimum absorbed energy shall be 45 J average / 35 J single. Reduction factors for subsize specimens shall be: 7.5 mm - 5/6 and 5 mm - 2/3.
9. CORROSION TEST	Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. The specimen shall have the internal and external surfaces in the as-delivered condition (including pickling). Cut edges shall be prepared according to ASTM G 48, and the whole specimen shall be pickled (20 % HNO_3 + 5 % HF, 60 °C, 5 minute). The test shall expose the external and internal surfaces and a cross section surface in full wall thickness. The acceptance criteria are: - No pitting 20 X magnification. - The weight loss shall be less than 4.0 g/m^2.
10. MICROGRAPHIC EXAMINATION	The micrographic examination shall cover the near surfaces and mid-thickness region of the pipe. The ferrite content shall be determined according to ASTM E 562 or equivalent and shall be within 35-55 %. The microstructure, as examined at 400 X magnification on a suitably etched specimen, shall be free from intermetallic phases and precipitates.
11. EXTENT OF TESTING	Charpy V-notch impact, microstructure, hardness, corrosion and tensile testing shall be carried out for each lot as defined in the referred standard. For batch furnace charges the specified tests shall be carried out for each heat treatment charge.

MATERIAL DATA SHEET	**MDS - D51**			**Rev. 2**
TYPE OF MATERIAL: Ferritic / Austenitic Stainless Steel, Type 25Cr duplex				**Page 2 of 2**
PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Seamless pipes	ASTM A 790	UNS S 32550 UNS S 32750 UNS S 32760	-	-
12. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual components.			
13. SURFACE FINISH	White pickled.			
14. REPAIR OF DEFECTS	Weld repair is not acceptable.			
15. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.			
15. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.			
16. CERTIFICATION	EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.			

MATERIAL DATA SHEET MDS - D52 Rev. 2

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

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

1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard. This MDS is based on the mechanical properties of UNS S 32750 which is the only Type 25 Cr dupøex listed in ASME B31.3.
2. QUALIFICATION	Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.
3. STEEL MAKING	The steel melt shall be refined with AOD or equivalent.
4. HEAT TREATMENT	The pipes shall be solution annealed followed by water quenching.
5. CHEMICAL COMPOSITION	PRE (% Cr + 3.3 % Mo + 16 % N) ≥ 40.0
6. TENSILE TESTING	$R_{p0.2} \geq 550$ MPa; $R_m \geq 795$ MPa; A ≥ 15 %
7. HARDNESS	The hardness shall be maximum 32 HRC (or alternatively 301 HB or 330 HV10) for base material, HAZ and weld metal.
8. IMPACT TESTING	Charpy V-notch testing according to ASTM A 370 at - 46 °C is required for thicknesses ≥ 6 mm. The minimum absorbed energy shall be 45 J average / 35 J single. Two sets, each 3 specimens, shall be carried out with notch located in weld meal and fusion line, respectively. Reduction factors for subsize specimens shall be: 7.5 mm - 5/6 and 5 mm - 2/3.
9. CORROSION TEST	Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. The specimen shall have the internal and external surfaces in the as-delivered condition (including pickling). Cut edges shall be prepared accorfing to ASTM G48, and the whole specimen shall be pickled (20 % HNO3 + 5 % HF, 60 °C, 5 minute). The test shall expose the external and internal surfaces and a cross section surface including weld zone in full wall thickness. The acceptance criteria are: - No pitting at 20 X magnification - The weight loss shall be less than 4.0 g/m^2
10. MICROGRAPHIC EXAMINATION	The micrographic examination shall cover the near surfaces and mid-thickness region of the pipe including the weld and heat affected zone. The ferrite content shall be determined according to ASTM E 562 or equivalent and shall be within 35-55 % for base material and 25-60 % for weld metal. The microstructure, as examined at 400 X magnification on a suitably etched specimen, shall be free from intermetallic phases and precipitates.
11. EXTENT OF TESTING	Tensile, impact, hardness, corrosion and microstructure examination shall be carried out for each lot. The lot is defined as follows: - For batch furnace a lot is defined as maximum 60 m of pipe of the same heat, size and heat treatment charge. - For continuous heat treatment furnacce the lot definition in para 8.1 of the ASTM standard apply.

MATERIAL DATA SHEET	**MDS - D52**			**Rev. 2**
TYPE OF MATERIAL: Ferritic / Austenitic Stainless Steel, Type 25Cr duplex				**Page 2 of 2**
PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Welded pipes	ASTM A 928	UNS S 32550 UNS S 32750 UNS S 32760	Class 1, 3 and 5	-
12. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual components.			
13. WELDING	The PQR/WPAR shall be qualified in accordance with ASME IX or EN 288-3 and shall include the same examinations as for the production testing. The qualification shall be carried out on the same material grade (UNS number) as used in production. Change of specific make (brand name) of welding consumables requires requalification.			
14. TOLERANCES	The pipes shall have a max. undertolerance of 0.3 mm.			
15. NON DESTRUCTIVE TESTING	Eddy current testing according to ASTM A 450 is acceptable as replacement for spot radiography for wall thicknesses less than 4.0 mm. Supplementary requirement S3, penetrant testing, according to ASME V Article 6 shall apply to the weld of 10 % of the pipes (same test lot as defined for mechanical testing) delivered. The testing shall be carried out after calibration and pickling. Acceptance criteria shall be to ASME VIII, Div 1, Appendix 8.			
16. SURFACE FINISH	White pickled.			
17. REPAIR OF DEFECTS	Weld repair of base material is not acceptable. For repair of welds the same requirements to PQR/WPAR shall apply as for production welding.			
18. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.			
19. CERTIFICATION	EN 10 204 Type 31.B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.			

MATERIAL DATA SHEET	**MDS - D53**			**Rev. 2**
TYPE OF MATERIAL: Ferritic / Austenitic Stainless Steel, Type 25Cr duplex				**Page 1 of 2**
PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Wrought fittings	ASTM A 815	UNS S 32550 UNS S 32750 UNS S 32760	WP-S, WP-WX and WP-W	S7

1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.
2. QUALIFICATION	Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.
3. STEEL MAKING	The steel melt shall be refined with AOD or equivalent.
4. HEAT TREATMENT	Solution annealing followed by water quenching.
5. CHEMICAL COMPOSITION	PRE (% Cr + 3.3 % Mo + 16 % N) ≥ 40.0
6. TENSILE TESTING	Base material properties: $R_{p0.2} \geq 550$ MPa; $R_m \geq 800$ MPa;
7. HARDNESS	The hardness shall be maximum 32 HRC (or alternatively 301 HB or 330 HV10) for base material, HAZ and weld metal.
8. IMPACT TESTING	Charpy V-notch testing according to ASTM A 370 at - 46 °C is required for the thicknesses ≥ 6 mm. The minimum absorbed energy shall be 45 J average / 35 J single. Reduction factors for subsize specimens shall be: 7.5 mm -5/6 and 5 mm -2/3. The notch location and number of specimen shall be: Seamless fittings: One set, (3 specimens). Welded fittings: Two sets, (each 3 specimen) located in weld metal and fusion line.
9. CORROSION TEST	Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. The specimen shall have the internal and external surfaces in the as-delivered condition (including pickling). Cut edges shall be prepared according to ASTM G 48, and the whole specimen shall be pickled (20 % HNO3 + 5 % HF, 60 °C, 5 minute). The test shall expose the external and internal surfaces and a cross section including weld zone (if relevant) in full wall thickness. The acceptance criteria are: - No pitting at 20 X magnification. - The weight loss shall be less than 4.0 g/m^2.
10. MICROGRAPHIC EXAMINATION	The micrographic examination shall cover the near surfaces and mid-thickness region. For welded fittings both the weld and the base material is required examined. The ferrite content shall be determined according to ASTM E 562 or equivalent and shall be within 35-55 % for base material and 25-60 % for weld metal. The microstructure, as examined at 400 X magnification on a suitably etched specimen, shall be free from intermetallic phases and precipitates.
11. EXTENT OF TESTING	Tensile testing, impact testing, hardness testing, corrosion testing and microstructure examination shall be carried out for each heat and heat treatment load within a wall thickness range of 5 mm and welded with the same WPS.

MATERIAL DATA SHEET	**MDS - D53**			**Rev. 2**
TYPE OF MATERIAL: Ferritic / Austenitic Stainless Steel, Type 25Cr duplex				**Page 2 of 2**
PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Wrought fittings	ASTM A 815	UNS S 32550 UNS S 32750 UNS S 32760	WP-S, WP-WX and WP-W	S7

12. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual components.
13. WELDING	The PQR/WPAR shall be qualified in accordance with ASME IX or EN 288-3 and shall include the same examinations as for the production testing. The qualification shall be carried out on the same material grade (UNS number) as used in production. Change of specific make (brand name) of welding consumables requires requalification.
14. DIMENSIONAL TOLERANCES	Fittings with reference to MSS-SP-75 shall have maximum wall thickness under tolerance of 0.3 mm.
15. NON DESTRUCTIVE TESTING	Supplementary requirements S7, liquid penetrant examination, shall apply to 10 % of seamless (from the test lot as defined above) and 100 % of welded fittings above NPS 2. The examination shall be carried out after calibration and pickling. For welded fittings the examination shall cover the weld only. The acceptance criteria shall be ASME VIII, Div. 1, Appendix 8.
16. SURFACE FINISH	White pickled.
17. REPAIR OF DEFECTS	Weld repair of base material is not acceptable. For repair of welds the same requirements to PQR/WPAR shall apply as for production welding.
18. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.
19. CERTIFICATION	EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET MDS - D54 Rev. 2

TYPE OF MATERIAL: Ferritic/Austenitic Stainless Steel, Type 25Cr duplex **Page 1 of 2**

PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Forgings	ASTM A 182	- UNS S 32550 F53 - UNS S 32750 F55 - UNS S 32760	-	S5

1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard. This MDS is based on the mechanical properties of UNS S 32750 which is the only Type 25 Cr duplex listed in ASME B31.3.
2. QUALIFICATION	Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.
3. STEEL MAKING	The steel melt shall be refined with AOD or equivalent.
4. MANUFACTURING PROCESS	The Hot Isostatic Pressed (HIP) process is an acceptable alternative to forging.
5. HEAT TREATMENT	Solution annealing followed by water quenching.
6. CHEMICAL COMPOSITION	PRE (% Cr + 3.3 % Mo + 16 % N) ≥ 40.0.
7. TENSILE TESTING	$R_{p0.2}$ ≥ 550 MPa; R_m ≥ 800 MPa; A ≥ 15 %.
8. HARDNESS	The hardness shall be less than 32 HRC (or alternatively 301 HB or 330 HV10).
9. IMPACT TESTING	Charpy V-notch testing according to ASTM A 370 at -46 °C is required for the thicknesses ≥ 6 mm (thickness at the weld neck). The minimum absorbed energy shall satisfy 45 J average / 35 J single. Reduction factors for subsize specimens shall be: 7.5 mm - 5/6 and 5 mm - 2/3.
10. MICROGRAPHIC EXAMINATION	The micrographic examination shall be carried out at the same area as location of specimens for mechanical testing. The area shall be minimum 10 x 10 mm. The ferrite content shall be determined according to ASTM E 562 or equivalent and shall be within 35 -55 %. The microstructure, as examined at 400 X magnification on a suitably etched specimen, shall be free from intermetallic phases and precipitates.
11. CORROSION TEST	Corrosion test according to ASTM G 48, Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. The corrosion test specimen shall be at the same location as those for mechanical testing. Cut edges shall be prepared according to ASTM G 48 and pickled (20 % HNO3 + 5 % HF, 60 °C, 5 Minute). The acceptance criteria are: - No pitting at 20 X magnification. - The weight loss shall be less than 4.0 g/m^2.
12. EXTENT OF TESTING	One set of impact, tensile, hardness, corrosion testing and microstructure examination shall be carried out for each heat and heat treatment load. A test lot shall not exceed 2000 kg for forgings with as forged weight ≤ 50 kg, and 5000 kg for forgings with as forged weight > 50 kg.

MATERIAL DATA SHEET	**MDS - D54**			**Rev. 2**
TYPE OF MATERIAL: Ferritic/Austenitic Stainless Steel, Type 25Cr duplex				**Page 2 of 2**
PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Forgings	ASTM A 182	- UNS S 32550 F53 - UNS S 32750 F55 - UNS S 32760	-	S5

13. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual components. Test samples shall be from prolongations on actual component. Sacrificial forgings shall be used for die forged components. However, special agreements may be made for die forged components with as forged weight exceeding 50 kg. Integrated test blocks shall be used for HIP. Test specimens shall be cut at the ¼ T location from the surface where T is the thickness of the test samples as heat treated. Sketches shall be established showing type, size and location of test samples and extraction of test specimens.
14. DIMENSIONAL TOLERANCES	Flanges to MSS SP-44 shall have maximum wall thickness under tolerance of 0.3 mm for the hub at the welding end.
15. NON DESTRUCTIVE TESTING	Supplementary requirement S5, liquid penetrant testing, shall apply to 10 % of forgings (from the lot as defined for mechanical testing) above NPS 2. The testing shall be carried out after final machining and pickling. The acceptance criteria shall be ASME VIII, Div. 1, Appendix 8.
16. SURFACE FINISH	White pickled including machined surfaces.
17. REPAIR OF DEFECTS	Weld repair is not acceptable.
18. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.
19. CERTIFICATION	EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET	**MDS - D55**			**Rev. 2**
TYPE OF MATERIAL: Ferritic/Austenitic Stainless Steel, Type 25Cr duplex				**Page 1 of 1**
PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Plates	ASTM A 240	UNS S 32550 UNS S 32750 UNS S 32760	-	-

1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard. This MDS is based on the mechanical properties of UNS S 32750 which is the only Type 25 Cr duplex listed in ASME B 31.3.
2. QUALIFICATION	Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.
3. STEEL MAKING	The steel melt shall be refined with AOD or equivalent.
4. HEAT TREATMENT	Solution annealing followed by water quenching.
5. CHEMICAL COMPOSITION	PRE (%Cr + 3.3 % Mo + 16 % N) ≥ 40.0.
6. TENSILE TESTING	$R_{p0.2} \geq 550$ MPa; $R_m \geq 750$ MPa; A ≥ 15%.
7. HARDNESS	The hardness shall be maximum 32 HRC or alternatively 301 HB or 330 HV10.
8. IMPACT TESTING	Charpy V-notch testing is required according to ASTM A 370 at - 46 °C. The minimum absorbed energy shall satisfy 45 J average / 35 J single. Reduction factors for subsize specimens shall be: 7.5 mm - 5/6 and 5 mm - 2/3.
9. MICROGRAPHIC EXAMINATION	The micrographic examination shall cover the near surface and mid-thickness region. The ferrite content shall be determined according to ASTM E 562 or equivalent and shall be within 35 -55 %. The microstructure, as examined at 400 X magnification on a suitably etched specimen, shall be free from intermetallic phases and precipitates.
10 CORROSION TEST	Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. The specimen shall have surfaces in the as-delivered condition (including pickling). Cut edges shall be prepared according to ASTM G 48, and the whole specimen shall be pickled (20 % HNO3 + 5 % HF, 60 °C, 5 minute). The test shall expose both surfaces and a cross section in full wall thickness. The acceptance criteria are: - No pitting at 20 X magnification. - The weight loss shall be less than 4.0 g/m^2.
11. EXTENT OF TESTING	Test samples for impact testing, microstructure, hardness, corrosion and tensile testing shall be carried out for each heat and heat treatment lot.
12. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual components.
13. SURFACE FINISH	White pickled.
14. REPAIR OF DEFECTS	Repair welding is not acceptable.
15. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.
16. CERTIFICATION	EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET MDS - D56 Rev. 2

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

PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Castings	ASTM A 890	UNS J93404 UNS J93380	-	S2, S3, S33

1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.
2. QUALIFICATION	Manufacturers of product to this MDS shall be qualified in accordance with NORSOK Standard M-650.
3. STEEL MAKING	The steel melt shall be refined with AOD or equivalent process.
4. HEAT TREATMENT	According to Grade 5A (UNS J93404).
5. CHEMICAL COMPOSITION	PRE (% Cr + 3.3 % Mo + 16 % N) ≥ 40.0.
6. TENSILE TESTING	$R_{p0.2} \geq 450$ MPa; $R_m \geq 700$ MPa; $A \geq 15$ %.
7. HARDNESS	The hardness shall be less than 32 HRC (or alternatively 301 HB or 330 HV10).
8. IMPACT TESTING	Charpy V-notch testing is required according to ASTM A 370 at - 46 °C. The minimum absorbed energy shall satisfy 45 J average / 35 J single.
9. MICROGRAPHIC EXAMINATION	The micrographic examination shall be carried out at the same area as location of specimens for mechanical tests. The area shall be minimum 10 x 10 mm. On WPQ's both the weld, HAZ and base material shall be examined. The ferrite content shall be determined according to ASTM E 562 or equivalent and shall be within 35 - 55 %. The microstructure, as examined at 200 X magnification on a suitably etched specimen, shall be free from intermetallic phases and precipitates.
10. CORROSION TEST	Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. The corrosion test specimen shall be at the same location as those for mechanical testing. Cut edges shall be prepared according to ASTM G 48 and pickled (20 % HNO3 + 5 % HF, 60 °C, 5 minute). The acceptance criteria are: - No pitting at 20X magnification. - The weight loss shall be less than 4.0 g/m^2.
11. EXTENT OF TESTING	A full set of mechanical and corrosion tests and microstructure examinations shall be made for each heat and heat treatment charge. A test lot shall not exceed 5 000 kg.
12. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual components. Thickness of the test block shall be equal to the thickness of the actual components up to a maximum thickness of 100 mm. For flanged components the largest flange thickness shall apply Test specimens shall be cut from the 1/4 T location from the surface where T is the thickness of the test block. Test block shall be integrally cast or gated onto the castings and shall not be removed from the castings until after the final quality heat treatment.

MATERIAL DATA SHEET	**MDS - D56**			**Rev. 2**
TYPE OF MATERIAL: Ferritic/Austenitic Stainless Steel, Type 25Cr duplex				**Page 2 of 2**
PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Castings	ASTM A 890	UNS J93404 UNS J93380	-	S2, S3, S33
13. NON DESTRUCTIVE TESTING	*Liquid penetrant testing:* Supplementary requirement S3 shall apply to all accessible surfaces of all castings. The testing shall be carried out after final machining and pickling. The acceptance criteria shall be ASME VIII, Div. 1, Appendix 7. *Radiographic testing:* Supplementary requirement S2 shall apply to: - Critical areas as per ANSI B16.34 of the pilot cast of each pattern. - All butt weld ends of each casting - Class 1500 psi and above; all critical areas to ANSI B16.34 of each casting. The acceptance criteria shall be to ASME VIII, Div. 1 Appendix 7.			
14. SURFACE FINISH	White pickled shall be carried out after any blasting and shall include finished machined surfaces.			
15. REPAIR OF DEFECTS	Supplementary requirement S33 shall apply. The repair welding procedure shall be qualified in accordance with ASME IX or EN 288-3 and this MDS. The repair welding procedure qualification shall include the following: - qualified on a cast plate of the same grade (UNS number) which shall be welded - change of specific make of filler metal (brand names) requires requalification - examination of microstructure of base material and weld zone. The ferrite content shall be 35 - 55 % for the base material and 25 - 60 % for the weld metal. - Charpy V-notch testing as specified above, with two sets (each 3 specimens), with notch located in weld metal and fusion line, respectively - corrosion test as specified above. The specimen shall include weld zone.			
16. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.			
17. CERTIFICATION	EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.			

MATERIAL DATA SHEET MDS - D57 Rev. 2

TYPE OF MATERIAL: Ferritic/Austenitic Stainless Steel, Type 25Cr duplex **Page 1 of 1**

PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Bars	ASTM A 276	UNS S 32550 UNS S 32750 UNS S 32760	-	-

1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard. This MDS is based on the mechanical properties of UNS S 32750 which is the only Type 25 Cr duplex listed in ASME B 31.3.
2. QUALIFICATION	Manufacturers of product to this MDS shall comply with the requirement in NORSOK Standard M-650.
3. STEEL MAKING	The steel melt shall be refined with AOD or equivalent.
4. HEAT TREATMENT	Solution annealing followed by water quenching.
5. CHEMICAL COMPOSITION	PRE (% Cr + 3.3 % Mo + 16 % N) ≥ 40.0.
6. TENSILE TESTING	$R_{p0.2} \geq 550$ MPa; $R_m \geq 800$ MPa; $A \geq 15$ %.
7. HARDNESS	The hardness shall be less than 32 HRC (or alternatively 301 HB or 330 HV10).
8. IMPACT TESTING	Charpy V-notch testing is required according to ASTM A 370 at - 46 °C. The minimum absorbed energy shall satisfy 45 J average / 35 J single.
9. MICROGRAPHIC EXAMINATION	The micrographic examination shall be carried out at the same area as location of specimens for mechanical testing. The area shall be minimum 10 x 10 mm. The ferrite content shall be determined according to ASTM E 562 or equivalent and shall be within 35 - 55 %. The microstructure, as examined at 400 X magnification on a suitably etched specimen, shall be free from intermetallic phases and precipitates.
10. CORROSION TEST	Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. The corrosion test specimen shall be at the same location as those for mechanical testing. Cut edges shall be prepared according to ASTM G 48 and pickled (20 % HNO3 + 5 % HF, 60 °C, 5 minute). The acceptance criteria are: - No pitting at 20 X magnification. - The weight loss shall be less than 4.0 g/m^2.
11. EXTENT OF TESTING	Test samples for impact testing, microstructure, hardness, corrosion and tensile testing shall be carried out for each heat and heat treatment lot.
12. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual components.
15. SURFACE FINISH	White pickled..
16. REPAIR OF DEFECTS	Weld repair is not acceptable.
17. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.
18. CERTIFICATION	EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET MDS - D58 Rev. 1

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

PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Tubes	ASTM A 789	UNS S 32550 UNS S 32750 UNS S 32760	-	S5

1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard. This MDS is based on the mechanical properties of UNS S 32750 which is the only Type 25 Cr duplex listed in ASME B31.3.
2. QUALIFICATION	Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.
3. STEEL MAKING	The steel melt shall be refined with AOD or equivalent.
4. HEAT TREATMENT	The tubes shall be solution annealed followed by water quenching.
5. CHEMICAL COMPOSITION	PRE (% Cr + 3.3 % Mo + 16 % N) ≥ 40.0.
6. TENSILE TESTING	$R_{p0.2} \geq 550$ MPa; $R_m \geq 750$ MPa; A ≥ 15 %.
7. HARDNESS	The hardness shall be max. 32 HRC (or alternatively 301 HB or 330 HV10).
8. IMPACT TESTING	Charpy V-notch testing (3 specimens) according to ASTM A 370 at - 46 °C is required for the thicknesses ≥ 6 mm.. The minimum absorbed energy shall be 45 J average / 35 J single. Reduction factors for subsize specimens shall be: 7.5 mm - 5/6 and 5 mm - 2/3.
9. CORROSION TEST	Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. The specimen shall have the internal and external surfaces in the as-delivered condition (including pickling). Cut edges shall be prepared according to ASTM G 48, and the whole specimen shall be pickled (20 % HNO3 + 5 % HF, 60 °C, 5 minute). The test shall expose the external and internal surfaces and a cross section surface in full wall thickness. The acceptance criteria are: - No pitting at 20 X magnification. - The weight loss shall be less than 4.0 g/m^2.
10 MICROGRAPHIC EXAMINATION	The ferrite content shall be determined according to ASTM E 562 or equivalent and shall be within 35 - 55 %. The microstructure, as examined at 400 X magnification on a suitably etched specimen, shall be free from intermetallic phases and precipitates.
11. EXTENT OF TESTING	Microstructure, hardness and tensile testing shall be carried out for each lot as defined in the referred standard..
12. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual components.
13. SURFACE FINISH	White pickled.
14. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.
15. CERTIFICATION	EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET MDS - K01 Rev. 1

TYPE OF MATERIAL: Copper/Nickel 90/10 **Page 1 of 2**

PRODUCT	*STANDARD*	*GRADE*	*ACCEPT. CLASS*	*SUPPL. REQ.*
Sml pipes & tubes	ASTM B 466	UNS C 70600	-	-
Welded pipes	ASTM B 467	UNS C 70600	-	-
Rod & bar	ASTM B 151	UNS C 70600	-	-
Plates & sheets	ASTM B 171	UNS C 70600	-	-
Fittings	-	UNS C 70600	-	-
Flanges	-	UNS C 76000	-	-

1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.
2. DESIGN AND DIMENSIONAL STANDARDS	The following EEMUA standards for: " 90/10 Copper/Nickel Piping for Offshore Applications " shall be used: - EEMUA Publication No. 144: " Tubes, Seamless and Welded". - EEMUA Publication No. 145: " Flanges, Composite and Solid ". - EEMUA Publication No. 146: " Fittings ".
3. MATERIALS	Materials for fittings and flanges shall comply with the above listed standards and this MDS.
4. MANUFACTURING PROCESS	*Forming:* Cold forming or hot forming may be used according to written procedures established in cooperation with the material manufacturers. *Welding:* An electric fusion welding process shall be used.
5. HEAT TREATMENT/ DELIVERY CONDITION	*Hot formed components:* Parts hot formed in the temperature range of 760 - 800 °C do not need annealing after forming. *Cold formed components:* Annealed. *Welded components:* Annealed, but acceptable as welded from annealed materials.
6. CHEMICAL COMPOSITION	For subsequent welding the chemical composition shall be modified as stated: Zn ≤ 0.50 %, Pb ≤ 0.02 % and C ≤ 0.05 %.
7. EXTENT OF TESTING	Tensile test specimens shall be taken from each lot. A lot is defined as all products of the same type, nominal size which are produced from the same heat of material and subject to the same finishing operation.
8. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual components. Test samples shall be cut from the products themselves. Sacrificial components or overlength on the components may be used. Sketches shall be established showing type, size and location of test samples and extraction of test specimens.
9. WELDING	Welding procedures shall be established and qualified in accordance with ASME IX.

MATERIAL DATA SHEET MDS - K01 Rev. 1

TYPE OF MATERIAL: Copper/Nickel 90/10 **Page 2 of 2**

PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Sml pipes & tubes	ASTM B 466	UNS C 70600	-	-
Welded pipes	ASTM B 467	UNS C 70600	-	-
Rod & bar	ASTM B 151	UNS C 70600	-	-
Plates & sheets	ASTM B 171	UNS C 70600	-	-
Fittings	-	UNS C 70600	-	-
Flanges	-	UNS C 76000	-	-

10. NON DESTRUCTIVE TESTING	*Welded Pipes to B 467:* Sch. 10S: Welded pipes shall be spot radigraphed to the extent of not less than 12 in. (300 mm) of radiograph per 50 ft (15 m) of weld. Otherwise: All welds shall be completly radiographed. The radiographic testing shall be in accordance with the requirements of the ASME Boiler and Pressure Vessel Code, Section VIII, Div. 1, Paragraph UW-51 and UW-52 for 100 % and spot check tested respectively.
11. HYDROSTATIC TESTS	*Sml. pipes & tubes to B 466 and Welded pipes to B 467:* Each length of finished pipe shall be subjected to the hydrostatictest in accordance with ASTM A 530.
12. CERTIFICATION	EN 10 204 Type 3.1B.

MATERIAL DATA SHEET MDS - K02 Rev. 1

TYPE OF MATERIAL: Aluminium - Bronze Sand Castings				**Page 1 of 1**
PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Castings	ASTM B 148	UNS C95800	-	-

1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.
2 CHEMICAL COMPOSITION	Pb $\leq$ 0.02 %.
3. HEAT TREATMENT	Heat treatment shall be carried out at the discretion of the manufacturer, e.g. approx. 700 °C for 6 hours.
4. EXTENT OF TESTING	One tensile test shall be carried out for each lot, as defined by the in B148, and heat treatment load.
5. TEST SAMPLING	Samples for mechanical testing shall realistically reflect the properties in the actual components. Thickness of the test block shall be equal to the thickness of the actual components up to a maximum thickness of 100 mm. For flanged components the largest flange thickness shall apply. Test specimens shall be cut from the 1/4 T location from the surface where T is the thickness of the test block. Test block shall be integrally cast or gated onto the castings and shall not be removed from the castings until after the final quality heat treatment.
6. WELDING	Welding procedures shall be established and qualified in accordance with ASME IX for all repair welding.
7. NON DESTRUCTIVE TESTING	*Liquid penetration testing:* 100 % on all accessible surfaces of all castings. The testing shall be carried out after final machining. The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 7. *Radiographic testing:* - Critical areas as per ANSI B 16.34 of the pilot cast of each pattern. - All butt weld ends of each casting. - Class 1500 psi and above, all critical areas to ANSI B16.34 of each casting. The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 7.
8. WELD REPAIR	The repair welding procedure shall be qualified in accordance with ASME IX and this MDS. - A cast plate of the same material grade shall be used. - A macro test shall be carried out. - Repairs by peening and impregnation are prohibited. - Change of filler metal brand names requires requalification.
9. CERTIFICATION	EN 10 204 Type 3.1B.

MATERIAL DATA SHEET MDS - N01 Rev. 2

TYPE OF MATERIAL: Nickel alloy Type 625 **Page 1 of 1**

PRODUCT	*STANDARD*	*GRADE*	*ACCEPT. CLASS*	*SUPPL. REQ.*
Wrought fittings	ASTM B 366	UNS N06625	-	S3
Pipes	ASTM B 705	UNS N06625	Class 1	-
Forgings	ASTM B 564	UNS N06625	-	-
Plates	ASTM B 443	UNS N06625	-	-
Bars	ASTM B 446	UNS N06625	-	-
Pipes and tubes	ASTM B 444	UNS N06625	-	-

1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.
2. QUALIFICATION	Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.
3. HEAT TREATMENT/ DELIVERY CONDITION	Annealed.
4. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual component.
5. DIMENSIONAL TOLERANCES	*Flanges to B 381:* Flanges to MSS SP-44 shall have a maximum wall thickness under tolerance of 0.3 mm at weld end.
6. NON DESTRUCTIVE TESTING	*Fittings to B 366:* Supplementary requirement S3, liquid penetrant testing, shall apply to the weld area at 10 % of seamless (from the same lot as defined for mechanical testing) and 100 % of welded fittings above NPS2. For welded fittings the testing shall cover the weld only. *Forgings to B 564:* Liquid penetrant testing shall be performed at 10 % of forgings above NPS 2 (of same lot as defined for mechanical testing).
7. SURFACE FINISH	White pickled. Shall be carried out after any blasting and shall include finished machined surfaces.
8. REPAIR OF DEFECTS	Weld repair of base material is not acceptable.
9. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.
10. CERTIFICATION	EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET	**MDS - N02**			**Rev. 2**
TYPE OF MATERIAL: Cast Nickel alloy				**Page 1 of 2**
PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Castings	ASTM A 494	Grade CW-6MC (UNS N06625)	Class 1	S2, S3
		Grade CX2MW (UNS N26022)	Class 1	S2, S3

1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.
2. QUALIFICATION	Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.
3. STEEL MAKING	The steel melt shall be refined with AOD or equivalent process. Remelting of AOD or equivalent steel in an electric furnace is acceptable. Use of internal scrap is not acceptable.
4. HARDNESS	The hardness shall be maximum 35 HRC (or alternatively 301HB or 330HV).
5. CORROSION TESTING	Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. The corrosion test specimen shall be at the same location as those for mechanical testing. Cut edges shall be prepared according to ASTM G 48 and pickled (20 % HNO3 + 5 % HF, 60 °C, 5 minute). The acceptance criteria are: - No pitting at 20 X magnification. - The weight loss shall be less than 4.0 g/m^2.
6. EXTENT OF TESTING	Tensile test and corrosion test shall be made for each melt and heat treatment load. A test lot shall not exceed 5 000 kg.
7. TEST SAMPLING	Samples for mechanical testing shall realistically reflect the properties in the actual components. Thickness of the test block shall be equal to the thickness of the actual components up to a maximum thickness of 100 mm. For flanged components the largest flange thickness shall apply. Test specimens shall be cut from the 1/4 T location from the surface where T is the thickness of the test block. Test block shall be integrally cast or gated onto the castings and shall not be removed from the castings until after the final quality heat treatment.
8. NON DESTRUCTIVE TESTING	*Liquid penetrant testing:* Supplementary requirement S3 shall apply to all accessible surfaces of all castings. The testing shall be carried out after final machining and pickling. The acceptance criteria shall be ASME VIII, Div.1, Appendix 7. *Radiographic testing:* Supplementary requirement S2 shall apply to: - Critical areas as per ANSI B 16.34 of the pilot cast of each pattern. - All butt weld ends of each casting. - Class 1500 psi and above; all critical areas to ANSI B 16.34 of each casting. The acceptance criteria shall be ASME VIII, Div. 1, Appendix 7.
9. SURFACE FINISH	White pickled. Shall be carried out after any blasting and shall include finished machined surfaces.

MATERIAL DATA SHEET	**MDS - N02**			**Rev. 2**
TYPE OF MATERIAL: Cast Nickel alloy				**Page 2 of 2**
PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Castings	ASTM A 494	Grade CW-6MC (UNS N06625) Grade CX2MW (UNS N26022)	Class 1 Class 1	S2, S3 S2, S3

10. REPAIR OF DEFECTS	Repair welding shall be carried out in accordance with ASTM A 488. The repair welding procedure shall be qualified in accordance with ASME IX or EN 288-3 and this MDS. - A cast plate of the same material grade (UNS number) which shall be used. - A macro and corrosion test as specified above shall be carried out. - Change of specific make of filler metal (brand name) requires requalification. All casting with major repairs shall be given a solution heat treatment after welding.
11. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.
12. CERTIFICATION	EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET	**MDS - P01**	**Rev.**
TYPE OF MATERIAL: Glassfibre Reinforced Plastics (GRP)		**Page 1 of 4**

PRODUCT	***STANDARD***
Pipes, Fittings, Flanges, Adhesive and pre-fabricated spools	UKOOA: Specification and Recommended Practice for the Use of GRP Piping Offshore. (UKOOA: United Kingdom Offshore Operators Association)
1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.
2. MANUFACTURING PROCESS	Pipes and fittings shall be made by filament winding or equivalent methods.
3. RESIN/HARDENER TYPE	Preferred resins are bisphenol A epoxies with aromatic or cycloaliphatic curing agents or vinylester.
4. INNER LINER	The internal lining when transporting non-aggressive fluids such as water, shall be a resin rich layer of min. 0,5 mm with C-glass or synthetic veil reinforcement. For transporting concentrated sulphuric acid and hypochlorite, an internal liner of PVC of min. 3 mm should be used. Application of PVC liner shall be according to the German standard KRV A984/82-02. C-glass or ECR-glass reinforcement should be used in the structural part of the pipe wall. (KRV: Kunststoff Rohrverband). For other agressive fluids such as acids, the internal lining shall be a resin rich layer of min. 3,0 mm with C-glass or syntetic veil reinforcement. C-glass or ECR-glass reinforcement should be used in the structural part of the pipe wall.
5. QUALIFICATION TESTING	Qualification testing shall be performed according to UKOOA document, Part 2, chapter 2 with the following additional requirements: *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:

MATERIAL DATA SHEET	**MDS - P01**	**Rev.**
TYPE OF MATERIAL: Glassfibre Reinforced Plastics (GRP)		**Page 2 of 4**

PRODUCT	***STANDARD***
Pipes, Fittings, Flanges, Adhesive and pre-fabricated spools	UKOOA: Specification and Recommended Practice for the Use of GRP Piping Offshore. (UKOOA: United Kingdom Offshore Operators Association)

5. QUALIFICATION TESTING (Cont.)

a) Assessment of previous well documented in-service experience.

b) Qualification results from tests done according to Qualification Option 1 in section 2.1.2. or 2.1.3. Alternatively use a pipe with a pressure rating of minimum one class higher than for 20 years design.

c) Design calculations shall be re-evaluated and extrapolation performed to verify the increased service life.

Adhesive/resin for bonded/laminated joints, (A new section 2.1.9):
The adhesive used for bonded joints or resin used for laminated joints shall be qualified according to section 2.1.2 or 2.1.3. The adhesive/resin shall have suitable properties for field assembly and fulfilling the following requirements:

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

Component Data for Fabrication, Prefabrication and Installation Quality Control Baselines.(A new section 2.1.10): The manufacturer shall generate from the qualification programme baseline values including acceptance criteria for the fabrication and installation quality control programme.
This includes measurement of degree of cure and glass content:

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

MATERIAL DATA SHEET	**MDS - P01**	**Rev.**
TYPE OF MATERIAL: Glassfibre Reinforced Plastics (GRP)		**Page 3 of 4**

PRODUCT	***STANDARD***
Pipes, Fittings, Flanges, Adhesive and pre-fabricated spools	UKOOA: Specification and Recommended Practice for the Use of GRP Piping Offshore. (UKOOA: United Kingdom Offshore Operators Association)
5. QUALIFICATION TESTING (Cont.)	<u>*Chemical Resistance*</u>, (*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 <u>Component Properties for System Design</u> (section 2.4) All listed properties shall be determined by the Manufacturer (Delete "Where applicable in UKOOA document) <u>Test Method for Determination of Degree of Cure by Differential Scanning Calorimetry (DSC)</u> (Annex C) C.5.3 (*Delete sentence and replace with:)* Obtain the T_{G1} (midpoint of the inflection in the DSC curve) and/or the residual heat of reaction from the first scan and second scan. (Sample not powdered). C.6.5 (*Delete sentence and replace with:)* Record of glass transition temperature (inflection value) as T_{G1} and /or residual heat of reaction for both the first and second scan.
6. ELECTRIC CONDUCTIVITY	If conductive components are specified, the conductivity in the structural layers shall not be accomplished by adding carbon black to the resin.
7. PRODUCTION TESTING	Production testing shall be performed according to UKOOA document, Part 2, Chapter 4 with the following additional requirements. <u>*Hydrostatic Mill Test*</u> (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. <u>*Degree of Cure*</u> *(Section 4.3.2, Add following sentences after last paragraph):* If the residual heat of reaction exceeds 10% of the measured value on the qualified component variant in the qualification tests, then the production lot shall be rejected, subject to the retest option of Section 4.3.8. Alternatively, vinylester or polyester based products may be tested in accordance with ISO 4901. The residual styrene content shall be maximum 10 % above the level measured during component qualification but not above 2 % total content.

MATERIAL DATA SHEET	**MDS - P01**	**Rev.**
TYPE OF MATERIAL: Glassfibre Reinforced Plastics (GRP)		**Page 4 of 4**

PRODUCT	***STANDARD***
Pipes, Fittings, Flanges, Adhesive and pre-fabricated spools	UKOOA: Specification and Recommended Practice for the Use of GRP Piping Offshore. (UKOOA: United Kingdom Offshore Operators Association)
8. FLANGES	Allowable bolt torque and flange mis-alignment shall be defined by manufacturer.
9. NDT/VISUAL TESTING	According to UKOOA, Part 4 or BS 7159.
10. CERTIFICATION	EN 10 204 Type 3.1B containing: - Hydrostatic mill test - Degree og cure - Short time failure pressure - Glass content - Visual inspection - Wall thickness - Resistivity (If conductive pipe is specified)

MATERIAL DATA SHEET MDS - P11 Rev. 1

TYPE OF MATERIAL: Hydrogenated Nitrile (HNBR)

PRODUCT	O-ring	**TEMPERATURE**	- 46°C to + 150°C. Only short time exposure below - 20°C acceptable.

1. SCOPE	This MDS specifies the technical requirements for the HNBR O-ring material.
2. PURCHASE INFORMATION	The purchase order shall contain the following information: Product form, dimensions, tolerances and / or referenced drawing(s) and grade designation.
3. CHEMICAL COMPOSITION	36 – 40% acrylonitrile content (ACN)
4. QUALIFICATION TEST REQUIREMENTS	The material shall be rapid pressure reduction resistant (ED resistant) and satisfy the following minimum requirements. The qualification shall be repeated if there are changes in the production route, manufacturing procedures, specified composition or properties of the product which exceeds the limits defined from qualification testing (each manufacturer and seal type shall be qualified): **ED-test** Qualification test requirements: O-ring cross section diameter 5.33 mm, 20% compression, text fixture, 70 – 85% groove fill, test medium 10% CO_2 in Methane, test temperature 100°C. 72 hours initial soak at full pressure, followed by 10 cycles of: • 200 bar (24h), • Depressurisation: 70 bar/min. • 1 hour rest time • Re-pressurisation • Leakage test No leakage shall occur in a leakage test at room temperature and service pressure following the 10 decompression cycles. Further, no cracks shall be longer than 50 % of the sample thickness, based on dissection, after the leakage test. **Mechanical properties** Hardness (Shore A) — ASTM D 2240 — 90 +/- 5 Tensile strength (min.) — ASTM D 412/ 1414 — 20 MPa Elongation at break (min.) — ASTM D 412/ 1414 — 100% Compression set (% max. 24 hr. 150°C) — ASTM D 395 — 25% **Physical properties** Specific gravity — ASTM D 792 — 1.24 – 1.27 g/cm^3
5. DIMENSIONS	BS 4518
6. PRODUCTION TEST REQUIREMENTS	The below properties shall be documented by testing for each production batch and satisfy the requirements listed above. Specific gravity (ASTM D 792) Hardness (ASTM D 2240) Tensile and elongation properties (ASTM D 412/ 1414)
7. MARKING & PACKAGING	Seals shall be supplied in sealed airtight bags. Markings on the bags shall clearly indicate batch number, and such markings shall ensure traceability through the producers QC system to raw materials, formulation and manufacturing details. In addition, the bags shall be marked with an expected shelf life assuming storage at room temperature and without direct exposure to sunlight.
8. CERTIFICATION	Inspection certificate to EN 10204 3.1 B shall contain ID no. and all test results.

MATERIAL DATA SHEET MDS – P12 Rev. 1

TYPE OF MATERIAL: Fluorocarbon terpolymer (FKM)

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

1. SCOPE	This MDS specifies the technical requirements for the FKM O-ring material.
2. PURCHASE INFORMATION	The purchase order shall contain the following information: Product form, dimensions, tolerances and / or referenced drawing(s) and grade designation.
3. CHEMICAL COMPOSITION	Vinylidene fluoride (VF2), hexafluoropropylene (HFP), and tetrafluoroethylene (TFE) with necessary fillers, stabilisers, cross-link agents.
4. QUALIFICATION TEST REQUIREMENTS	The material shall be rapid pressure reduction resistant (ED resistant) and satisfy the following minimum requirements. The qualification shall be repeated if there are changes in the production route, manufacturing procedures, specified composition or properties of the product which exceeds the limits defined from qualification testing (each manufacturer and seal type shall be qualified): **ED - test** Qualification test requirements: O-ring cross section diameter 5.33 mm, 20% compression, text fixture, 70 – 85% groove fill, test medium 10% CO_2 in Methane, test temperature 100°C. 72 hours initial soak at full pressure, followed by 10 Cycles of: • 200 bar (24h), • Depressurisation: 70 bar/min. • 1 hour rest time • Re-pressurisation • Leakage test No leakage shall occur in a leakage test at room temperature and service pressure following the 10 decompression cycles. Further, no cracks shall be longer then 50 % of the sample thickness, based on dissection, after the leakage test. **Mechanical properties** Hardness (Shore A) — ASTM D 2240 — 90 +/- 5 Tensile strength (min.) — ASTM D 412/ 1414 — 11 MPa. Elongation at break (min.) — ASTM D 412/ 1414 — 90% Compression set (% max. 24 hr. 200°C) — ASTM D 395 — 40% **Physical properties** Specific gravity — ASTM D 792 — 1.65 - 1.72 g/cm^3
5. DIMENSIONS	BS 4518
6. PRODUCTION TEST REQUIREMENTS	The below properties shall be documented by testing for each production batch and satisfy the requirements listed above. Specific gravity (ASTM D 792) Hardness (ASTM D 2240) Tensile and elongation properties (ASTM D 412/ 1414)
7. MARKING & PACKAGING	Seals shall be supplied in sealed airtight bags. Markings on the bags shall clearly indicate batch number, and such markings shall ensure traceability through the producers QC system to raw materials, formulation and manufacturing details. In addition, the bags shall be marked with an expected shelf life assuming storage at room temperature and without direct exposure to sunlight.
8. CERTIFICATION	Inspection certificate to EN 10204 3.1 B shall contain ID no. and all test results.

MATERIAL DATA SHEET MDS – P13 Rev. 1

TYPE OF MATERIAL: Fluorocarbon low T terpolymer (FKM GLT)

PRODUCT	O-ring	**TEMPERATURE**	- 46°C to + 200°C. Only short time exposure below - 20°C acceptable.

1. SCOPE	This MDS specifies the technical requirements for the FKM-GLT O-ring material.
2. PURCHASE INFORMATION	The purchase order shall contain the following information: Product form, dimensions, tolerances and / or referenced drawing(s) and grade designation.
3. CHEMICAL COMPOSITION	36 – 40% acrylonitrile content (ACN)
4. QUALIFICATION TEST REQUIREMENTS	The material shall be rapid pressure reduction resistant (ED resistant) and satisfy the following minimum requirements. The qualification shall be repeated if there are changes in the production route, manufacturing procedures, specified composition or properties of the product which exceeds the limits defined from qualification testing (each manufacturer and seal type shall be qualified): **ED-test** Qualification test requirements: O-ring cross section diameter 5.33 mm, 20% compression, text fixture, 70 – 85% groove fill, test medium 10% CO_2 in Methane, test temperature 100°C. 72 hours initial soak at full pressure, followed by 10 Cycles of: • 200 bar (24h), • Depressurisation: 70 bar/min. • 1 hour rest time • Re-pressurisation • Leakage test No leakage shall occur in a leakage test at room temperature and service pressure following the 10 decompression cycles. Further, no cracks shall be longer than 50 % of the sample thickness, based on dissection, after the leakage test. **Mechanical properties** Hardness (Shore A) ASTM D 2240 11 +/- 5 Tensile strength (min.) ASTM D 412/ 1414 90% MPa Elongation at break (min.) ASTM D 412/ 1414 90% Compression set ASTM D 395 40% (% max. 24 hr. 200°C) **Physical properties** Specific gravity ASTM D 792 1.65 - 1.72 g/cm^3
5. DIMENSIONS	BS 4518
6. PRODUCTION TEST REQUIREMENTS	The below properties shall be documented by testing for each production batch and satisfy the requirements listed above. Specific gravity (ASTM D 792) Hardness (ASTM D 2240) Tensile and elongation properties (ASTM D 412/ 1414)
7. MARKING & PACKAGING	Seals shall be supplied in sealed airtight bags. Markings on the bags shall clearly indicate batch number, and such markings shall ensure traceability through the producers QC system to raw materials, formulation and manufacturing details. In addition, the bags shall be marked with an expected shelf life assuming storage at room temperature and without direct exposure to sunlight.
8. CERTIFICATION	Inspection certificate to EN 10204 3.1 B shall contain ID no. and all test results.

MATERIAL DATA SHEET MDS – P14 Rev. 1

TYPE OF MATERIAL: Nitrile (NBR)

PRODUCT	O-ring	**TEMPERATURE**	- 46°C to + 100°C. Only short time exposure below - 20°C acceptable.

1. SCOPE	This MDS specifies the technical requirements for the NBR O-ring material.
2. PURCHASE INFORMATION	The purchase order shall contain the following information: Product form, dimensions, tolerances and / or referenced drawing(s) and grade designation.
3. CHEMICAL COMPOSITION	36 – 40% acrylonitrile content (ACN)
4. QUALIFICATION TEST REQUIREMENTS	The material shall not be used for gas service or gas containing fluids and hence, there are no need for be rapid pressure reduction testing (ED testing). The materials shall satisfy the following minimum requirements. The qualification shall be repeated if there are changes in the production route, manufacturing procedures, specified composition or properties of the product which exceeds the limits defined from qualification testing (each manufacturer and seal type shall be qualified): **Oil resistance test** Qualification test requirements: O-ring cross section diameter 5.33 mm, 20% compression, text fixture, 70 – 85% groove fill, test medium 10% toluene/ 90% Iso-octane/ ASTM oil no. 3, test temperature 70°C, 72 hours soak time. The test vessel shall be pressurised with nitrogen to 50 bar. No leakage shall occur in a leakage test at room temperature and service pressure following the exposure time. Further, the volume change shall be within + 20%/ -5%. **Mechanical properties** Hardness (Shore A) — ASTM D 2240 — 70 +/- 5 Tensile strength (min.) — ASTM D 412/ 1414 — 15 MPa Elongation at break (min.) — ASTM D 412/ 1414 — 350% Compression set (% max. 24 hr. 100°C) — ASTM D 395 — 25% **Physical properties** Specific gravity — ASTM D 792 — 1.24 - 1.27 g/cm^3
5. DIMENSIONS	BS 4518
6. PRODUCTION TEST REQUIREMENTS	The below properties shall be documented by testing for each production batch and satisfy the requirements listed above. Specific gravity (ASTM D 792) Hardness (ASTM D 2240) Tensile and elongation properties (ASTM D 412/ 1414)
7. MARKING & PACKAGING	Seals shall be supplied in sealed airtight bags. Markings on the bags shall clearly indicate batch number, and such markings shall ensure traceability through the producers QC system to raw materials, formulation and manufacturing details. In addition, the bags shall be marked with an expected shelf life assuming storage at room temperature and without direct exposure to sunlight.
8. CERTIFICATION	Inspection certificate to EN 10204 3.1 B shall contain ID no. and all test results.

MATERIAL DATA SHEET MDS – P21 Rev. 1

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

PRODUCT	Back-up rings and seat inserts	**TEMPERATURE**	-100°C to +250°C

1. SCOPE	This MDS specifies the technical requirements for the PEEK material.
2. PURCHASE INFORMATION	The purchase order shall contain the following information: Product form, dimensions, tolerances and / or referenced drawing(s) and grade designation.
3. CHEMICAL COMPOSITION	Poly-ether-ether-ketone polymer with necessary stabilisers and processing aids.
4. QUALIFICATION TEST REQUIREMENTS	The material shall satisfy the following minimum requirements. The qualification shall be repeated if there are changes in the production route, manufacturing procedures, specified composition or properties of the product which exceeds the limits defined from qualification testing:

Mechanical properties		**Virgin**	**Glass filled**
Tensile strength	ASTM D 638	95 MPa	>150 MPa
Tensile Modulus	ASTM D 638	>3000MPa	>3500MPa
Compressive strength	ASTM D 695	110 MPa	150 MPa
HDT @ 1.81 MPa	ASTM D 648	160°C	>300°C
Impact strength (notched)	ASTM D 256	>70 J/m	>70 J/m
Ultimate elongation (%)	ASTM D 638	> 60 %	> 5 %
Physical properties			
Density (g/cm$^{3)}$	ASTM D 792	1.3 - 1.33	1.46 - 1.55
Melting point	ASTM 3418	340°C	340°C
Water absorbtion (24 hrs.)	ASTM D 570	0.15 %	0.15%

5. DIMENSIONS	BS 4518
6. PRODUCTION TEST REQUIREMENTS	The below properties shall be documented by testing for each production batch and satisfy the requirements listed above. Density ASTM D 792 Tensile strength ASTM D 638 Ultimate elongation (%) ASTM D 638
7. MARKING & PACKAGING	Components shall be supplied in suitable packaging as to protect the items from physical damage prior to installation. Markings on the packaging shall clearly indicate material batch number, and such markings shall ensure traceability through the producers QC system to raw materials, formulation and manufacturing details.
8. CERTIFICATION	Inspection certificate to EN 10204 3.1 B shall contain ID no. and all test results.

MATERIAL DATA SHEET MDS - P22 Rev. 1

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

PRODUCT	Lip-seals, back-up rings and seat inserts	**TEMPERATURE**	-190°C to +200°C

1. SCOPE	This MDS specifies the technical requirements for the PTFE material.
2. PURCHASE INFORMATION	The purchase order shall contain the following information: Product form, dimensions, tolerances and / or referenced drawing(s) and grade designation.
3. CHEMICAL COMPOSITION	Carbon and fluorine, polymeric di-fluoromethane with necessary fillers, stabilisers and process aids. Also with graphite, glass or carbon fibre fillers. The lip-seal must be energised internally by a metallic spring (UNS R30003) or similar.
4. QUALIFICATION TEST REQUIREMENTS	The material shall satisfy the following minimum requirements. The qualification shall be repeated if there are changes in the production route, manufacturing procedures, specified composition or properties of the product which exceeds the limits defined from qualification testing:

Mechanical properties		**Virgin**	**25%Glass**	**25%Graph**
Tensile strength (MPa)	ASTM D 638	>25	> 15	> 15
Hardness (Shore D)	ASTM D 785	50 - 60	50 - 60	60-70
Compressive strength (1%) (MPa)	ASTM D 695	4	6	6
Compressive modulus (MPa)	ASTM D 695	> 400	> 600	>600
HDT @ 1.81 MPa	ASTM D 648	54°C	110°C	95°C
Impact strength (notched) (J/m)	ASTM D 256	>145	>130	140
Ultimate elongation (%)	ASTM D 638	>180	>180	>65
Physical properties				
Density (g/cm^3)	ASTM D 792	2 - 2.2	2- 2.24	1.9- 2.1
Melting point (°C)	ASTM 3418	325	325	325
Water absorbtion (24 hrs.)	ASTM D 570	0.01 %	0.02%	0.01%

5. PRODUCTION TEST REQUIREMENTS	The below properties shall be documented by testing for each production batch and satisfy the requirements listed above. Hardness (Shore D) ASTM D785 Density ASTM D792 Tensile strength ASTM D638 Ultimate elongation (%) ASTM D638
6. MARKING & PACKAGING	Components shall be supplied in suitable packaging as to protect the items from physical damage prior to installation. Markings on the packaging shall clearly indicate material batch number, and such markings shall ensure traceability through the producers QC system to raw materials, formulation and manufacturing details.
7. CERTIFICATION	Inspection certificate to EN 10204 3.1 B shall contain ID no. and all test results.

MATERIAL DATA SHEET MDS - P23 Rev. 1

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

PRODUCT	Seat inserts	**TEMPERATURE**	-100°C to +200°C

1. SCOPE	This MDS specifies the technical requirements for the PEEK/ PTFE material.
2. PURCHASE INFORMATION	The purchase order shall contain the following information: Product form, dimensions, tolerances and / or referenced drawing(s) and grade designation.
3. CHEMICAL COMPOSITION	Poly-ether-ether-ketone polymer with necessary stabilisers and processing aids and 10 to 20 % PTFE (Poly-tetra-fluoro-ethylene) added.
4. QUALIFICATION TEST REQUIREMENTS	The material shall satisfy the following minimum requirements. The qualification shall be repeated if there are changes in the production route, manufacturing procedures, specified composition or properties of the product which exceeds the limits defined from qualification testing:

Mechanical properties		**Virgin**
Tensile strength	ASTM D 638	> 80 MPa
Hardness (Shore D)	ASTM D 785	82- 88
Tensile Modulus	ASTM D 638	>3000MPa
Compressive strength	ASTM D 695	100 MPa
HDT @ 1.81 MPa	ASTM D 648	150°C
Impact strength (notched)	ASTM D 256	HOLD J/m
Ultimate elongation (%)	ASTM D 638	> 20 %
Physical properties		
Density (g/cm$^{3)}$	ASTM D 792	1.36 - 1.40
Melting point	ASTM 3418	340 °C
Water absorbtion (24 hrs.)	ASTM D 570	0.10 %

5. DIMENSIONS	BS 4518
6. PRODUCTION TEST REQUIREMENTS	The below properties shall be documented by testing for each production batch and satisfy the requirements listed above. Hardness ASTM D 785 Density ASTM D 792 Tensile strength ASTM D 638 Ultimate elongation (%) ASTM D 638
7. MARKING & PACKAGING	Components shall be supplied in suitable packaging as to protect the items from physical damage prior to installation. Markings on the packaging shall clearly indicate material batch number, and such markings shall ensure traceability through the producers QC system to raw materials, formulation and manufacturing details.
8. CERTIFICATION	Inspection certificate to EN 10204 3.1 B shall contain ID no. and all test results.

MATERIAL DATA SHEET MDS - R11 Rev. 2

TYPE OF MATERIAL: Austenitic stainless steel, Type 6Mo **Page 1 of 1**

PRODUCT	*STANDARD*	*GRADE*	*ACCEPT. CLASS*	*SUPPL. REQ.*
Seamless pipes	ASTM A 312	UNS S31254 UNS N08367 UNS N08925 UNS N08926	-	-

1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard. Material grades not included in A 312 shall comply to the test and tolerance requirements given to Grade UNS S31254.
2. QUALIFICATION	Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.
3. STEEL MAKING	The steel melt shall be refined by AOD or equivalent .
4. HEAT TREATMENT	The pipes shall be solution annealed followed by water quenching.
5. CORROSION TESTING	Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. Test specimens shall have the internal and external surfaces in the as-delivered condition (including pickling). Cut edges shall be prepared according to ASTM G48, and the whole specimen shall be pickled (20 % HNO3 + 5 % HF, 60 °C, 5 minute). The test shall expose the external and internal surfaces and a cross section surface in full wall thickness. The acceptance criteria are: - No pitting at 20 X magnification. - The weight loss shall be less than 4.0 g/m.
6. EXTENT OF TESTING	Corrosion test shall be carried out to the same extent as stated for mechanical tests in the referred standard.
7. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual components.
8. SURFACE FINISH	White pickled.
9. REPAIR OF DEFECTS	Weld repair is not acceptable.
10. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.
11. CERTIFICATION	EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET	**MDS - R12**			**Rev. 2**
TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo				**Page 1 of 2**
PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Welded Pipes	ASTM A 358	UNS S31254 UNS N08367 UNS N08925 UNS N08926	Class 1, 3 and 5.	S3

1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard. Material grades not included in A 240 shall comply with the test and tolerance requirements given to Grade UNS S31254.
2. QUALIFICATION	Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.
3. STEEL MAKING	Steel melt shall be refined with AOD or equivalent refining.
4. HEAT TREATMENT	The pipes shall be solution annealed followed by water quenching. Post weld solution annealing is not required of pipes with nominal wall thickness up to 7.11 mm manufactured out of solution annealed plate material as stated in chapter 5.3.2.2 of A 358.
5. CHEMICAL COMPOSITION	UNS N08925 and N08926: N = 0.18 - 0.22 %.
6. CORROSION TESTING	Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. Test specimens shall have the internal and external surfaces in the as-delivered condition (including pickling). Cut edges shall be prepared according to ASTM G 48, and the whole specimen shall be pickled (20 % HNO3 + 5 % HF, 60 °C, 5 minute). The test shall expose the external and internal surfaces and a cross section surface including weld zone in full wall thickness. The acceptance criteria are: - No pitting at 20 X magnification. - The weight loss shall be less than 4.0 g/m^2.
7. EXTENT OF TESTING	Tensile and corrosion testing shall be carried out for each lot defined as follows: - For batch furnace a lot is defined as maximum 60 m pipe of the same heat, size and heat treatment charge. - For continuous heat treatment furnace a lot is defined as maximum 60 m of pipe of the same heat and size and which are heat treated the same day.
8. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual components.
9. WELDING	The PQR/WPAR shall be qualified in accordance with ASME IX or EN 288-3 and this MDS: - The weld consumable shall be Ni-base and the alloying content shall be: Mo ≥ 8.0 %; Cr ≥ 15.0 %; (Mo + Cr) ≥ 28 %; C ≤ 0.030 %; S ≤ 0.015 % and Nb < 0.5 %. - The PQR/WPAR shall be corrosion tested as specified above. The qualification shall be carried out on the same material grade (UNS number) as used in production. Change of specific make (brand name) of welding consumables requires requalification.

MATERIAL DATA SHEET	**MDS - R12**			**Rev. 2**
TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo				**Page 2 of 2**
PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Welded Pipes	ASTM A 358	UNS S31254 UNS N08367 UNS N08925 UNS N08926	Class 1, 3 and 5.	S3
10. NON DESTRUCTIVE TESTING	Eddy current testing according to ASTM A 450 is acceptable as replacement for radiography for wall thicknesses less than 4,0 mm. Supplementary requirement S3, penetrant testing, shall apply according to ASME V Article 6, to the weld area of 10 % of the pipes (same test lot as defined for mechanical testing) delivered. The testing shall be carried out after calibration and pickling. Acceptance criteria shall be to ASME VIII Div. 1 Appendix 8.			
11. SURFACE FINISH	White pickled.			
12. REPAIR OF DEFECTS	Weld repair of base material is not acceptable. For repair of welds same requirements to PQR/WPAR as for production welding.			
13. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.			
14. CERTIFICATION	EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.			

MATERIAL DATA SHEET MDS - R13 Rev. 2

TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo **Page 1 of 2**

PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Wrought fittings	ASTM A 403	WP S31254 UNS N08367 UNS N08925 UNS N08926	WP-S, WP-WX and WP-W	S2, S7

1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard. Material grades not included in A 403 shall comply with the test and tolerance requirements given to Grade UNS S31254.
2. QUALIFICATION	Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.
3. STEEL MAKING	Steel melt shall be refined with AOD or equivalent.
4. HEAT TREATMENT	The fittings shall be solution annealed followed by water quenching.
5. CORROSION TESTING	Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. The specimen shall have the internal and external surfaces in the as-delivered condition (including pickling). Cut edges shall be prepared according to ASTM G 48, and the whole specimen shall be pickled (20 % HNO3 + 5 % HF, 60 °C, 5 minute). The test shall expose the external and internal surfaces and a cross section including weld zone (if relevant) in full wall thickness. The acceptance criteria are: - No pitting at 20 X magnification. - The weight loss shall be less than 4.0 g/m^2.
6. EXTENT OF TESTING	Tensile and corrosion testing shall be performed for each heat, heat treatment load with a wall thickness range of 5 mm and welded with the same WPS.
7. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual components.
8. WELDING	The welding procedure shall be qualified in accordance with ASME IX or EN 288-3 and this MDS: - The weld consumable alloying content shall be: Mo ≥ 8.0 %; Cr ≥ 15.0 %; (Mo + Cr) ≥ 28 %; C ≤ 0.030 %; S ≤ 0.015 %; Nb < 0.5 %. - The PQR/WPAR shall be corrosion tested as specified above. The qualification shall be carried out on the same material grade (UNS number) as used in production. Change of specific make (brand name) of welding consumables requires requalification.
9. DIMENSIONAL TOLERANCES	Fittings with reference to MSS-SP-75 shall have maximum wall thickness under tolerance of 0.3 mm.
10. NON DESTRUCTIVE TESTING	Supplementary requirement S7, liquid penetrant testing, shall apply to 10 % of seamless fittings (from the test lot as defined above) and 100 % of welded fittings above NPS 2. For welded fittings the testing shall cover the weld only. The resting shall be carried out after calibration and pickling. The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 8.

MATERIAL DATA SHEET		**MDS - R13**		**Rev. 2**
TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo				**Page 2 of 2**
PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Wrought fittings	ASTM A 403	WP S31254 UNS N08367 UNS N08925 UNS N08926	WP-S, WP-WX and WP-W	S2, S7

11. SURFACE FINISH	White pickled.
12. REPAIR OF DEFECTS	Weld repair of base material is not acceptable. For repair of welds the same requirement to PQR/WPAR shall apply as for production testing.
13. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.
14. CERTIFICATION	EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET MDS - R14 Rev. 2

TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo

PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Forgings	ASTM A 182	F44 UNS N08367 UNS N08925 UNS N08926	-	S5

1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard. Material grades not included in A 182 shall comply with the test and tolerance requirements given to Grade F44.
2. QUALIFICATION	Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.
3. STEEL MAKING	The steel melt shall be refined with AOD or equivalent.
4. MANUFACTURING PROCESS	The Hot Isostatic Pressed (HIP) process is an acceptable alternative to forging.
5. HEAT TREATMENT	The forgings shall be solution annealed followed by water quenching.
6. CHEMICAL COMPOSITION	*UNS N08925 and N08926:* N = 0.18 - 0.22 %
7. CORROSION TESTING	Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. The corrosion test specimens shall be at the same location as those for mechanical testing. Cut edges shall be prepared according to ASTM G 48 and pickled (20 % HNO3 + 5 % HF, 60 °C, 5 minute). The acceptance criteria are: - No pitting at 20 X magnification. - The weight loss shall be less than 4.0 g/m^2.
8. EXTENT OF TESTING	One set of tensile test and corrosion test shall be carried out for each heat and heat treatment load. A test lot shall not exceed 2000 kg for forgings with as forged weight ≤ 50 kg, and 5000 kg for forgings with as forged weight > 50 kg.
9. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual components. Test samples shall be from prolongations on actual component. Sacrificial forgings shall be used for die forged components. However, special agreements may be made for die forged components with as forged weight exceeding 50 kg. Integrated blocks shall be used for HIP. Test specimens shall be cut at the 1/4 T location from the surface where T is the thickness of the test samples as heat treated. Sketches shall be established showing type, size and location of test samples and extraction of test specimens.
10. DIMENSIONAL TOLERANCES	Flanges to MSS SP-44 shall have maximum wall thickness under tolerance of 0.3 mm at the welding end.

MATERIAL DATA SHEET	**MDS - R14**			**Rev. 2**
TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo				**Page 2 of 2**
PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Forgings	ASTM A 182	F44 UNS N08367 UNS N08925 UNS N08926	-	S5

11. NON DESTRUCTIVE TESTING	Supplementary requirement S5, liquid penetrant testing, shall apply to 10 % of all forgings (from the lot as defined for mechanical testing) above NPS 2. The testing shall be carried out after final machining and pickling. The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 8.
12. SURFACE FINISH	White pickled including machined surfaces.
13. REPAIR OF DEFECTS	Weld repair is not acceptable.
14. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.
15. CERTIFICATION	EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET MDS - R15 Rev. 2

TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo **Page 1 of 1**

PRODUCT	*STANDARD*	*GRADE*	*ACCEPT. CLASS*	*SUPPL. REQ.*
Plates	ASTM A 240	UNS S31254 UNS N08367 UNS N08925 UNS N08926	-	-

1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard. Material grades not included in A 240 shall comply with the test and tolerance requirements given to Grade UNS S31254.
2. QUALIFICATION	Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.
3. STEEL MAKING	The steel melt shall be refined with AOD or equivalent.
4. HEAT TREATMENT	The plates shall be solution annealed followed by water quenching.
5. CHEMICAL COMPOSITION	*UNS N08925 and N08926:* N = 0.18 - 0.22 %
6. CORROSION TESTING	Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. Test specimens shall have the surfaces in the as-delivered condition (including pickling). Cut edges shall be prepared according to ASTM G 48, and the whole specimen shall be pickled (20 % HNO3 + 5 % HF, 60 °C, 5 minute). The test shall expose the external and internal surfaces and a cross section surface in full wall thickness. The acceptance criteria are: - No pitting at 20 X magnification. - The weight loss shall be less than 4.0 g/m^2.
7. EXTENT OF TESTING	Corrosion testing shall be carried out to the same extent as stated for mechanical tests in the referred standard.
8. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual components.
9. SURFACE FINISH	White pickled.
10. REPAIR OF DEFECTS	Weld repair is not acceptable.
11. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.
CERTIFICATION	EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET MDS - R16 Rev. 2

TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo

PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Castings	ASTM A 351	CK-3MCuN CN-3MN	-	S5, S6

1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.
2. QUALIFICATION	Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.
3. STEEL MAKING	The steel melt shall be refined with AOD or equivalent process. Remelting of AOD or equivalent steel in an electric furnace is acceptable. Use of internal scrap is not acceptable.
4. HEAT TREATMENT	Solution annealed at temperature ≥ 1225 °C.
5. CHEMICAL	P ≤ 0.030 %
6. CORROSION TESTING	Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. The corrosion test specimen shall be at the same location as those for mechanical testing. Cut edges shall be prepared according to ASTM G 48 and pickled (20 % HNO3 + 5 % HF, 60 °C, 5 minute). The acceptance criteria are: - No pitting at 20 X magnification. - The weight loss shall be less than 4.0 g/m^2.
7. EXTENT OF TESTING	Tensile test and corrosion test shall be made for each melt and heat treatment load. A test lot shall not exceed 5 000 kg.
8. TEST SAMPLING	Samples for mechanical testing shall realistically reflect the properties in the actual components. Thickness of the test block shall be equal to the thickness of the actual components up to a maximum thickness of 100 mm. For flanged components the largest flange thickness shall apply. Test specimens shall be cut from the 1/4 T location from the surface where T is the thickness of the test block. Test block shall be integrally cast or gated onto the castings and shall not be removed from the castings until after the final quality heat treatment.
9. NON DESTRUCTIVE TESTING	*Liquid penetrant testing:* Supplementary requirement S6 shall apply to all accessible surfaces of all castings. The testing shall be carried out after final machining and pickling. The acceptance criteria shall be ASME VIII, Div.1, Appendix 7. *Radiographic testing:* Supplementary requirement S5 shall apply to: - critical areas as per ANSI B 16.34 of the pilot cast of each pattern - All butt weld ends of each casting - Class 1500 psi and above; all critical areas to ANSI B16.34 of each casting. The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 7.
10. SURFACE FINISH	White pickled. Shall be carried out after any blasting and shall include finished machined surfaces.

MATERIAL DATA SHEET MDS - R16				**Rev. 2**
TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo				**Page 2 of 2**
PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Castings	ASTM A 351	CK-3MCuN CN-3MN	-	S5, S6

11. REPAIR OF DEFECTS	Repair welding shall be carried out with Ni-based consumables with alloying content: Mo ≥ 8.0 %; Cr ≥ 15.0 %; (Mo + Cr) ≥ 28 %; C ≤ 0.030 %; S ≤ 0.015 %; Nb < 0.5 %. Welding consumables with matching chemical composition is acceptable provided solution annealing heat treatment after welding. The repair welding procedure shall be qualified in accordance with ASME IX or EN 288-3 and this MDS. - A cast plate shall be used for the test welding. - A macro and corrosion test as specified above shall be carried out. - Change specific make of filler metal (brand name) requires requalification. All casting with major repairs shall be given a solution heat treatment after welding.
12. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.
13. CERTIFICATION	EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET MDS - R17 Rev. 2

TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo **Page 1 of 1**

PRODUCT	*STANDARD*	*GRADE*	*ACCEPT. CLASS*	*SUPPL. REQ.*
Bars	ASTM A 276	UNS S31254 UNS N08367 UNS N08925 UNS N08926	-	-

1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard. Material grades not included in A 276 shall comply with the test and tolerance requirements given to UNS S31254.
2. QUALIFICATION	Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.
3. STEEL MAKING	The steel melt shall be refined with AOD or equivalent.
4. HEAT TREATMENT	Solution annealing followed by water quenching.
5. CHEMICAL COMPOSITION	*UNS N08925 and N08926:* N = 0.18 - 0.22 %
6. CORROSION TESTING	Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. The corrosion test specimens shall be at the same location as those for mechanical testing. Cut edges shall be prepared according to ASTM and pickled (20 % HNO3 + 5 % HF, 60 °C, 5 minute). The acceptance criteria are: - No pitting at 20 X magnification. - The weight loss shall be less than 4.0 g/m^2.
7. EXTENT OF TESTING	One tensile test and corrosion test shall be carried out for each heat and heat treatment load.
8. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual components.
9. SURFACE FINISH	Finished product shall be white pickled.
10. REPAIR OF DEFECTS	Weld repair is not acceptable
11. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.
12. CERTIFICATION	EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET MDS - R18 Rev. 2

TYPE OF MATERIAL: Austenitic stainless steel, Type 6Mo **Page 1 of 1**

PRODUCT	*STANDARD*	*GRADE*	*ACCEPT. CLASS*	*SUPPL. REQ.*
Tubes	ASTM A 269	UNS S31254 UNS N08367 UNS N08925 UNS N08926	-	-

1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard. Material grades not included in A 269 shall comply to the test and tolerance requirements given to Grade UNS S31254.
2. QUALIFICATION	Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.
3. STEEL MAKING	The steel melt shall be refined by AOD or equivalent.
4. HEAT TREATMENT	The tubes shall be solution annealed followed by water quenching.
5. CORROSION TESTING	Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. Test specimens shall have internal and external surfaces in an as-delivered condition (including pickling). Cut edges shall be prepared according to ASTM G 48 and the whole specimen shall be pickled (20 % HNO3 + 5 % HF, 60 °C, 5 minute). The acceptance criteria are: - No pitting at 20 X magnification. - The weight loss shall be less than 4.0 g/m^2.
6. EXTENT OF TESTING	Corrosion testing shall be carried out to the same extent as stated for mechanical tests in the referred standard.
7. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual components.
8. SURFACE FINISH	White pickled.
9. REPAIR OF DEFECTS	Weld repair is not acceptable.
10. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.
11. CERTIFICATION	EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET MDS - R18 Rev. 2

TYPE OF MATERIAL: Austenitic stainless steel, Type 6Mo **Page 1 of 1**

PRODUCT	*STANDARD*	*GRADE*	*ACCEPT. CLASS*	*SUPPL. REQ.*
Tubes	ASTM A 269	UNS S31254 UNS N08367 UNS N08925 UNS N08926	-	-

1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard. Material grades not included in A 269 shall comply to the test and tolerance requirements given to Grade UNS S31254.
2. QUALIFICATION	Manufacturers of product to this MDS shall comply with the requirement of NORSOK Standard M-650.
3. STEEL MAKING	The steel melt shall be refined by AOD or equivalent.
4. HEAT TREATMENT	The tubes shall be solution annealed followed by water quenching.
5. CORROSION TESTING	Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. Test specimens shall have internal and external surfaces in an as-delivered condition (including pickling). Cut edges shall be prepared according to ASTM G 48 and the whole specimen shall be pickled (20 % HNO3 + 5 % HF, 60 °C, 5 minute). The acceptance criteria are: - No pitting at 20 X magnification. - The weight loss shall be less than 4.0 g/m^2.
6. EXTENT OF TESTING	Corrosion testing shall be carried out to the same extent as stated for mechanical tests in the referred standard.
7. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual components.
8. SURFACE FINISH	White pickled.
9. REPAIR OF DEFECTS	Weld repair is not acceptable.
10. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.
11. CERTIFICATION	EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET MDS - S01 Rev. 2

TYPE OF MATERIAL: Austenitic Stainless Steel, Type 316 **Page 1 of 1**

PRODUCT	*STANDARD*	*GRADE*	*ACCEPT. CLASS*	*SUPPL. REQ.*
Wrought fittings	ASTM A 403	WP 316	W/S/WX	-
Welded pipes	ASTM A 358	316	Class 1, 3, 4 or 5	-
Seamless & welded pipes	ASTM A 312	TP 316	-	-
Forgings	ASTM A 182	F 316	-	-
Plates	ASTM A 240	316	-	-
Tubes	ASTM A 269	316	-	-

1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.
2. CHEMICAL COMPOSITION	All products: $C \leq 0.035$ % Plates to A 240: $S \leq 0.015$ %
3. TENSILE TESTING	Grade 316 L with $R_{p0.2} \geq 205$ MPa and $R_m \geq 515$ MPa is acceptable.
4. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual component.
5. DIMENSIONAL TOLERANCES	*Flanges to A 182:* Flanges to MSS SP-44 shall have a maximum wall thickness under tolerance of 0.3 mm at weld end.
6. NON DESTRUCTIVE TESTING	*Welded pipes to A 358:* Eddy current testing according to ASTM A450 is acceptable as replacement for spot radiography for wall thicknesses less than 4.0 mm. *Welded tubes to A269:* Eddy current testing according to ASTM A 450, section 23 is required.
7. SURFACE FINISH	White pickled. Machined surfaces do not require pickling.
8. REPAIR OF DEFECTS	Weld repair of base material is not acceptable.
9. CERTIFICATION	EN 10 204 Type 3.1B

MATERIAL DATA SHEET MDS - S02 Rev. 2

TYPE OF MATERIAL: Austenitic Stainless Steel Castings **Page 1 of 1**

PRODUCT	*STANDARD*	*GRADE*	*ACCEPT. CLASS*	*SUPPL. REQ.*
Castings	ASTM A 351	CF8M CF3M	- -	S5, S6 S5, S6

1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.
2. EXTENT OF TESTING	Tensile testing is required for each heat and heat treatment load .
3. TEST SAMPLING	For castings with weight 250 kg and above the test blocks shall be integrally cast with the casting. The test blocks shall be heat treated together with the castings they represents. Samples for mechanical testing shall realistically reflect the properties in the actual components.
4. NON DESTRUCTIVE TESTING	*Liquid penetrant testing:* Supplementary requirement S6 shall apply to all accessible surfaces of all castings. The testing shall be carried out after final maching and pickling. The acceptance criteria shall be ASME VIII, Div.1, Appendix 7. *Radiographic testing:* Supplementary requirement S5 shall apply to: - Critical areas as per ANSI B16.34 of the pilot cast of each pattern - All butt weld ends of each casting. - Class 1500 psi and above; all critical areas according to ANSI B16.34 of each casting. The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 7.
5. SURFACE FINISH	White pickled. Machined surfaces do not require pickling.
6. CERTIFICATION	EN 10 204 Type 3.1B

MATERIAL DATA SHEET MDS - T01 Rev. 2

TYPE OF MATERIAL: Titanium Grade 2 **Page 1 of 1**

PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Seamless pipes	ASTM B 861	2	-	-
Welded pipes	ASTM B 862	2	-	-
Wrought fittings	ASTM B 363	WPT2/WPT2W	-	-
Forgings	ASTM B 381	F2	-	-
Plates	ASTM B 265	2	-	-
Bars	ASTM B 348	2	-	-
Tubes	ASTM B 338	2	-	-

1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard. Equivalent Titanium grade (GOST VT 1-0) is acceptable provided the requirements in the referred standard and this MDS is fulfilled.	
2. CHEMICAL COMPOSITION	Chemical composition other than Grade 2 (GOST VT 1-0) is acceptable.	
3. HEAT TREATMENT	*Wrought fittings to B 363, Forgings to B 381, Plates to B 265 and Bars to B 348:* Annealed condition if not the tensile properties in the referred standard can be acheived in as formed condition.	
4. EXTENT OF TESTING	*Wrought fittings to B 363:*	Tensile test shall be carried out for each heat, heat treatment load, type and size.
	Forgings to B 381:	Tensile test specimen shall be taken from each lot. A lot is defined as all products of the same heat and heat treatment load with a maximum deviation from the test block thickness of 10 mm
	Bars to B 348:	Tensile test specimen shall be taken from each lot. A lot is defined as all products of the same heat and heat treatment load with a maximum deviation from the test block thickness of 10 mm.
5. TEST SAMPLING	*All products:*	Samples for production testing shall realistically reflect the properties in the actual component.
6. WELDING	*Welded pipes to B 862:*	Welding procedures shall be qualified in accordance with ASME IX.
7. DIMENSIONAL TOLERANCES	*Flanges to B 381:*	Flanges to MSS SP-44 shall have a maximum wall thickness under tolerance of 0.3 mm at weld end.
8. CERTIFICATION	EN 10 204 Type 3.1B.	

MATERIAL DATA SHEET	**MDS - T02**			**Rev. 2**
TYPE OF MATERIAL: Titanium Grade 2				**Page 1 of 1**
PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Castings	ASTM B 367	C2	-	S1, S2

1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard. Equivalent Titanium grades (GOST VT 1-0) are acceptable provided the requirements in this MDS is fulfilled.
2. QUALIFICATION	Manufacturers of product to this MDS shall be qualified in accordance with NORSOK Standard M-650.
3. CHEMICAL COMPOSTION	Chemical composition other than Grade 2 (GOST VT 1-0) is acceptable.
4. EXTENT OF TESTING	Tensile testing is required for each heat and heat treatment load.
5. TEST SAMPLING	Samples for mechanical testing shall realistically reflect the properties in the actual components. For castings with weight 250 kg and above the test blocks shall be integrally cast with the casting. The test blocks shall be heat treated together with the castings they represents.
6. NON DESTRUCTIVE TESTING	*Liquid penetrant testing:* Supplementary requirement S*2* shall apply to all accessible surfaces of all castings. The testing shall be carried out after final machining. The acceptance criteria shall be ASME VIII, Div.1, Appendix 7. *Radiographic testing:* Supplementary requirement S1 shall apply to: - Critical areas as per ANSI B16.34 of the pilot cast of each pattern - All butt weld ends of each casting. - Class 1500 psi and above; all critical areas according to ANSI B16.34 of each casting. The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 7.
7. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.
8. CERTIFICATION	EN 10 204 Type 3.1B

MATERIAL DATA SHEET MDS - X01 Rev. 1

***TYPE OF MATERIAL*:** Low Alloyed Steel Type AISI 4130 **Page 1 of 1**

PRODUCT	*STANDARD*	*GRADE*	*ACCEPT. CLASS*	*SUPPL. REQ.*
Seamless pipes Wrought fittings (seamless)	ASTM A 519 ASTM A 234	AISI 4130 AISI 4130		S2

1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.
2. HEAT TREATMENT	Fittings and pipes shall be delivered in the liquid quenched and tempered condition. The tempering temperature shall be minimum 650 °C.
3. MANUFACTURING PROCESS	Pipes shall be manufactured by means of the hot finished (HF) sizing method. Only seamless fittings are acceptable.
4. CHEMICAL COMPOSITION	Max. sulphur content: $S \leq 0.025$ % Max. phosphorous content: $P \leq 0.025$ %
5. TENSILE TESTING	Minimum yield strength: Reh $\geq$ 415 MPa Minimum tensile strength: Rm $\geq$ 620 MPa Minimum elongation: A5 $\geq$ 18 % Minimum red. of area: Z $\geq$ 35 %
6. IMPACT TESTING	Charpy V-notch impact testing shall be carried out according to ASTM A 370 for thicknesses t $\geq$ 6 mm. Full sized Charpy V-notch specimens shall be used wherever possible. The notch shall be perpendicular to the surface. The test temperature shall be - 30 °C. The minimum absorbed energy for full size specimens shall be 42 J average and 30 J single. Reduction factors for subsize specimens shall be: 7.5 mm - 5/6 and 5 mm - 2/3.
7. EXTENT OF TESTING	One set of tensile and impact test shall be carried out for each lot. A lot is defiened as all products of the same type, nominal size and wall thickness, produced from the same heat and heat treatment load. For pipes heat treated in continous furnace the maximum lot size shall be 60 m.
8. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual component. *Fittings:* According to supplementary requirement S2.
9. NON DESTRUCTIVE TESTING	*Pipes:* All pipes shall be 100 % tested in accordance with API 5L supplementary requirement 4 (SR4). Alternatively, ultrasonic testing according to SEL 1915 may be carried out. *Fittings:* Fittings shall be 100 % magnetic particle tested in accordance with ASME VIII, div. 1, Appendix 6.
10. REPAIR OF DEFECTS	Weld repair is not acceptable.
11. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.
12. CERTIFICATION	EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate

MATERIAL DATA SHEET	**MDS - X02**			**Rev. 2**
TYPE OF MATERIAL: High Strength Low Alloyed Steel Type AISI 4140				**Page 1 of 1**
PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Forgings	ASTM A 788	AISI 4140	-	S18

1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.
2. MANUFACTURING PROCESS	The forgings shall be finished hot-worked.
3. HEAT TREATMENT	The forgings shall be austenitised, liquid quenched and tempered.
4. CHEMICAL COMPOSITION	According to ASTM A 29, AISI 4140
5. TENSILE TESTING	Minimum yield strength: Reh $\geq$ 620 MPa Minimum tensile strength: Rm $\geq$ 850 MPa Minimum elongation: A5 $\geq$ 15 %
6. IMPACT TESTING	Charpy V-notch testing is required according to ASTM A 370 at - 30 °C. The nocth shall be perpendicular to the surface. The minimum absorbed energy for full size specimens shall be 42 J average and 30 J single.
7. EXTENT OF TESTING	One set of tensile and impact test shall be carried out for each melt, section thickness +/- 25 % and heat treatment load.
8. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual component. Test samples shall be from prolongations on actual components. Sacrificial forgings shall be used for die forged components. However, special agreements may be made for die forged components with as forged weight exceeding 50 kg. Test specimens shall be cut at the 1/4 T location from the surface where T is the thickness of the test samples as heat treated. Sketches shall be established showing type, size and location of test samples and extraction of test specimens.
9. NON DESTRUCTIVE TESTING	Supplementary Requirement, S18, magnetic particle tested, shall apply to 10 % of all forgings (from the lot as defined for mechanical testing). The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 6.
10. REPAIR OF DEFECTS	Weld repair is not acceptable.
11. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.
12. CERTIFICATION	EN 10 204 Type 3.1B Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET MDS - X03 Rev. 2

TYPE OF MATERIAL: High Strength Low Alloy Steel **Page 1 of 1**

PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Castings	ASTM A 487	Grade 2B, 2C	-	S4, S5

1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.
2. IMPACT TESTING	Charpy V-notch testing is required according to ASTM A 370 at - 30 °C. The notch shall be perpendicular to the surface. The minimum absorbed energy shall be 42 J average (of (3 specimens) and 30 J single value.
3. EXTENT OF TESTING	One set of tensile and impact test is required for each melt and heat treatment load. A test lot shall not exceed 5000 kg.
4. TEST SAMPLING	Samples for mechanical testing shall realistically reflect the properties in the actual components. Thickness of the test block shall be equal to the thickness of the actual components up to a maximum thickness of 100 mm. For flanged components the largest flange thickness shall apply. Test specimens shall be cut from the 1/4 T location from the surface where T is the thickness of the test block. Test block shall be integrally cast or gated onto the castings and shall not be removed from the castings until after the final quality heat treatment.
5. NON DESTRUCTIVE TESTING	*Magnetic particle testing:* Supplementary requirement S4 shall apply to all accessible surfaces of all castings. The examination shall be carried out after machining. The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 7. *Radiographic testing:* Supplementary requirement S5 shall apply to: - Critical areas as per ANSI B16.34 of the pilot cast of each pattern. - All butt weld ends of each casting. - Class 1500 psi and above; all critical areas to ANSI B16.34 of each casting. The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 7.
6. REPAIR OF DEFECTS	All weld repairs shall be post weld heat treated. The repair welding procedure qualification shall include the following: - qualification on a cast plate of the same grade - one set of impact test (3 specimens), shall be taken from weld metal and fusion line.
7. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.
8. CERTIFICATION	EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET MDS - X04 Rev. 1

TYPE OF MATERIAL: High Strength Low Alloyed Steel Type AISI 4130 **Page 1 of 1**

PRODUCT	*STANDARD*	*GRADE*	*ACCEPT. CLASS*	*SUPPL. REQ.*
Forgings	API 6A	60K (AISI 4130)	Product Specification Level (PSL) 3	-

1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.
2. MANUFACTURING PROCESS	The flanges shall be forged to shape. Flanges machined out of bar and or plate are not accepted.
3. HEAT TREATMENT/ DELIVERY CONDITION	The flanges shall be austenitised, liquid quenched and tempered.
4. CHEMICAL COMPOSITION	The steel chemistry shall comply with the requirements of AISI 4130, however modified in accordance with the requirements PSL 3 given in table 404.6 of API 6A. The chemical composition shall be agreed.
5. IMPACT TESTING	Charpy V-notch testing at - 30 °C is required. The minimum absorbed energy for full size specimens shall be 42 J average and 30 J single.
6. EXTENT OF TESTING	One set of tensile and impact test shall be carried out for each melt, section thickness according to API 6A, PSL 3, and heat treatment load. A test lot shall not exceed 2000 kg.
7. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual component. Test samples shall be from prolongations on actual components. Sacrificial forgings shall be used for die forged components. However, special agreements may be made for die forged components with as forged weight exceeding 50 kg. Test specimens shall be cut at the 1/4 T location from the surface where T is the thickness of the test samples as heat treated. Sketches shall be established showing type, size and location of test samples and extraction of test.
8. DIMENSIONAL TOLERANCES	Flanges to MSS SP-44 shall have a maximum wall thickness under tolerance of 0.3 mm for the hub at the welding end.
9. NON DESTRUCTIVE TESTING	NDT shall be carried out after final heat treatment: - 100 % MT according to ASME VIII, Div.1, App.6, shall be carried out. - 100 % UT according to ASTM A 388, shall be carried out. The acceptance criterias shall be according to ASTM A 388 para 8.
10. REPAIR OF DEFECTS	Weld repair is not acceptable.
11. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.
12. CERTIFICATION	EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate

MATERIAL DATA SHEET	MDS - X05			Rev. 1
TYPE OF MATERIAL: High Strength Low Alloyed Steel Type F22				**Page 1 of 1**
PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Forgings	ASTM A 182	F22	3	S4

1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.
2. HEAT TREATMENT	Normalized and tempered.
3. IMPACT TESTING	Charpy V-notch testing at - 46 °C is required. The minimum absorbed energy for full size specimens shall be 27 J average and 20 J single. Reduction factors for subsize specimens shall be: 7,5 mm - 5/6 and 5 mm - 2/3.
4. EXTENT OF TESTING	One set of tensile and impact test shall be carried out for each heat and heat treatment load. A test lot shall not exceed 2000 kg.
5. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual component Test samples shall be from prolongations on actual components. Sacrificial forgings shall be used for die forged components. However, special agreements may be made for die forged components with as forged weight exceeding 50 kg. Test specimens shall be cut at the 1/4 T location from the surface where T is the thickness of the test samples as heat treated. Sketches shall be established showing type, size and location of test samples and extraction of test specimens.
6. DIMENSIONAL TOLERANCES	Flanges to MSS SP -44 shall have a maximum wall thickness under tolerance of 0.3 mm for the hub at the welding end.
7. NON DESTRUCTIVE TESTING	Supplementary Requirement, S4, Magnetic Particle testing, shall apply to 10 % of all forgings (from the lot as defined for mechanical testing). The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 6.
8. REPAIR OF DEFECTS	Weld repair of base material is not acceptable.
9. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.
10. CERTIFICATION	EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET	**MDS - X06**			**Rev. 1**
TYPE OF MATERIAL: High Strength Low Alloy Steel for application down to -46 °C				**Page 1 of 1**
PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Castings	ASTM A 487	Grade 2B, 2C	-	S4, S5

1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.
2. CHEMICAL COMPOSITION	C $\leq$ 0.14 %; Si $\leq$ 0.50 %; Mn = 1.30-1.60 %; Cr $\leq$ 0.20 %; Ni = 0.90-1.10 % and Mo = 0.15-0.25 %
3. IMPACT TESTING	Charpy V-notch testing is required according to ASTM A 370 at -46 °C. The notch shall be perpendicular to the surface. The minimum absorbed energy shall be 42 J average (of (3 specimens) and 30 J single value.
4. EXTENT OF TESTING	One set of tensile and impact test is required for each melt and heat treatment load. A test lot shall not exceed 5000 kg.
5. TEST SAMPLING	Samples for mechanical testing shall realistically reflect the properties in the actual components. Thickness of the test block shall be equal to the thickness of the actual components as heat treated up to a maximum thickness of 100 mm. For flanged components the largest flange thickness apply. Test specimens shall be cut from the 1/4 T location from the surface where T is the thickness of the test block. Test block shall be integrally cast or gated onto the castings and shall not be removed from the castings before after the final quality heat treatment.
6. NON DESTRUCTIVE TESTING	*Magnetic particle testing:* Supplementary requirement S4 shall apply to all accessible surfaces of all castings. The examination shall be carried out after machining. The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 7. *Radiographic testing:* Supplementary requirement S5 shall apply to: - critical areas as per ANSI B16.34 of the pilot cast of each pattern - all butt weld ends of each casting - Class 1500 psi and above; all critical areas to ANSI B16.34 of each casting. The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 7.
7. REPAIR OF DEFECTS	All weld repairs shall be post weld heat treated. The repair welding procedure qualification shall include the following: - qualification on a cast plate of the same grade - one set of impact test (3 specimens) shall be taken from weld metal and fusion line.
8. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.
9. CERTIFICATION	EN 10 204 Type 3.1B. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.