NORSOK STANDARD M-630

Rev. 4, January 2004

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 Subject to development and publication of international standards, the relevant NORSOK standard will be withdrawn.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 supported by The Norwegian Oil Industry Association (OLF) and Federation of Norwegian Manufacturing Industries (TBL).

NORSOK standards are administered and published by Standards Norway.

Introduction

The provision of the NORSOK standards are intended to comply with the requirements of the EC "Pressure Equipment Directive" and the Norwegian implementation regulation "Forskrift for trykkpåkjent utstyr" issued 9 June 1999. When this NORSOK standard refers to PED only, it is implicit that it also refers to the Norwegian implementation regulation. In those applications where PED is governing, it is therefore necessary to apply the PED and to involve a notified body to obtain the required approvals dependent of the selected conformity assessment module applicable to each specific project.

An objective has been to facilitate and standardise the implementation of PED requirement for the Norwegian petroleum industry. The correct implementation of these requirements or any other requirement is left with the user of the MDSes.

This revision replace NORSOK standard M-630 rev 3. Revision 4 of this NORSOK standard is an update to include changes deemed necessary due to:

- Introduction of PED
- Changes made in the reference standards
- Experiences gained with the previous revision of the standard
- Deletion of the MDS P01, this due to the issue of ISO 14692

The MDSes under material type K (Cu/Ni 90/10) and type X (high strength low-alloyed steel) are not revised in this issue of this NORSOK standard.

The basis for the requirements included in the MDSes are fulfilment of the requirements deemed necessary for piping systems classified to PED category III. The PED specific requirements for materials to be used for pressure equipment are related to the following:

- No less than 14% elongation and no less than 27 J absorbed energy measured on Charpy V-notch at the lowest scheduled operating temperature
- Approval of welders and welding procedures by a 3rd party organization recognized an EC member state for Category II-IV.
- Approval of NDT operators for Category III-IV by a 3rd party organization recognized an EC member state
- Certification of specific product control.

The minimum elongation requirement is included unless covered by the reference standard. The minimum Charpy V-notch absorbed energy for carbon steel type 235 is implemented by limiting the carbon content to ≤ 0.20 % and $CE_{(IIW)}$ = C + Mn/6 + (Cr+Mo+V)/5 + (Cu+Ni)/15 ≤ 0.43, with reference to Guideline 7/17. The

use of this material type is in the NORSOK L-001 Pipe and Valve specification, limited to piping systems with minimum design temperature of -15ºC (due to ambient conditions) and to a maximum wall thickness of < 16 mm.

The other requirements are included as deemed relevant on MDSes in the material Type C-, D-, N-, R- and S-serie except for MDSes for tubes to A 269/A 789. Tubes to A 269/A 789 are within the NORSOK standards not specified used in pressure equipment in Category II-IV.

The MDSes for Titanium Grade 2 are not prepared to comply with PED category II-IV requirements. The Titanium grade 2 (MDS T-01/-02) are only intended used for piping systems classified to SEP or Category I. The MDS for Cu/Ni material K-01/-02 are not specified used within the NORSOK standards, but are established as an optional material for seawater systems.

Polymer products specified by the MDSes in the P-serie are not classified as pressure bearing parts.

When any MDS is used for applications not covered by PED or to SEP and category I, those specific PED requirements listed above need not be applied as mandatory.

1 Scope

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

2 Terms, definitions and abbreviations

2.1 Terms and definitions

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

2.1.1
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

2.1.2
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

2.1.3
may
verbal form used to indicate a course of action permissible within the limits of the standard

2.1.4
can
verbal form used for statements of possibility and capability, whether material, physical or casual.

2.1.5
carbon steel type 235
carbon steel with SMYS ≥ 220MPa and not impact tested

2.1.6
carbon steel type 235LT
carbon steel with SMYS ≥ 220 MPa and impact tested at - 46 °C

2.1.7
carbon steel type 360LT
carbon steel with SMYS ≥ 350 MPa and impact tested at - 46 °C

2.1.8
stainless steel type 316
austenitic stainless steel alloys with approx. 2.5 % Mo of type AISI 316

2.1.9
stainless steel type 6Mo
austenitic stainless steel alloys with 6 % Mo and PRE ≥ 40

2.1.10
stainless steel type 22Cr duplex
ferritic/austenitic stainless steel alloys with 22 % Cr e.g. UNS S31803

2.1.11
stainless steel type 25Cr duplex
ferritic/austenitic stainless steel alloys with 25 % Cr and PRE ≥ 40, often also referred to as "super duplex".

2.2 Abbreviations

API	The American Petroleum Institute
ASTM	The American Society of Testing and Materials
ASME	The American Society of Mechanical Engineers
CE	Carbon Equivalent
EN	European Standard
MDS	Material Data Sheet
NDT	Non Destructive Testing
NPS	Nominal Pipe Size
SMYS	Specified Minimum Yield Strength
PED	Pressure Equipment Directive
PRE	Pitting Resistance Equivalent
UNS	Unified Numbering System
WPAR	Welding Procedure Approval Record

3 Collection of material data sheets

3.1 General

Materials/components manufactured in accordance with M- 630 rev. 2 and 3 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 in the respective project Piping & Valve specification.

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.

3.2 Deviations from ASME B31.3 code requirements

The use of the piping materials according to NORSOK Standards (L- 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 sub-size Charpy V-notch impact test specimens are used, the energy requirement is increased instead of lowering the test temperature.
- Eddy current examination is accepted as replacement for spot radiography of stainless steel welds for wall thickness 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 safe use of the material grades.

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 UNS S32205	A790 UNS S32550, UNS S32750, UNS S32760	A312 UNS S31354, UNS N08367, UNS N08926	B466 UNS C70600	B705 UNS N06625	B861 Grade 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 UNS S32205 Class 1/3/5	A928 UNS S32550, UNS S32750, UNS S32760, Class 1/3/5	A358 UNS S31254, UNS N08367, UNS N08926 Class 1/3/5	B467 UNS C70600	B705 UNS N06625	B862 Grade 2	
Fittings	A234 Grade WPB	A420 Grade WPL 6	A860 Grade WPHY 52	A403 Grade WP 316 Class S/W/WX	A815 UNS S31803 UNS S32205 Class S/W/WX	A815 UNS S32550, UNS S32750, UNS S32760, Class S/W/WX	A403 WP S31254, UNS N08367, UNS N08926 Class S/W/WX	- UNS C70600	B366 UNS N06625	B363 Grade WPT2 / WPT2W	A234 AISI 4130
Forgings	A105	A350 Grade LF2	A694 Grade F52	A182 Grade F316	A182 Grade F51 Grade F60	A182 F53/F55/F61	A182 Grade F44, UNS N08367, UNS N08926	- UNS C70600	B564 UNS N06625	B381 Grade F2	ASTM A 788 AISI 4140 API 6A 60K (AISI 4130) A182 F22
Plate	A516 Grade 60/70	A516 Grade 60/70	A516 Grade 70	A240 Grade 316	A240 UNS S31803 UNS S32205	A240 UNS S32550, UNS S32750, UNS S32760	A 240 UNS S31254, UNS N08367, UNS N08926	B171 UNS C70600	B443 UNS N06625	B265 Grade 2	
Castings	A216 Grade WCB	A352 Grade LCC	A352 Grade LCC	A351 Grade CF8M or CF3M	A995 UNS Grade 4 (J92205)	A995 A5 (UNS J93404), A6 (UNS J93380)	A 351 CK-3MCuN, CN-3MN	B148 UNS C95800	A494 Grade CW-6MC and CX2MW	B367 Grade C2	ASTM A 487 Gr 2B/2C
Bars				A276 UNS S31600	A276 UNS S31803 UNS S32205	A276 UNS S32550 UNS S32750 UNS S32760	A276 UNS S31254 UNS N08367 UNS N08926		B446 UNS N06625	B348 Grade 2	

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
Tubes				A269 Grade 316	A789 UNS S31803 UNS S32205	A789 UNS S32550 UNS S32750 UNS S32760	A269 UNS S31254 UNS N08367 UNS N08926		B444 UNS N06625	B338 Grade 2	

Note 1) Type 235 should be used in piping systems with minimum design temperature above or equal to -15 $^{\circ}$C and thickness less than 16 mm.
Note 2) The grades UNS N08367 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 to Grade 2.

3.3 Referenced standards and corresponding MDS

MDS No.	Rev. No.	Standard and Grade[1) (	Products
		Carbon Steel Type 235	
C01	3	A 106-02Grade B	Seamless pipes
		API 5L-00 Grade B	Welded pipes
		A 672-01 Grade CC60, CC70	Welded pipes
		A 234-02 Grade WPB	Wrought fittings
		A 105-02	Forgings
		A 516-01Grade 60, 70	Plates
C02	3	A 216-03Grade WCB	Castings
		Carbon Steel Type 235LT	
C11	3	A 333-99 Grade 6	Seamless pipes
		A 671-01 Grade CC60, CC70	Welded pipes
		A 420-02 Grade WPL 6	Wrought fittings
		A 350-02 Grade LF 2	Forgings
		A 516-01 Grade 60, 70	Plates
C12	3	A 352-03 Grade LCC	Castings
		Carbon Steel Type 360LT	
C21	3	A 694-00 Grade F52	Forgings
	3	A 860-00 WPHY 52	Wrought fittings
C22	3	API 5L-00 Grade X52	Seamless pipes
		Ferritic/Austenitic Stainless Steel Type 22Cr Duplex	
D41	3	A 790-03 UNS S31803, UNS S32205	Seamless pipes
D42	3	A 928-00 UNS S31803, UNS S32205	Welded pipes
D43	3	A 815-01 UNS S31803, UNS S32205	Wrought fittings
D44	3	A 182-02 Grade F51, F61	Forgings
D45	3	A 240-03 UNS S31803, UNS S32205	Plates
D46	3	A 995-03 Grade 4A (UNS J92205)	Castings
D47	3	A 276-03 UNS S31803, UNS S32205	Bars
D48	3	A 789-02 UNS S31803, UNS S32205	Tubes
		Ferritic/Austenitic Stainless Steel Type 25Cr Duplex	
D51	3	A 790-03 UNS S32550 UNS S32750 UNS S32760	Seamless pipes
D52	3	A 928-00 UNS S32550 UNS S32750 UNS S32760	Welded pipes Wrought fittings
D53	3	A 815-01 UNS S32550 UNS S32750 UNS S32760	
D54	3	A 182-02 Grade F61UNS S32550 Grade F53 (UNS S32750) Grade F55 (UNS S32760)	Forgings
D55	3	A 240-03 UNS S32550 UNS S32750 UNS S32760	Plates
D56	3	A 995-03 Grade 6A (UNS J93380), Grade 5A (UNS J93404)	Castings

MDS No.	Rev. No.	Standard and Grade[1)]	Products
D57	3	A 276-03 UNS S32550 UNS S32750 UNS S32760	Bars
D58	2	A 789-02 UNS S32550 UNS S32750 UNS S32760	Tubes
		Copper/Nickel 90/10	
K01	1	B 466-02 UNS C 70600 B 467-97 UNS C 70600 B 151-00 UNS C 70600 B 171-99 UNS C 70600 UNS C 70600 UNS C 70600	Seaml. pipes & tubes Welded pipes Rod & bar Plates & sheets Fittings Flanges
		Aluminium - Bronze Sand Castings	
K02	1	B 148-97 UNS C 9580	Castings
		Nickel Alloy Type 625	
N01	3	B 366-01 UNS N06625 B 705-00 UNS N06625 B 564-00 UNS N06625 B 443-00 UNS N06625 B 446-02 UNS N06625 B 444-00 UNS N06625	Wrought fittings Pipes Forgings Plates Bars Pipes and tubes
N02	3	A 494-03 Grade CW-6MC, CX 2MW	Castings
		Polymers	
P11	2	Hydrogenated Nitrile (HNBR)	O-ring
P12	2	Fluorocarbon terpolymer (FKM)	O-ring
P13	2	Fluorocarbon low T terpolymer (FKM GLT)	O-ring
P14	1	Nitrile (NBR)	O-ring
P21	2	PEEK (Poly-ether-ether-ketone)	Back-up rings and seal inserts
P22	2	PTFE (Poly-tetra-fluoro-ethylene)	Lipseals,back-up rings and seal inserts
P23	1	PEEK (Poly-ether-ether-ketone) with PTFE added	Seal inserts

MDS No.	Rev. No.	Standard and Grade[1)]	Products
		Austenitic Stainless Steel Type 6Mo	
R11	3	A 312-02 UNS S31254, UNS N08367, UNS N08926	Seamless pipes
R12	3	A 358-01 UNS S31254, UNS N08367, UNS N08926	Welded pipes
R13	3	A 403-03 UNS S31254, UNS N08367, UNS N08926	Wrought fittings
R14	3	A 182-02 Grade F44, UNS N08367, UNS N08926	Forgings
R15	3	A 240-03 UNS S31254, UNS N08367, UNS N08926	Plates
R16	3	A 351-03 Grade CK-3MCuN, CN-3MN	Castings
R17	3	A 276-03 UNS S31254, UNS N08367, UNS N08926	Bars
R18	3	A 269-02 UNS S 31254, UNS N08367, UNS N08926	Tubes
		Austenitic Stainless Steel Type 316	
S01	3	A 312-02 Grade TP 316	Seamless & welded pipes
		A 358-01 Grade 316	Welded pipes
		A 403-03 Grade WP 316	Wrought fittings
		A 182-02 Grade F 316	Forgings
		A 240-03 Grade 316	Plates
		A 276-03 Grade 316	Bars
		A 269-02 Grade 316	Tubes
S02	3	A 351-03 Grade CF3M, CF8M	Castings
		Titanium Grade 2	
T01	3	B 861-02 Grade 2	Seamless pipes
		B 862-02 Grade 2	Welded pipes
		B 363-03 Grade WPT2/WPT2W	Wrought fittings
		B 381 Grade F2	Forgings
		B 265-02 Grade 2	Plates
		B 348-02 Grade 2	Bars
		B 338-02 Grade 2	Tubes
T02	3	B 367-93 Grade C2	Castings
		High Strength Low Alloy Steel	
X01	1	A 519-94 AISI 4130	Seamless pipes
		A 234-96 AISI 4130	Wrought fittings (seamless)
X02	2	A 788-94 AISI 4140 (1994)	Forgings
X03	2	A 487-93 Grade 2B	Castings
X04	1	API 6A-96 60K (AISI 4130)	Forgings
X05	1	A 182-96 F22	Forgings
X06	1	A 487-93 Grade 2B, 2C	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. 3

TYPE OF MATERIAL: Carbon Steel Type 235

PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Wrought fittings	ASTM A 234	WPB	-	S3
Welded pipes	API 5L	B	PSL 1	-
	ASTM A 672	CC60, CC70	t ≤ 19 mm: Class 12 t > 19 mm: Class 22	A 20 S20 A 20 S20
Seamless pipes	ASTM A 106	B	-	S5
Forgings	ASTM A 105	-	-	S4
Plates	ASTM A 516	60, 70	-	A 20 S20

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:* Pipes shall be made by the sub-merged arc welding process adding filler material. Electric resistance welded pipes are not acceptable. *All welded products:* Welding shall be carried out by qualified welders according to qualified procedures approved by a 3rd party organization recognized by an EC member State.
3. HEAT TREATMENT	*Welded pipes to API 5L:* Stress relieving when the nominal thickness t ≥ 19 mm.
4. CHEMICAL COMPOSITION	C ≤ 0.20 %; Si ≥ 0.10 %; Mn = 0.50 - 1.35%; S ≤ 0.025 %; P ≤ 0.030 %; $CE_{(IIW)}$ = C + Mn/6 + (Cr+Mo+V)/5 + (Cu+Ni)/15 ≤ 0.43.
5. MECHANICAL PROPERTIES	*Welded pipes to API 5L:* A_5 > 22% (long.), 16% (transv.) *Seamless pipes to A 106:* $A_{5(Transverse)}$ >14 %.
6. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual component.
7. NON DESTRUCTIVE TESTING	*Pipes to API 5L*: RT of weld seam or RT at ends and US/Eddy Current of the remaining weld. *Fittings to A 234:* UT is not acceptable as replacement of RT. *All products:* NDT operator qualification shall be approved by a 3rd party organization recognized by an EC member state.
8. REPAIR OF DEFECTS	Weld repair of base material is not acceptable.
9. CERTIFICATION	Certification shall affirm compliance with the specification and shall be according to EN 10204 Type 3.1B provided the manufacturer has a quality assurance system certified by a competent body established within the EC, and having undergone a specific assessment for materials.

MATERIAL DATA SHEET	MDS C02	Rev. 3
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	$C \leq 0.20$ % and $CE_{(IIW)} = C + Mn/6 + (Cr+Mo+V)/5 + (Cu+Ni)/15 \leq 0.43$ 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 surfaces (including internal surfaces) of all castings. The examination shall be carried out after final machining. The acceptance criteria~~s~~ 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. NDT operator qualification shall be approved by a 3rd party organization recognized by an EC member state.~~.~~
6. REPAIR OF DEFECTS	Welding shall be carried out by qualified welders according to qualified procedures approved by a 3rd party organization recognized by an EC member State.
7. CERTIFICATION	Certification shall affirm compliance with the specification and shall be according to EN 10204 Type 3.1B provided the manufacturer has a quality assurance system certified by a competent body established within the EC, and having undergone a specific assessment for materials.

MATERIAL DATA SHEET MDS C11 Rev. 3

TYPE OF MATERIAL: Carbon Steel Type 235LT

PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Wrought fittings	ASTM A 420	WPL 6	-	S51, S53, S69
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	S6, S55
Plates	ASTM A 516	60, 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. MANUFACTURING PROCESS	*All welded products:* Welding shall be carried out by qualified welders according to qualified procedures approved by a 3rd party organization recognized by an EC member State.
3. CHEMICAL COMPOSITION	C ≤ 0.20 %; Mn = 0.50 - 1.55 %; S ≤ 0.025 %; P ≤ 0.030 %; $CE_{(IIW\ long\ formula)}$ = C + Mn/6 + (Cr+Mo+V)/5 + (Cu+Ni)/15 ≤ 0.43. *Seamless pipes to A 333:* Cr ≤ 0.40, Ni ≤ 0.40, Mo ≤ 0.15, Cu ≤ 0.40, Nb ≤ 0.010 V ≤ 0.08
4. IMPACT TESTING	Charpy V-notch testing at - 46°C is required for the thickness ≥ 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 sub-size specimens shall be: 7.5mm - 5/6 and 5 mm - 2/3.
5. EXTENT OF TESTING	*Fittings to A 420:* Supplementary requirement ASTM A 960, S51 shall apply. Impact testing shall be carried out to the same extent as tensile testing. *Pipes to A 671:* Supplementary requirement S2 shall apply to the same extent as for 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.
6. TEST SAMPLING	*All products:* Samples for production testing shall realistically reflect the properties in the actual component. *Forgings to A350:* Sketches shall be established showing type, size and location of test samples and extraction of test specimens.

MATERIAL DATA SHEET	**MDS C11**			**Rev. 3**
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	-	S51, S53, S69
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*	S6, S55
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 ASTM A 960, S53 and S69, magnetic particle testing, shall apply to 10 % of all fittings (same test lot as defined for mechanical testing) for nominal thickness < 12.7 mm and 100 % of all fittings for nominal thickness ≥ 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 ASTM A 961, S55, 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. *All products:* NDT operator qualification shall be approved by a 3rd party organization recognized by an EC member state
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	Certification shall affirm compliance with the specification and shall be according to EN 10204 Type 3.1B provided the manufacturer has a quality assurance system certified by a competent body established within the EC, and having undergone a specific assessment for materials. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET MDS C12 Rev. 3

TYPE OF MATERIAL: Carbon Steel Type 235LT

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 surfaces (including internal 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. NDT operator qualification shall be approved by a 3rd party organization recognized by an EC member state.
7. REPAIR OF DEFECTS	A cast plate shall be used in the qualification of the repair welding procedure. Welding shall be carried out by qualified welders according to qualified procedures approved by a 3rd party organization recognized by an EC member State.
8. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.
9. CERTIFICATION	Certification shall affirm compliance with the specification and shall be according to EN 10204 Type 3.1B provided the manufacturer has a quality assurance system certified by a competent body established within the EC, and having undergone a specific assessment for materials. Heat treatment temperature, soaking time and cooling medium shall be stated in the certificate.

MATERIAL DATA SHEET MDS C21 Rev. 3

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 thickness ≥ 6 mm. The minimum absorbed energy for full size specimen shall be 40 J average and 30 J single. Reduction factors for sub-size specimens shall be: 7.5 mm - 5/6 and 5 mm - 2/3.
4. EXTENT OF TESTING	*Forgings:* One set of tensile and impact testing shall be carried out for each heat and heat treatment load. The testing shall be carried out on the component with heaviest wall thickness within the 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. *Forgings:* 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 location and orientation shall be: ▪ For forgings having maximum section thickness, T ≤ 50 mm, the test specimens shall be taken at mid thickness and its mid length shall be at least 50 mm from any second surface. ▪ For forgings having maximum section thickness, T > 50 mm, the test specimen shall be taken at least ¼ T from the nearest surface and at least T or 100 mm, whichever is less, from any second surface. Sketches shall be established showing type, size and location of test samples and extraction of test specimens.
6. WELDING	*Fittings to A 860:* Welding shall be carried out by qualified welders according to qualified procedures approved by a 3rd party organization recognized by an EC member State. The WPQ shall be qualified in accordance with ASME IX or EN 288-3.
7. NON DESTRUCTIVE TESTING	*All products:* The acceptance criteria shall be to ASME VIII Div. 1, Appendix 6. NDT operator qualification shall be approved by a 3rd party organization recognized by an EC member state. *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 thickness < 12.7 mm and 100 % of all fittings for nominal thickness ≥ 12.7 mm. The testing shall be carried out after calibration. *Forgings to A 694:* 10 % of all forgings with NPS > 2 (same test lot as defined for mechanical testing) shall be magnetic particle testing according to ASME V Article 7. The testing shall be carried out after final machining.

MATERIAL DATA SHEET	MDS C21	Rev. 3
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	

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	Certification shall affirm compliance with the specification and shall be according to EN 10204 Type 3.1B provided the manufacturer has a quality assurance system certified by a competent body established within the EC, and having undergone a specific assessment for materials. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET MDS C22 Rev. 3

TYPE OF MATERIAL: Carbon Steel Type 360LT

PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Seamless pipes	API 5L	X52	PSL 2	SR4.3, SR18

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	Normalised or Quenched and Tempered.
4. CHEMICAL COMPOSITION	C ≤ 0.16 %; Mn = 0.90 - 1.60 %; Si= 0.10-0.50 %; Ti ≤ 0.05 %; Nb ≤ 0.04 %; Al ≤ 0.06 %; N ≤ 0.015 %; V+Nb+Ti ≤ 0.10 %; V+Nb ≤ 0.07 %; $CE_{(IIW)}$ = C + Mn/6 + (Cr+Mo+V)/5 + (Cu+Ni)/15 ≤ 0.43.
5. TENSILE TESTING	A_5 > 22% (long.), 16% (transv.)
6. IMPACT TESTING	Charpy V-notch testing according to ASTM A 370 at - 46 °C is required for the thickness ≥ 6 mm. The minimum absorbed energy for full size specimens shall be 40 J average and 30 J single. Reduction factors for sub-size specimens shall be: 7.5 mm - 5/6 and 5 mm - 2/3.
7. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual component.
8. NON DESTRUCTIVE TESTING	Supplementary requirement SR 4.3 with notch calibration of 5 % of the nominal wall thickness shall apply for all thickness.
9. SURFACE FINISH	The surface finish shall comply with ASTM A 106 para. 18.3.2.
10. REPAIR OF DEFECTS	Weld repair is not acceptable.
11. CERTIFICATION	Certification shall affirm compliance with the specification and shall be according to EN 10204 Type 3.1B provided the manufacturer has a quality assurance system certified by a competent body established within the EC, and having undergone a specific assessment for materials.

MATERIAL DATA SHEET MDS D41 Rev. 3

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

PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Seamless pipes	ASTM A 790	UNS S 31803 UNS S 32205	-	-

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 thickness ≥ 6 mm. The minimum absorbed energy shall be 45 J average / 35 J single. Reduction factors for sub-size 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	Certification shall affirm compliance with the specification and shall be according to EN 10204 Type 3.1B provided the manufacturer has a quality assurance system certified by a competent body established within the EC, and having undergone a specific assessment for materials. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET MDS D42 Rev. 3

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

PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Welded pipes	ASTM A 928	UNS S31803 UNS S32205	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. MANUFACTURING PROCESS	Welding shall be carried out by qualified welders according to qualified procedures approved by a 3rd party organization recognized by an EC member State.
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; $A_5 \geq 25$ %.
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 thickness ≥ 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 sub-size 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 35-65 % 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 for pipe with nominal OD ≥ 8”.

MATERIAL DATA SHEET	MDS - D42			Rev. 3
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 UNS S 32205	Class 1, 3 and 5	S3

14. NON DESTRUCTIVE TESTING	Eddy current testing according to ASTM A 450 is acceptable as replacement for spot radiography for wall thickness 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. NDT operator qualification shall be approved by a 3rd party organization recognized by an EC member state.
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	Certification shall affirm compliance with the specification and shall be according to EN 10204 Type 3.1B provided the manufacturer has a quality assurance system certified by a competent body established within the EC, and having undergone a specific assessment for materials. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET MDS D43 Rev. 3

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

PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Wrought fittings	ASTM A 815	UNS S 31803 UNS S 32205	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 thickness ≥ 6 mm. The minimum absorbed energy shall be 45 J average and 35 J single. Reduction factors for sub-size 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.
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 35-65 % 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. Test sampling shall be made from an actual fitting or from a prolongation thereof.
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. Welding shall be carried out by qualified welders according to qualified procedures approved by a 3rd party organization recognized by an EC member State
12. 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. NDT operator qualification shall be approved by a 3rd party organization recognized by a EC member state.

MATERIAL DATA SHEET	MDS D43	Rev. 3
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 UNS S 32205	WP-W, WP-S or WP-WX	S7

13. SURFACE FINISH	White pickled. Machined surfaces do not require pickling.
14. 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.
15. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.
16. CERTIFICATION	Certification shall affirm compliance with the specification and shall be according to EN 10204 Type 3.1B provided the manufacturer has a quality assurance system certified by a competent body established within the EC, and having undergone a specific assessment for materials. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET	MDS D44	Rev. 3
TYPE OF MATERIAL: Ferritic / Austenitic Stainless Steel, Type 22Cr duplex		Page 1 of 2

PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Forgings	ASTM A 182	F51, F60	-	S56

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 intended for forgings with maximum section thickness of 300 mm. For larger thickness special agreements shall be made in each case.
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 maximum 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 thickness ≥ 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. The testing shall be carried out on the component with heaviest wall thickness within the 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 D44		Rev. 3
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, F60	-	S56

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 location and orientation shall be: ▪ For forgings having maximum section thickness, T ≤ 50 mm, the test specimens shall be taken at mid thickness and its mid length shall be at least 50 mm from any second surface. ▪ For forgings having maximum section thickness, T > 50 mm, the test specimen shall be taken at least ¼ T from the nearest surface and at least T or 100 mm, whichever is less, from any second surface. Sketches shall be established showing type, size and location of test samples and extraction of test specimens.
12. NON DESTRUCTIVE TESTING	Supplementary requirement ASTM A 961 S56, penetrant testing, shall apply to 10 % of forgings (from the lot as defined for mechanical testing) above NPS 2. The testing shall be carried out after final machining. Non-machined surfaces shall be pickled prior to the testing. The acceptance criteria shall be ASME VIII, Div. 1, Appendix 8. NDT operator qualification shall be approved by a 3rd party organization recognized by an EC member state.
13. SURFACE FINISH	Finished products shall be white pickled. Machined surfaces do not require pickling.
14. REPAIR OF DEFECTS	Weld repair is not acceptable.
15. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.
16. CERTIFICATION	Certification shall affirm compliance with the specification and shall be according to EN 10204 Type 3.1B provided the manufacturer has a quality assurance system certified by a competent body established within the EC, and having undergone a specific assessment for materials. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET MDS D45 Rev. 3

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

PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Plates	ASTM A 240	UNS S 31803 UNS S 32205	-	-

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 thickness ≥ 6 mm. The minimum absorbed energy shall satisfy 45 J average and 35 J single. Reduction factors for sub-size 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.
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	Certification shall affirm compliance with the specification and shall be according to EN 10204 Type 3.1B provided the manufacturer has a quality assurance system certified by a competent body established within the EC, and having undergone a specific assessment for materials. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET MDS D46 Rev. 3

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

PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Castings	ASTM A 995	4A (UNS J92205)	-	S5, S6, S20

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 magnification on a suitably etched specimen, shall be free from intermetallic phases and precipitates.
9. EXTENT OF TESTING	A full set of tensile, impact, hardness 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.
11. NON DESTRUCTIVE TESTING	*Liquid penetrant testing:* Supplementary requirement S6 shall apply to all surfaces (including internal 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 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. NDT operator qualification shall be approved by a 3rd organization recognized by an EC member state.

MATERIAL DATA SHEET	MDS D46	Rev. 3
TYPE OF MATERIAL: Ferritic / Austenitic Stainless Steel, Type 22Cr duplex		Page 2 of 2

PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Castings	ASTM A 995	4A (UNS J92205)	-	S5, S6, S8, S20

12. SURFACE FINISH	White pickled. Machined surfaces do not require pickling.
13. REPAIR OF DEFECTS	Supplementary requirement ASTM A 703 S20 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 35-65 % 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. Welding shall be carried out by qualified welders according to qualified procedures approved by a 3rd party organization recognized by an EC member State.
14. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.
15. CERTIFICATION	Certification shall affirm compliance with the specification and shall be according to EN 10204 Type 3.1B provided the manufacturer has a quality assurance system certified by a competent body established within the EC, and having undergone a specific assessment for materials. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET MDS D47 Rev. 3

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

PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Bars	ASTM A 276	UNS S 31803 UNS S 32205	-	-

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 intended for bars with maximum section thickness of 300 mm. For larger thickness special agreements shall be made in each case.
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. The solution annealing temperature shall be as defined in ASTM A 182 for the actual grade/UNS number.
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 400 X magnification on a suitably etched specimen, shall be free from intermetallic phases and precipitates.
9. 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.
10. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual components. Test location and orientation shall be: ▪ For bars having maximum section thickness, T ≤ 50 mm, the test specimens shall be taken at mid thickness and its mid length shall be at least 50 mm from any second surface. ▪ For bars having maximum section thickness, T > 50 mm, the test specimen shall be taken at least ¼ T from the nearest surface and at least T or 100 mm, whichever is less, from any second surface. ▪ The testing shall be carried out in longitudinal direction. For thickness exceeding 160 mm, the testing shall be carried out both in longitudinal and transverse (tangential) direction. All testing in longitudinal direction shall meet specified requirements (ASTM A 276 and this MDS). For testing in transverse (tangential) direction elongation shall be minimum 20 % and the minimum Charpy V-notch absorbed energy shall satisfy 27 J average and 20 J single.

MATERIAL DATA SHEET	MDS D47	Rev. 3
TYPE OF MATERIAL: Ferritic / Austenitic Stainless Steel, Type 22Cr duplex		Page 2 of 2

PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Bars	ASTM A 276	UNS S 31803 UNS S 32205	-	-

11. SURFACE FINISH	Finished products shall be 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	Certification shall affirm compliance with the specification and shall be according to EN 10204 Type 3.1B provided the manufacturer has a quality assurance system certified by a competent body established within the EC, and having undergone a specific assessment for materials. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET MDS D48 Rev. 3

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

PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Tubes	ASTM A 789	UNS S 31803 UNS S 32205	-	-

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 according to ASTM A 370 at - 46 °C is required for the thickness ≥ 6 mm. The minimum absorbed energy shall be 45 J average / 35 J single. Reduction factors for sub-size 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 or bright annealed.
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. 3

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

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.
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; $A_5 \geq 25\%$
7. HARDNESS	The harness shall be max. 32 HRC (or alternatively 301 HB or 330 HV 10).
8. IMPACT TESTING	Charpy V-notch testing according to ASTM A 370 at - 46 °C is required for thickness ≥ 6 mm. The minimum absorbed energy shall be 45 J average / 35 J single. Reduction factors for sub-size 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.
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.

MATERIAL DATA SHEET		MDS D51		Rev. 3
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	-	-
15. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.			
16. CERTIFICATION	Certification shall affirm compliance with the specification and shall be according to EN 10204 Type 3.1B provided the manufacturer has a quality assurance system certified by a competent body established within the EC, and having undergone a specific assessment for materials. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.			

MATERIAL DATA SHEET MDS D52 Rev. 3

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.
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 ≥ 25 %
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 thickness ≥ 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 sub-size specimens shall be: 7.5 mm - 5/6 and 5 mm - 2/3.
9. CORROSION TEST	Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. The specimen shall have the internal and external surfaces in the as-delivered condition (including pickling). Cut edges shall be prepared according to ASTM G48, and the whole specimen shall be pickled (20 % HNO3 + 5 % HF, 60 °C, 5 minute). The test shall expose the external and internal surfaces and a cross section surface including weld zone in full wall thickness. The acceptance criteria are: - No pitting at 20 X magnification - The weight loss shall be less than 4.0 g/m^2
10. MICROGRAPHIC EXAMINATION	The micrographic examination shall cover the near surfaces and mid-thickness region of the pipe including the weld and heat affected zone. The ferrite content shall be determined according to ASTM E 562 or equivalent and shall be within 35-55 % for base material and 35-65% for weld metal. The microstructure, as examined at 400 X magnification on a suitably etched specimen, shall be free from intermetallic phases and precipitates.
11. EXTENT OF TESTING	Tensile, impact, hardness, corrosion and microstructure examination shall be carried out for each lot. The lot is defined as follows: - For batch furnace a lot is defined as maximum 60 m of pipe of the same heat, size and heat treatment charge. - For continuous heat treatment furnace the lot definition in para 8.1 of the ASTM standard apply.

MATERIAL DATA SHEET	MDS D52	Rev. 3
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. Welding shall be carried out by qualified welders according to qualified procedures approved by a 3rd party organization recognized by an EC member State.
14. TOLERANCES	The pipes shall have a max. undertolerance of 0.3 mm for nominal OD ≥ 8".
15. NON DESTRUCTIVE TESTING	Eddy current testing according to ASTM A 450 is acceptable as replacement for spot radiography for wall thickness 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 weld of each examined pipe shall be ground flush in a length of 100 mm prior to penetrant testing. The testing shall be carried out after calibration and pickling. Acceptance criteria shall be to ASME VIII, Div 1, Appendix 8. NDT operator qualification shall be approved by a 3rd party organization recognized by an EC member state.
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	Certification shall affirm compliance with the specification and shall be according to EN 10204 Type 3.1B provided the manufacturer has a quality assurance system certified by a competent body established within the EC, and having undergone a specific assessment for materials. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET MDS D53 Rev. 3

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

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; $A_5 \geq 25$ %
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 thickness ≥ 6 mm. The minimum absorbed energy shall be 45 J average / 35 J single. Reduction factors for sub-size 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 35-65 % 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. 3
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. Test sampling shall be made from an actual fitting or from a prolongation thereof.
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. Welding shall be carried out by qualified welders according to qualified procedures approved by a 3rd party organization recognized by an EC member State.
14. NON DESTRUCTIVE TESTING	Supplementary requirements S7, Penetrant Testing, 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 weld of each examined fitting shall be ground flush in a length of 100 mm prior to penetrant testing. The acceptance criteria shall be ASME VIII, Div. 1, Appendix 8. NDT operator qualification shall be approved by a 3rd party organization recognized by an EC member state.
15. SURFACE FINISH	White pickled.
16. REPAIR OF DEFECTS	Weld repair of base material is not acceptable. For repair of welds the same requirements to PQR/WPAR shall apply as for production welding.
17. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.
18. CERTIFICATION	Certification shall affirm compliance with the specification and shall be according to EN 10204 Type 3.1B provided the manufacturer has a quality assurance system certified by a competent body established within the EC, and having undergone a specific assessment for materials. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET	MDS D54	Rev. 3
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	F61 - UNS S 32550 F53 - UNS S 32750 F55 - UNS S 32760	-	S56

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 intended for forgings with maximum section thickness of 200 mm. For larger thickness special agreements shall be made in each case.
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 component shall be quenched in water after forging. 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 ≥ 25 %. For thickness > 50 mm, the tensile properties shall be $R_{p0.2}$ ≥ 515 MPa; R_m ≥ 730 MPa; A ≥ 25 % or as agreed with Purchaser.
8. HARDNESS	The hardness shall be maximum 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 thickness ≥ 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.

MATERIAL DATA SHEET	MDS D54	Rev. 3
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	F61 - UNS S 32550 F53 - UNS S 32750 F55 - UNS S 32760	-	S56

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. The testing shall be carried out on the component with heaviest wall thickness within the 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.
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 location and orientation shall be: ▪ For forgings having maximum section thickness, T ≤ 50 mm, the test specimens shall be taken at mid thickness and its mid length shall be at least 50 mm from any second surface. ▪ For forgings having maximum section thickness, T > 50 mm, the test specimen shall be taken at least ¼ T from the nearest surface and at least T or 100 mm, whichever is less, from any second surface. Sketches shall be established showing type, size and location of test samples and extraction of test specimens.
14. NON DESTRUCTIVE TESTING	Supplementary requirement of ASTM A 961 S56, 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. NDT operator qualification shall be approved by a 3rd party organization recognized by an EC member state.
15. SURFACE FINISH	Finished products shall be white pickled, including machined surfaces.
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	Certification shall affirm compliance with the specification and shall be according to EN 10204 Type 3.1B provided the manufacturer has a quality assurance system certified by a competent body established within the EC, and having undergone a specific assessment for materials. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET MDS D55 Rev. 3

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

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.
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 ≥ 25%.
7. HARDNESS	The hardness shall be maximum 32 HRC or alternatively 301 HB or 330 HV10.
8. IMPACT TESTING	Charpy V-notch testing according to ASTM A 370 at - 46 °C is required for thickness ≥ 6mm. The minimum absorbed energy shall satisfy 45 J average / 35 J single. Reduction factors for sub-size 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	Certification shall affirm compliance with the specification and shall be according to EN 10204 Type 3.1B provided the manufacturer has a quality assurance system certified by a competent body established within the EC, and having undergone a specific assessment for materials. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET	MDS D56	Rev. 3

TYPE OF MATERIAL: Ferritic/Austenitic Stainless Steel, Type 25Cr duplex				Page 1 of 2
PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Castings	ASTM A 995	5A (UNS J93404) 6A (UNS J93380)	-	S5, S6, S20

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) or 6A (UNS J93380).
5. CHEMICAL COMPOSITION	PRE = % Cr + 3.3 % Mo + 16 % N ≥ 40.0. S ≤ 0.025 and P ≤ 0.030,
6. TENSILE TESTING	$R_{p0.2}$ ≥ 450 MPa; R_m ≥ 700 MPa; A ≥ 18 %.
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. 3
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	-	S5, S6, S8, S20

13. NON DESTRUCTIVE TESTING	*Liquid penetrant testing:* Supplementary requirement S6 shall apply to all surfaces (including internal surfaces) of all castings. The testing shall be carried out after final machining and pickling. The acceptance criteria shall be ASME VIII, Div. 1, Appendix 7. *Radiographic testing:* Supplementary requirement S5 shall apply to: - Critical areas as per ANSI B16.34 of the pilot cast of each pattern - All butt weld ends of each casting - Class 1500 psi and above; all critical areas to ANSI B16.34 of each casting. The acceptance criteria shall be to ASME VIII, Div. 1 Appendix 7. NDT operator qualification shall be approved by a 3rd party organization recognized by an EC member state.
14. SURFACE FINISH	White pickled shall be carried out after any blasting and shall include finished machined surfaces.
15. REPAIR OF DEFECTS	Supplementary requirement of ASTM A 703 S20 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 35-65 % 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. Welding shall be carried out by qualified welders according to qualified procedures approved by a 3rd party organization recognized by an EC member State.
16. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.
17. CERTIFICATION	Certification shall affirm compliance with the specification and shall be according to EN 10204 Type 3.1B provided the manufacturer has a quality assurance system certified by a competent body established within the EC, and having undergone a specific assessment for materials. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET	MDS D57	Rev. 3
TYPE OF MATERIAL: Ferritic/Austenitic Stainless Steel, Type 25Cr duplex		Page 1 of 2

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 intended for bars with maximum thickness of 200 mm. For larger thickness special agreements shall be made in each case.
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. The solution annealing temperature shall be as defined in ASTM A 182 for the actual grades/UNS number.
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 ≥ 25 %.
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.
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	One set of impact test, tensile test, hardness test, microstructure examination and corrosion test shall be carried out for each heat and heat treatment load.

MATERIAL DATA SHEET		MDS D57		Rev. 3
TYPE OF MATERIAL: Ferritic/Austenitic Stainless Steel, Type 25Cr duplex				Page 2 of 2
PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Bars	ASTM A 276	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. Test location and orientation shall be: ▪ For bars having maximum section thickness, T ≤ 50 mm, the test specimens shall be taken at mid thickness and its mid length shall be at least 50 mm from any second surface. ▪ For bars having maximum section thickness, T > 50 mm, the test specimen shall be taken at least ¼ T from the nearest surface and at least T or 100 mm, whichever is less, from any second surface. ▪ The testing shall be carried out in longitudinal direction. For thickness exceeding 160 mm, the testing shall be carried out both in longitudinal and transverse (tangential) direction. All testing in longitudinal direction shall meet specified requirements (ASTM A 276 and this MDS). For testing in transverse (tangential) direction elongation shall be minimum 20 % and the minimum Charpy V-notch absorbed energy shall satisfy 27 J average and 20 J single.
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	Certification shall affirm compliance with the specification and shall be according to EN 10204 Type 3.1B provided the manufacturer has a quality assurance system certified by a competent body established within the EC, and having undergone a specific assessment for materials. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET	MDS D58	Rev. 2
TYPE OF MATERIAL: Ferritic/Austenitic Stainless Steel, Type 25Cr duplex		Page 1 of 1

PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Tubes	ASTM A 789	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.
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 ≥ 25 %.
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 thickness ≥ 6 mm. The minimum absorbed energy shall be 45 J average / 35 J single. Reduction factors for sub-size 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 (pickling or bright annealed). 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, tensile testing, impact testing and corrosion 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 or bright annealed.
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 and 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

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

MATERIAL DATA SHEET 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. 3

TYPE OF MATERIAL: Nickel alloy Type 625

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	-	S5.3
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.
3. HEAT TREATMENT	Annealed.
4. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual component.
5. 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:* Supplementary requirement S5.3, liquid penetrant testing, shall be performed at 10 % of forgings above NPS 2 (of same lot as defined for mechanical testing). NDT operator qualification shall be approved by a 3rd party organization recognized by an EC member state.
6. SURFACE FINISH	White pickled. Shall be carried out after any blasting and shall include finished machined surfaces.
7. REPAIR OF DEFECTS	Weld repair of base material is not acceptable.
8. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.
9. CERTIFICATION	Certification shall affirm compliance with the specification and shall be according to EN 10204 Type 3.1B provided the manufacturer has a quality assurance system certified by a competent body established within the EC, and having undergone a specific assessment for materials. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET	MDS N02	Rev. 3
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. NDT operator qualification shall be approved by a 3rd party organization recognized by an EC member state.
9. SURFACE FINISH	White pickled. Shall be carried out after any blasting and shall include finished machined surfaces.

MATERIAL DATA SHEET		**MDS N02**		**Rev. 3**
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)	Class 1	S2, S3
		Grade CX2MW (UNS N26022)	Class 1	S2, S3
10. REPAIR OF DEFECTS	Repair welding shall be carried out in accordance with ASTM A 488. Welding shall be carried out by qualified welders according to qualified procedures approved by a 3rd party organization recognized by an EC member State. 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	Certification shall affirm compliance with the specification and shall be according to EN 10204 Type 3.1B provided the manufacturer has a quality assurance system certified by a competent body established within the EC, and having undergone a specific assessment for materials. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.			

MATERIAL DATA SHEET MDS P11 Rev. 2

TYPE OF MATERIAL: Hydrogenated Nitrile (HNBR) | Page 1 of 1

PRODUCT	O-ring	***TEMPERATURE RANGE***	- 46°C to + 150°C. Only short time exposure below - 20°C is 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 3% CO_2 in Methane, test temperature 100 °C, 72 hours initial soak at full pressure, followed by 5 cycles of: • 200 bar (24h) • Depressurisation: 20-40 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 5 decompression cycles. Further, no cracks shall be longer than 80 % of the sample thickness, based on dissection, after the leakage test. **Mechanical properties** • Hardness ASTM D 2240 90 ± 5 Shore A • Tensile strength ASTM D 412/1414 min. 20 MPa • Elongation at break ASTM D 412/1414 min. 100% • Compression set ASTM D 395 max. 25% (after 24 hours at 150°C) **Physical properties** • Specific gravity ASTM D 792 1.2 – 1.3 g/cm^3
5. DIMENSIONS	According to 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 Type 3.1B shall contain ID No. and all test results.

MATERIAL DATA SHEET MDS P12 Rev. 2

TYPE OF MATERIAL: Fluorocarbon terpolymer (FKM)

PRODUCT	O-ring	***TEMPERATURE RANGE***	- 46°C to + 150°C. Only short time exposure below - 10°C is 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 3% CO_2 in Methane, test temperature 100°C, 72 hours initial soak at full pressure, followed by 5 cycles of: • 200 bar (24h) • Depressurisation: 20-40 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 5 decompression cycles. Further, no cracks shall be longer than 80 % of the sample thickness, based on dissection, after the leakage test. **Mechanical properties** • Hardness ASTM D 2240 90 ± 5 Shore A • Tensile strength ASTM D 412/1414 min. 11 MPa • Elongation at break ASTM D 412/1414 min. 90% • Compression set ASTM D 395 max. 40% (after 24 hours at 150°C) **Physical properties** • Specific gravity ASTM D 792 1.6 – 1.9 g/cm^3
5. DIMENSIONS	According to 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 Type 3.1B shall contain ID No. and all test results.

MATERIAL DATA SHEET MDS P13 Rev. 2

TYPE OF MATERIAL: Fluorocarbon low T terpolymer (FKM GLT) | Page 1 of 1

PRODUCT	O-ring	***TEMPERATURE RANGE***	- 46°C to + 150°C. Only short time exposure below - 30°C is 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	Vinylidenefluoride (VF2) and tetrafluoroethylene (TFE) with necessary fillers, stabilisers and 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 3% CO_2 in Methane, test temperature 100°C, 72 hours initial soak at full pressure, followed by 5 cycles of: • 200 bar (24h) • Depressurisation: 20-40 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 5 decompression cycles. Further, no cracks shall be longer than 80 % of the sample thickness, based on dissection, after the leakage test. **Mechanical properties** • Hardness ASTM D 2240 90 ±5 Shore A • Tensile strength ASTM D 412/1414 min. 11 MPa • Elongation at break ASTM D 412/1414 min. 90 % • Compression set ASTM D 395 max. 40 % (after 24 hours at 150°C) **Physical properties** • Specific gravity ASTM D 792 1.6 – 1.9 g/cm^3
5. DIMENSIONS	According to 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 Type 3.1B shall contain ID No. and all test results.

MATERIAL DATA SHEET MDS P14 Rev. 2

TYPE OF MATERIAL: Nitrile (NBR) | Page 1 of 1

PRODUCT	O-ring	***TEMPERATURE RANGE***	- 46°C to + 150°C. Only short time exposure below – 20 and 100°C is 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 be tested for oil resistance 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): **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 bars. 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 + 25%/ -5%. **Mechanical properties** • Hardness ASTM D 2240 70 ± 5 Shore A • Tensile strength ASTM D 412/1414 min. 15 MPa • Elongation at break ASTM D 412/1414 min. 350% • Compression set ASTM D 395 max. 25% (after 24 hours at 150°C) **Physical properties** • Specific gravity ASTM D 792 1.2 – 1.3 g/cm^3
5. DIMENSIONS	According to 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 Type 3.1B shall contain ID No. and all test results.

MATERIAL DATA SHEET MDS P21 Rev. 2

TYPE OF MATERIAL: PEEK (Poly-ether-ether-ketone) | Page 1 of 1

PRODUCT	Back-up rings and seat inserts	***TEMPERATURE RANGE***	-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	**Test standard**	**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	150 °C	300 °C
• Impact strength (notched)	ASTM D 256	> 70 J/m	> 70 J/m
• Ultimate elongation	ASTM D 638	> 55 %	> 3 %
Physical properties			
• Specific gravity	ASTM D 792	1.3 - 1.4 g/cm^3	1.4 - 1.6 g/cm^3
• Melting point	ASTM D 3418	340 °C	340 °C
• Water absorption (24 hrs.)	ASTM D 570	0.15 %	0.15 %

5. DIMENSIONS	According to 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 • 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 Type 3.1B shall contain ID No. and all test results.

MATERIAL DATA SHEET MDS P22 Rev. 2

TYPE OF MATERIAL: PTFE (Poly-tetra-fluoro-ethylene) | Page 1 of 1

PRODUCT	Lip-seals, back-up rings and seat inserts	***TEMPERATURE RANGE***	-100°C to +250°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	**Test standard**	**Virgin**	**25%Glass**	**25%Graph**
• Tensile strength	ASTM D 638	> 25 MPa	> 15 MPa	> 15 MPa
• Hardness	ASTM D 785	50-60 Shore D	50-60 Shore D	60-70 Shore D
• Compressive strength, 1%	ASTM D 695	> 4 MPa	> 6 MPa	> 6 MPa
• Compressive modulus	ASTM D 695	> 400 MPa	> 600 MPa	> 600 MPa
• HDT @ 1.81 MPa	ASTM D 648	54°C	110°C	95°C
• Impact strength (notched)	ASTM D 256	> 145 J/m	> 130 J/m	> 140 J/m
• Ultimate elongation	ASTM D 638	> 220 %	> 180 %	> 75 %
Physical properties				
• Specific gravity	ASTM D 792	2,0 - 2.2 g/cm^3	2,0- 2.3 g/cm^3	1.9- 2.1 g/cm^3
• Melting point	ASTM D 3418	325 °C	325 °C	325 °C
• Water absorption (24hrs)	ASTM D 570	0.01 %	0.02 %	0.01 %

5. DIMENSIONS

According to 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 (Shore D) ASTM D785
- Specific gravity 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 Type 3.1B shall contain ID No. and all test results.

MATERIAL DATA SHEET MDS P23 Rev. 2

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

PRODUCT	Seat inserts	***TEMPERATURE RANGE***	-100°C to +250°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	**Test standard**	**Virgin**
• Tensile strength	ASTM D 638	> 80 MPa
• Hardness	ASTM D 785	82 - 88 Shore D
• 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	> 50 J/m
• Ultimate elongation	ASTM D 638	> 20 %
Physical properties		
• Specific gravity	ASTM D 792	1.4 - 1.5 g/cm^3
• Melting point	ASTM D 3418	340 °C
• Water absorption (24 hrs.)	ASTM D 570	0.10 %

5. DIMENSIONS	According to 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 • Specific gravity 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 Type 3.1B shall contain ID No. and all test results.

MATERIAL DATA SHEET MDS R11 Rev. 3

TYPE OF MATERIAL: Austenitic stainless steel, Type 6Mo

PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Seamless pipes	ASTM A 312	UNS S31254 UNS N08367 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.
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. TENSILE TESTING	$R_{P0,2} \geq 310$ MPa, $R_M \geq 675$ MPa for $t \leq 5.0$ mm and $R_M \geq 655$ MPa for $t > 5.0$ mm, $A_5 \geq 35$ % (long.)
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 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.
7. EXTENT OF TESTING	Corrosion test 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.
12. CERTIFICATION	Certification shall affirm compliance with the specification and shall be according to EN 10204 Type 3.1B provided the manufacturer has a quality assurance system certified by a competent body established within the EC, and having undergone a specific assessment for materials. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET MDS R12 Rev. 3

TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo

PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Welded Pipes	ASTM A 358	UNS S31254 UNS N08367 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.
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. TENSILE TESTING	$R_{P0,2} \geq 310$ MPa, $R_M \geq 690$ MPa, $A_5 \geq 35$ %.
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 %; and S ≤ 0.015 % - 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. Welding shall be carried out by qualified welders according to qualified procedures approved by a 3rd party organization recognized by an EC member State.

MATERIAL DATA SHEET	MDS R12	Rev. 3
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 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 thickness 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 weld of each examined pipe shall be ground flush in a length of 100 mm prior to penetrant testing. The testing shall be carried out after calibration and pickling. Acceptance criteria shall be to ASME VIII Div. 1 Appendix 8. NDT operator qualification shall be approved by a 3rd party organization recognized by an EC member state.
11. SURFACE FINISH	White pickled.
12. REPAIR OF DEFECTS	Weld repair of base material is not acceptable. For repair of welds the same requirements to PQR/WPAR as for production welding shall apply.
13. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.
14. CERTIFICATION	Certification shall affirm compliance with the specification and shall be according to EN 10204 Type 3.1B provided the manufacturer has a quality assurance system certified by a competent body established within the EC, and having undergone a specific assessment for materials. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET MDS R13 Rev. 3

TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo

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

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	Steel melt shall be refined with AOD or equivalent.
4. HEAT TREATMENT	The fittings shall be solution annealed followed by water quenching.
5. TENSILE TESTING	$R_{P0,2} \geq 300$ MPa, $R_M \geq 650$ - 820 MPa, $A_5 \geq 35$ %.
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 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.
7. 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.
8. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual components. Test sampling shall be made from an actual fitting or from a prolongation thereof.
9. 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 %; - 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. Welding shall be carried out by qualified welders according to qualified procedures approved by a 3rd party organization recognized by an EC member State.

MATERIAL DATA SHEET		MDS R13		Rev. 3
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 N08926	WP-S, WP-WX and WP-W	

10. NON DESTRUCTIVE TESTING	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 weld of each examined fitting shall be ground flush in a length of 100 mm prior to penetrant testing. The resting shall be carried out after calibration and pickling. The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 8. NDT operator qualification shall be approved by a 3rd party organization recognized by an EC member state.
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	Certification shall affirm compliance with the specification and shall be according to EN 10204 Type 3.1B provided the manufacturer has a quality assurance system certified by a competent body established within the EC, and having undergone a specific assessment for materials. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET MDS R14 Rev.3

TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo

PRODUCT	*STANDARD*	*GRADE*	*ACCEPT. CLASS*	*SUPPL. REQ.*
Forgings	ASTM A 182	F44 UNS N08367 UNS N08926	-	S56

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 intended for forgings with maximum thickness of 200 mm. For larger thickness special agreements shall be made in each case.
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. TENSILE TESTING	$R_{P0,2} \geq 300$ MPa, $R_M \geq 650$ MPa, $A_5 \geq 35$ %.
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. The testing shall be carried out on the component with heaviest wall thickness within the 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 location and orientation shall be: ▪ For forgings having maximum section thickness, T ≤ 50 mm, the test specimens shall be taken at mid thickness and its mid length shall be at least 50 mm from any second surface. ▪ For forgings having maximum section thickness, T > 50 mm, the test specimen shall be taken at least ¼ T from the nearest surface and at least T or 100 mm, whichever is less, from any second surface. Sketches shall be established showing type, size and location of test samples and extraction of test specimens.

MATERIAL DATA SHEET			MDS R14	Rev. 3
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 N08926	-	S56

10. NON DESTRUCTIVE TESTING	Supplementary requirement ASTM A 961 S56, 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. NDT operator qualification shall be approved by a 3rd party organization recognized by an EC member state.
11. SURFACE FINISH	White pickled including machined surfaces.
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	Certification shall affirm compliance with the specification and shall be according to EN 10204 Type 3.1B provided the manufacturer has a quality assurance system certified by a competent body established within the EC, and having undergone a specific assessment for materials. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET MDS R15 Rev. 3

TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo

PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Plates	ASTM A 240	UNS S31254 UNS N08367 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.
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. TENSILE TESTING	$R_{P0,2} \geq 310$ MPa, $R_M \geq 655$ MPa, $A_5 \geq 35$ %.
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.
12. CERTIFICATION	Certification shall affirm compliance with the specification and shall be according to EN 10204 Type 3.1B provided the manufacturer has a quality assurance system certified by a competent body established within the EC, and having undergone a specific assessment for materials Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET MDS R16 Rev. 3

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 surfaces (including internal 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. NDT operator qualification shall be approved by a 3rd party organization recognized by an EC member state.
10. SURFACE FINISH	White pickled. Shall be carried out after any blasting and shall include finished machined surfaces.

MATERIAL DATA SHEET			MDS R16	Rev. 3
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 %; 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. Welding shall be carried out by qualified welders according to qualified procedures approved by a 3rd party organization recognized by an EC member State.
12. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.
13. CERTIFICATION	Certification shall affirm compliance with the specification and shall be according to EN 10204 Type 3.1B provided the manufacturer has a quality assurance system certified by a competent body established within the EC, and having undergone a specific assessment for materials. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.

MATERIAL DATA SHEET MDS R17 Rev. 3

TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo

PRODUCT	*STANDARD*	*GRADE*	*ACCEPT. CLASS*	*SUPPL. REQ.*
Bars	ASTM A 276	UNS S31254 UNS N08367 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. This MDS is intended for bars with maximum thickness of 200 mm. For larger thickness special agreements shall be made in each case and based on the result of qualification testing specified in NORSOK M-650.
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. TENSILE TESTING	$R_{P0,2} \geq 300$ MPa, $R_M \geq 650$ MPa, $A_5 \geq 35$ %,
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. Test location and orientation shall be: ▪ For bars having maximum section thickness, T ≤ 50 mm, the test specimens shall be taken at mid thickness and its mid length shall be at least 50 mm from any second surface. ▪ For bars having maximum section thickness, T > 50 mm, the test specimen shall be taken at least ¼ T from the nearest surface and at least T or 100 mm, whichever is less, from any second surface. ▪ The testing shall be carried out in longitudinal direction. For thickness exceeding 160 mm, the testing shall be carried out both in longitudinal and transverse (tangential) direction. All testing in longitudinal direction shall meet specified requirements (ASTM A 276 and this MDS). For testing in transverse (tangential) direction elongation shall be minimum 20 %.
9. SURFACE FINISH	Finished product shall be white pickled.
10. REPAIR OF DEFECTS	Weld repair is not acceptable

MATERIAL DATA SHEET			**MDS R17**	**Rev. 3**
TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo				Page 2 of 2
PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Bars	ASTM A 276	UNS S31254 UNS N08367 UNS N08926	-	-
11. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.			
12. CERTIFICATION	Certification shall affirm compliance with the specification and shall be according to EN 10204 Type 3.1B provided the manufacturer has a quality assurance system certified by a competent body established within the EC, and having undergone a specific assessment for materials. Heat treatment temperature, soaking time and cooling medium should be stated in the certificate.			

MATERIAL DATA SHEET MDS R18 Rev. 3

TYPE OF MATERIAL: Austenitic stainless steel, Type 6Mo

PRODUCT	***STANDARD***	***GRADE***	***ACCEPT. CLASS***	***SUPPL. REQ.***
Tubes	ASTM A 269	UNS S31254 UNS N08367 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 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 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 (pickling or bright annealing). 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.
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. 3

TYPE OF MATERIAL: Austenitic Stainless Steel, Type 316

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	-	-
Bars	ASTM A 276	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. MANUFACTURING PROCESS	*All welded products:* Welding shall be carried out by qualified welders according to qualified procedures approved by a 3rd party organization recognized by a EC member State.
3. CHEMICAL COMPOSITION	*All products:* $C \leq 0.035$ % *Welded pipes and plates to A 240*: $S \leq 0.015$ %
4. TENSILE TESTING	Grade 316 L with $R_{p0.2} \geq 205$ MPa, $R_m \geq 515$ MPa and $A_5 > 35\%$ is acceptable.
5. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual component.
6. NON DESTRUCTIVE TESTING	*Welded pipes to A 358:* Eddy current testing according to ASTM A 450 is acceptable as replacement for spot radiography for wall thickness less than 4.0 mm. *Welded tubes to A 269:* Eddy current testing according to ASTM A 450, section 23 is required. *All products:* NDT operator qualification shall be approved by a 3rd party organization recognized by a EC member state.
7. SURFACE FINISH	White pickled. Machined surfaces do not require pickling. *Tubes to A 269:* According to the standard.
8. REPAIR OF DEFECTS	Weld repair of base material is not acceptable.
9. MARKING	The product shall be marked to ensure full traceability to melt and heat treatment lot.
10. CERTIFICATION	Certification shall affirm compliance with the specification and shall be according to EN 10204 Type 3.1B provided the manufacturer has a quality assurance system certified by a competent body established within the EC, and having undergone a specific assessment for materials.

MATERIAL DATA SHEET			MDS S02	Rev. 3
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	*Penetrant testing:* Supplementary requirement S6 shall apply to all surfaces (including internal surfaces) of all castings. The testing shall be carried out after final machining and pickling. The acceptance criteria shall be ASME VIII, Div.1, Appendix 7. *Radiographic testing:* Supplementary requirement S5 shall apply to: - Critical areas as per ANSI B16.34 of the pilot cast of each pattern - *A*ll 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. NDT operator qualification shall be approved by a 3rd party organization recognized by an EC member state.
5. REPAIR OF DEFECTS	Welding shall be carried out by qualified welders according to qualified procedures approved by a 3rd party recognized by an EC member State.
6. SURFACE FINISH	White pickled. Machined surfaces do not require pickling.
7. CERTIFICATION	Certification shall affirm compliance with the specification and shall be according to EN 10204 Type 3.1B provided the manufacturer has a quality assurance system certified by a competent body established within the EC, and having undergone a specific assessment for materials

MATERIAL DATA SHEET MDS T01 Rev. 3

TYPE OF MATERIAL: Titanium Grade 2

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 achieved in as formed condition.	
4. EXTENT OF TESTING	*Fittings to B 363:*	Tensile test shall be carried out for each heat, heat treatment load, type and size.
	Products to B 381/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. CERTIFICATION	EN 10 204 Type 3.1B.	

MATERIAL DATA SHEET MDS T02 Rev. 3

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 HOT ISOSTATIC PRESSING	All castings shall be subject to Hot Isostatic Pressing (HIP). HIP may be substituted for required heat treatment provided all requirements are met and the temperature is not detrimental to the material.
4. CHEMICAL COMPOSTION	Chemical composition other than Grade 2 (GOST VT 1-0) is acceptable.
5. EXTENT OF TESTING	Tensile testing is required for each heat and heat treatment load.
6. TEST SAMPLING	Samples for mechanical testing shall realistically reflect the properties in the actual components. For castings with weight 150 kg and above the test blocks shall be integrally cast with the casting. Test samples shall accompany the castings through any heat treatment, chemical cleaning process or any other operation that may alter metallurgical or mechanical properties.
7. NON DESTRUCTIVE TESTING	*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.
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

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

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 ≥ 620 MPa Minimum tensile strength: Rm ≥ 850 MPa Minimum elongation: A5 ≥ 15 %
6. IMPACT TESTING	Charpy V-notch testing is required according to ASTM A 370 at - 30 °C. The 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

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 criteria 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

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 ≤ 0.14 %; Si ≤ 0.50 %; Mn = 1.30-1.60 %; Cr ≤ 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.