Material data sheets and element data sheets for piping

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

Standards Norway Strandveien 18, P.O. Box 242 N-1326 Lysaker NORWAY Telephone: + 47 67 83 86 00 Fax: + 47 67 83 86 01 Email: petroleum@standard.no Website: www.standard.no/petroleum

Copyrights reserved

Fc	Foreword		
In	troduc	tion	2
1		Scope	3
2		Normative references	3
3		Terms, definitions and abbreviations	3
	3.1	Terms and definitions	3
	3.2	Abbreviations	4
4		Material data sheets (MDSs)	5
	4.1	General	5
	4.2	Implementation of Pressure Equipment Directive (PED)	5
	4.3	Compliance with ISO 15156 all parts	6
	4.4	Deviations from ASME B31.3	7
	4.5	Tensile testing and elongation	7
	4.6	Impact test temperature	7
	4.7	Microstructural examination	7
	4.8	Referenced standards (ASTM and ISO) and corresponding MDS	11
5		Element data sheets (EDSs)	14
Aı	nnex A	A (normative) Material data sheets (MDSs)	16
Aı	nnex E	3 (normative) Element data sheets (EDSs)	130

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 Subject to development and publication of international standards, the relevant NORSOK standard will be withdrawn.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 for most standards work and according to established procedures defined in NORSOK A-001.

The NORSOK standards are prepared and published with support by The Norwegian Oil and Gas Association, The Federation of Norwegian Industry, Norwegian Shipowners' Association and The Petroleum Safety Authority Norway.

NORSOK standards are administered and published by Standards Norway.

Introduction

This edition 6 of NORSOK M-630 replaces edition 5 and is an update to include the following main changes:

- the material certification requirements are revised to include information of M-650 QTR No. (Dxx and Rxx)
- the requirements to microstructural examination of duplex stainless steels are modified
- the requirements for measuring ferrite content is modified (Dxx);
- requirement for test sketch to be established for fittings is added for MDS C23, Dxx and Rxx;
- · test block dimensions for castings are updated to be consistent;
- the extent of radiographic testing of castings are modified;
- testing at both ends of coiled sheet is added (D45, D55, R15 and R25);
- all major repairs of castings shall be documented is added;
- a change of specific make or brand name for weld repair of castings in DSS is deleted (D46 and D56);
- the absorbed energy requirement of Charpy V-notch testing of bars in DSS is changed to 45 J (D47 and D57) in both axial and tangential direction;
- Charpy V-notch testing in transvers direction of bars in DSS with OD >100 mm is added (D47 and D57);
- delivery condition of seamless pipes and tubes in DSS is changed to solution annealed followed by accelerated cooling (D41, D48, D51 and D58);
- requirement of water cooling after forging in type 25Cr duplex is modified to a recommendation (D54);
- new MDS D59 and D60 for fasteners in type 25Cr duplex is added;
- new MDS N04 and N05 to cover fasteners in Grade 660 and alloy 718 is added;
- welded pipes in Alloy 625 with addition of filler material is added (N01);
- tensile strength of products in type 6Mo is changed to 655 MPa for all thicknesses except for castings (R1x series);
- requirements are changed to obtain consistency between different material grades;
- NORSOK M-650 is added as requirement to EDS' for fabrication of bends in DSS and type 6Mo (NBE2);
- requirement for material certification to EN 10204 Type 3.1 is added for induction heated bends (NBE2);
- thickness of thermal sprayed tungsten carbide is changed to 0,10 0,20 mm (NHF2);
- laser beam and electro beam welding is added as acceptable welding methods for weld overlay and hard facing;
- a number of editorial modifications are made.

1 Scope

This NORSOK standard includes material requirement in a collection of MDS' for use in piping systems, selected according to NORSOK L-001.

The MDSs can also be applied for components other than piping, e.g. pressure vessels, pumps, strainer, etc.

2 Normative references

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

ASME B31.3, Process Piping

ASTM standards and ISO standards listed in Table 2.

EN 10204,	Metallic products — Types of inspection documents
NORSOK L-001,	Piping and Valves
NORSOK M-601,	Welding and inspection of piping
ISO 15156-2,	Petroleum and natural gas industries — Materials for use in H_2S -containing environments in oil and gas production — Part 2: Cracking-resistant carbon and low alloy steels, and the use of cast irons
ISO 15156-3,	Petroleum and natural gas industries — Materials for use in H ₂ S-containing environments in oil and gas production — Part 3: Cracking-resistant CRAs (corrosion- resistant alloys) and other alloys

3 Terms, definitions and abbreviations

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

3.1 Terms and definitions

3.1.1

shall

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

3.1.2

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

3.1.3

may

verbal form used to indicate a course of action permissible within the limits of this NORSOK standard

3.1.4

can

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

3.1.5

carbon steel type 235

carbon steel with SMYS ≤ 275 MPa and not impact tested

3.1.6

carbon steel type 235LT

carbon steel with SMYS ≤ 275 MPa and impact tested at - 46 °C

3.1.7

carbon steel type 360LT

carbon steel with 300 MPa < SMYS \leq 360 MPa and impact tested at - 46 $^\circ\text{C}$

3.1.8

stainless steel type 316

austenitic stainless steel alloys with approximately 2,5 % Mo of type AISI 316

3.1.9

stainless steel type 6Mo

austenitic stainless steel alloys with 6 % Mo and PRE \ge 40

3.1.10

stainless steel type 565

austenitic stainless steel alloys with SMYS \ge 450 MPa and PRE \ge 40

3.1.11

stainless steel type 22Cr duplex

ferritic/austenitic stainless steel alloys with 22 % Cr (e.g. UNS S32205 and UNS S31803)

3.1.12

stainless steel type 25Cr duplex

ferritic/austenitic stainless steel alloys with 25 % Cr and PREN \ge 40

NOTE: Often referred to as "super duplex".

3.2 Abbreviations

- AISI The American Iron and Steel Institute
- API The American Petroleum Institute
- ASTM The American Society of Testing and Materials
- ASME The American Society of Mechanical Engineers
- EC European Community
- EDS equipment data sheet
- EN European Standard
- FKM fluorocarbon terpolymer
- FKM GLT fluorocarbon low T terpolymer
- GOST (Russian standardization organization)
- HIC hydrogen-induced cracking
- HNBR hydrogenated nitrile
- ISO International Organization for Standardization
- MDS material data sheet
- NBR nitrile

- NDT non destructive testing
- PE polyethylene
- PEEK poly-ether-ether-ketone
- PED Pressure Equipment Directive
- PRE pitting resistance equivalent
- PREN pitting resistance equivalent number
- SOHIC stress-oriented hydrogen-induced cracking
- SMYS specified minimum yield strength
- UNS unified numbering system

4 Material data sheets (MDS')

4.1 General

Materials/components manufactured in accordance with previous editions of this NORSOK standard may be accepted. This shall be agreed with the actual project/company.

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

The materials shall be delivered in accordance with the standard referred to in the MDS'. In addition the MDS' specify the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard. Provided the MDS' does not specify any additional requirements all the requirements of the referred standard apply. The latest issue of the referred standard shall apply unless a specific year of issue is specified by the purchaser.

The actual types of materials covered are as follows:

- 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
- P Polymers including fibre reinforced
- R Austenitic stainless steels: Type 6Mo, Type 565
- S Austenitic stainless steels: Type 316
- T Titanium
- X Low alloyed steels
- NOTE Welded products according to MDS C11, MDS D42, MDS D43, MDS D52, MDS D53, MDS N01, MDS R12, MDS R13, MDS R22, MDS R23, MDS S01 and MDS T01 have acceptance classes, which give welding factors 0,8 or 1,0. The correct class is specified on the piping class sheet. The purchase order shall specify acceptable class for each item.

4.2 Implementation of Pressure Equipment Directive (PED)

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.

The PED specific requirements for materials to be used for pressure equipment classified to PED category III 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 by an EC member state;
- approval of NDT operators by a 3rd party organization recognized by an EC member state.
- certification of specific product control;
- the material manufacturer shall have an appropriate quality-assurance system, certified by a competent body established within the Community and having undergone a specific assessment for materials.

All the above requirements are included in the collected MDS' covering iron based alloys, i.e. C-, D-, S-, R- and X-series, except for the following:

- carbon steels specified at MDS C01 and MDS C02 do not include impact test requirements;
- the requirement for 3rd party organization approval of welders and welding procedures and approval of NDT operators is not included;
- the requirement for a quality-assurance system certified by a body established within the Community is not included.

Polymer products specified by the MDS' in the P-series are not classified as pressure bearing parts, except for PE-pipe covered by MDS P41. Pipes to MDS P41 are only intended used for civil piping systems designed to sound engineering practise within category 0.

For installation projects to the PED requirements the above listed exceptions to the PED requirements should be considered, and added to the collected MDS' as found necessary in agreement with the selected notified body when applicable.

4.3 Compliance with ISO 15156 all parts

The specified requirements of ISO 15156-2 and ISO 15156-3 are included in the relevant MDS' as defined below:

Carbon steel MDS C- series

- All the carbon steel grades covered by the MDS C-series have nickel content less than 1 % and are not free-machining steels.
- The MDS' specify components to be delivered in normalised, normalised and tempered, or austenitized, quenched and tempered condition.
- Since all components are specified to be delivered in heat treated conditions, hardness testing is not specified unless hardness is a mandatory requirement of the relevant reference standard such as A 105 and A 350.
- The recommended requirement in ISO 15156-2 regarding sensitivity to HIC and SOHIC for carbon steel is not implemented since the sulphur content of wrought products such as plate, welded pipes, seamless pipes, and fittings made thereof, are not specified to comply with the recommended maximum sulphur values, but specified to be ≤ 0,025 %.

Austenitic stainless steels and nickel base alloys MDS N-, R- and S-series

- The MDS' specify all components to be manufactured and certified in solution heat treated condition except for welded pipes in Type 6Mo with wall thickness less than 7,11 mm, which are to be made from solution annealed plates and delivered in welded condition.
- No hardness measurement is specified since all components are specified to be certified in solution annealed condition.

Ferritic/austenitic stainless steels MDS D-series

- The MDS' specify all components to be manufactured and certified in solution heat treated condition except for bolts to MDS D59 which are specified in solution annealed and strain hardened condition.
- The ferrite content is specified to be in the range 35 % to 55 % for base material and 35 % to 65 % for weld metal in welded products.
- The microstructure shall be free from inter metallic phases and precipitates. If intermetallic phases or precipitates are present these shall be reported and acceptance shall be based upon Charpy V-notch and corrosion testing.

Low alloyed steels MDS X- series

- All the low alloyed steels grades covered by the MDS' C-series have all nickel content less than 1 % and are not free-machining steels.
- The MDS' specify components to be delivered in normalised or austenitized and quenched and tempered conditions.
- Hardness measurements are specified and maximum hardness values are included in all the relevant MDS' in compliance with ISO 15156-2, except for MDS X04 for which sour service requirements are not complied with.

4.4 Deviations from ASME B31.3

The use of the piping materials according to NORSOK L-001, NORSOK M-601 and this NORSOK standard will result in some deviations from ASME B31.3. All deviations have been carefully considered, and they are in line with the PED harmonised standards. The deviations are as follows:

- 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 test temperature is not reduced;
- eddy current examination is accepted as replacement for spot radiography of longitudinal welds in stainless steel pipes for wall thickness less than 4,0 mm;
- thin walled (thickness up to 7,11 mm) longitudinal welded pipes in Type 6Mo 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.

4.5 Tensile testing and elongation

Tensile testing shall in general be carried out in accordance with ASTM A370 as specified the referenced product standards in the respective MDSes. However, testing in accordance with ISO 6892-1 is also acceptable. The elongation shall be measured and reported in accordance with the selected tensile test standard ASTM A370 or ISO 6892-1. For specimens to ASTM A 370 the gauge length shall be 50mm as far as practical possible. For specimens to ISO 6892-1 test specimens with proportional gauge length shall be used. Since these standards have different gauge length the specified minimum required elongation "A" shall apply as relevant for each applicable standard.

4.6 Impact test temperature

The test temperature for carbon, low alloyed and duplex stainless steels is in general specified to be minus 46°C since this is the lowest standardized test temperature within ASME B31.3 for these materials. In case a lower test temperature is applied this is acceptable, but the specified minimum absorbed energy shall apply unless otherwise agreed with end user.

4.7 Microstructural examination

Intermetallic phases, chromium nitrides or carbides are to some degree present in stainless steel, even if the amounts are minute. When viewing an austenitic or ferritic/austenitic stainless steel microstructure using light optical microscopy inclusions of intermetallic phases, cooling nitrides in the ferrite phase of ferritic/austenitic stainless steels or carbides can be seen if the examination is made very carefully and with large enough magnification. The difficulty using light microscope in the examination is to identify any possible dark spots as precipitates or other inclusions or etching effects. In general it is therefore difficult to state that the microstructure is free from intermetallic phases and precipitates at minimum 400X or 500X (200 X for castings) magnification. The experience is also that it is difficult to quantify the amount of intermetallic phases and precipitates as the amount is likely to be different through the wall thickness of the component and the counting method.

Basically it is the detrimental effect to the intermetallic phases and precipitates to the physical and corrosion properties of the material that shall be assured by performing the quality control testing. In addition to this there is a need to have test acceptance criteria that are definite to avoid discussions or to challenge the integrity of the operator of microstructure examination.

The test requirements and acceptance criteria for the microstructure examination are therefore modified to read as follows:

"The specimen shall be polished and etched in 20 % NaOH electrolyte or another etchant qualified by the M-650 qualification program.

The microstructure shall be examined and shall be free from detrimental intermetallic phases and precipitations at 400 to 500 X magnification. Any presence of intermetallic phases and/or precipitates shall be reported.

In case intermetallic phases and/or precipitations are detected the acceptance of product shall be based upon the corrosion and Charpy V-notch test results."

The current approach is therefore that the microstructure shall be free from detrimental intermetallic phases at 400 or 500X magnification (200 X for castings), but if present the acceptance the products represented shall be based upon the corrosion and Charpy V-notch test results. The findings from the microstructure examination will in those cases become informative.

As a consequence of this change in quality control testing corrosion test in accordance with ASTM G48 is introduced as new test to type 22Cr duplex, ref. MDS' D41 to D48. The test temperature is specified to be 25°C and the test conditions the same as for type 25Cr duplex.

NORSOK standard M-630

Edition 6, October 2013

			i adie 1 – Materia	I selection menu	lable 1 – Material selection menu for piping systems	IS		
Type of materials	Pipes seamless	Pipes welded	Fittings	Forgings	Plate	Castings	Bars/Fasteners	Tubes
Carbon steel	A 106 Grade B	API 5L Grade B	A 234 Grade WPB	A 105	A 516 Grade	A 216 Grade WCB		
Type 235 ^a		A 672			07/00			
		CC60, CC70 Class 12 22						
Carbon steel	A 333 Grade 6	A 671 Grade	A 420	A 350 Grade LF2	A 516 Grade	A 352 Grade LCC		
Type 235LT		CC60, CC70	Grade WPL 6		0//00			
impact tested		Class 12/22						
Carbon steel	API 5L Grade X52		A 860 Grade	A 694 Grade F52				
Type 360LT impact tested ^d								
Stainless steel	A 312 Grade TP	A 312 Grade	A 403 Grade WP	A 182 Grade F316	A 240 Grade 316	A 351 Grade	A 479 UNS	A 269 Grade 316
Type 316	316	TP316 A 358	316 Class			CF8M or CF3M	S31600	
		Grade 316					A 320 Grade B8M	
		Class 1/3/4/5					A 194 Grade 8M	
Stainless steel	A 790	A 928	A 815	A 182	A 240	A 995	A 479	A 789
Type 22Cr	UNS S31803	UNS S31803	UNS S31803	Grade F51	UNS S31803	UNS Grade 4	UNS S31803	UNS S31803
Duplex	UNS S32205	UNS S32205	UNS S32205	Grade F60	UNS S32205		UNS S32205	UNS S32205
		Class 1/3/5	Class S/W/WX					
Stainless steel	A 790	A 928	A 815	A 182	A 240	A 995	A 479	A 789
Type 25Cr	UNS S32550	UNS S32550	UNS S32550	F53/F55/F57/F61	UNS S32550	A5 (UNS J93404)	UNS S32550	UNS S32550
Duplex	UNS S32750	UNS S32750	UNS S32750		UNS S32750	A6 (UNS J93380)	UNS S32750	UNS S32750
	UNS S32760	UNS S32760	UNS S32760		UNS S32760		UNS S32760	UNS S32760
	UNS S39274	Class 1/3/5	Class S/W/WX				A 1082	UNS S39274
							UNS S32750	
							UNS S32760	

Table 1 – Material selection menu for piping systems

NORSOK standard

Page 9 of 155

NORSOK standard M-630

Edition 6, October 2013

Type of materials	Pipes seamless	Pipes welded	Fittings	Forgings	Plate	Castings	Bars/Fasteners	Tubes
Stainless steel	A 312	A 358	A 403	A 182 Grade F44	A 240	A 351	A 479	A 269
Type 6Mo ^b	UNS S31254	UNS S31254	WP S31254	UNS N08367	UNS S31254	CK-3MCuN	UNS S31254	UNS S31254
	UNS N08367	UNS N08367	UNS N08367	UNS N08926	UNS N08367	CN-3MN	UNS N08367	UNS N08367
	UNS N08926	UNS N08926	UNS N08926		UNS N08926		UNS N08926	UNS N08926
		Class 1/3/5	Class S/W/WX					
Stainless steel	A 312	A 358	A 403	A 182 Grade F49	A 240		A 479	
Type 565	UNS S34565	UNS S34565	UNS S34565		UNS S34565		UNS S34565	
Cu/Ni 90/10 and other conner	B 466	B 467	UNS C70600	UNS C70600	B 171	B 148		
alloys	UNS C70600	UNS C70600			UNS C70600	UNS C95800		
Nickel alloy	B 705 UNS N06625	B 705 UNS N06625	B 366 UNS N06625	B 564 UNS N06625	B 443 UNS N06625	A 494 CW-6MC and	B 446 UNS N06625	B 444 UNS N06625
						CX2MW	A 453 Grade 660	
							A 1014 UNS N07718	
Titanium	B 861	B 862	B 363 Grade	B 381	B 265	B 367	B 348	B 338
Grade 2 $^{\circ}$	Grade 2	Grade 2	WPT2 / WPT2W	Grade F2	Grade 2	Grade C2	Grade 2	Grade 2
High strength	AISI 4130		A 234 AISI 4130	A 788		A 487	A320 Grade B7,	
low alloyed steel				AISI 4140 API 6A 60K		Gr 2B/2C	B7M, L7, L7M A 194 Grade 2H,	
				(AISI 4130)			2HM, 4, 7 and 7M	
				A 182 F22				
^a Type 235 should be ^b The grades UNS N0	^a Type 235 should be used in piping systems with minimum design temperature above or equal to -29 °C in accordance with ASME B31.3, Table 323.2.A. ^b The grades UNS N08367 and N08926 are considered equivalent to UNS S31254. The grade CN-3 MN is considered equivalent to CK-3MCuN.	s with minimum design considered equivalent t	temperature above or e o UNS S31254. The gr	equal to -29 °C in accor ade CN-3 MN is consic	dance with ASME B31 lered equivalent to CK-	.3, Table 323.2.2A. -3MCuN.		
^c GOST VT-1-0 is cor	^c GOST VT-1-0 is considered equivalent to Grade 2.	Brade 2.			•			
["] For those products r	no standard and materi	al grade is stated the pi	ping classes of NORSC	DK L-001 specify use o	f the standard and mat	⁵ For those products no standard and material grade is stated the piping classes of NORSOK L-001 specify use of the standard and material grade listed for carbon steel Type 235LT.	bon steel Type 235LT.	

NORSOK standard

4.8 Referenced standards (ASTM and ISO) and corresponding MDS

The established MDSs are listed in Table 2. They are collected in Annex A.

Table 2 – List of MDSs for each type of material collected in Annex A

MDS No.	Rev. No.	Standard and grade (see NOTE)	Products
		Carbon steel type 235	
C01	5	A 106 Grade B	Seamless pipes
		ISO 3183 Grade L245 (API 5L-04 Grade B)	Welded pipes
		A 672 Grade CC60, CC70	Welded pipes
		A 234 Grade WPB	Wrought fittings
		A 105	Forgings
		A 516 Grade 60, 70	Plates
C02	5	A 216 Grade WCB	Castings
		Carbon steel type 235LT	
C11	5	A 333 Grade 6	Seamless pipes
		A 671 Grade CC60, CC70	Welded pipes
		A 420 Grade WPL 6	Wrought fittings
		A 350 Grade LF2	Forgings
		A 516 Grade 60, 70	Plates
C12	5	A 352 Grade LCC	Castings
		Carbon steel type 360LT	
C21	5	A 694 Grade F52	Forgings
C22	5	ISO 3183 Grade 52 (API 5L Grade X52)	Seamless pipes
C23	2	A 860 WPHY 52	Wrought fittings
		Ferritic/austenitic stainless steel type 22Cr Du	ıplex
D41	5	A 790 UNS S31803, UNS S32205	Seamless pipes
D42	5	A 928 UNS S31803, UNS S32205	Welded pipes
D43	5	A 815 UNS S31803, UNS S32205	Wrought fittings
D44	5	A 182 Grade F51, F60	Forgings and HIP products
D45	5	A 240 UNS S31803, UNS S32205	Plates
D46	5	A 995 Grade 4A (UNS J92205)	Castings
D47	5	A 479 UNS S31803, UNS S32205	Bars
D48	5	A 789 UNS S31803, UNS S32205	Tubes
		Ferritic/austenitic stainless steel type 25Cr Du	ıplex
D51	5	A 790 UNS S32550, S32750, S32760 and UNS S39274	Seamless pipes
D52	5	A 928 UNS S32550, S32750 and S32760	Welded pipes
D53	5	A 815 UNS S32550, S32750 and S32760	Wrought fittings and HIP products

MDS No.	Rev. No.	Standard and grade (see NOTE)	Products
D54	5	A 182 Grade F61 (UNS S32550)	Forgings and HIP prod
004	5	Grade F53 (UNS S32750)	
		Grade F57 (UNS S39277)	
		Grade F55 (UNS S39277) Grade F55 (UNS S32760)	
D55	5	A 240 UNS S32550, S32750 and S32760	Plates
D55 D56	5		
D30	5	A 995 Grade 6A (UNS J93380), Grade 5A (UNS J93404)	Castings
D57	5	A 479 UNS S32550, S32750 and S32760	Bars
D58	5	A 789 UNS S32550, S32750, S32760 and UNS S39274	Tubes
D59	1	A 1082 UNS S32750, S32760	Studs, bolts, nuts
D60	1	A 1082 UNS S32750, S32760	Studs, bolts, nuts
		Copper/nickel 90/10	
K01	3	B 466 UNS C70600	Seamless pipes and tubes
		B 467 UNS C70600	Welded pipes
		B 151 UNS C70600	Rod and bar
		B 171 UNS C70600	Plates and sheets
		UNS C70600	Fittings
		UNS C70600	Flanges
		Aluminium - bronze sand castings	
K02	3B	B 148 UNS C09580	Castings
		Nickel alloy 625	
N01	5B	B 366 UNS N06625	Wrought fittings
		B 705 UNS N06625	Pipes
		B 564 UNS N06625	Forgings
		B 443 UNS N06625	Plates
		B 446 UNS N06625	Bars
		B 444 UNS N06625	Pipes and tubes
N02	5B	A 494 Grade CW-6MC, CX 2MW	Castings
N03	2B	F 468/467 Grade Ni625	Studs, bolts, screws and nuts
N04	1B	A 453 Grade 660	Studs, bolts, screws and nuts
N05	1B	A 1014 UNS N07718	Studs, bolts, screws and nuts
		Polymers	
P11	3	Hydrogenated nitrile (HNBR)	O-ring
P12	3	Fluorocarbon terpolymer (FKM)	O-ring

MDS No.	Rev. No.	Standard and grade (see NOTE)	Products
P14	2	Nitrile (NBR)	O-ring
P21	3	PEEK (Poly-ether-ether-ketone)	Back-up rings and sea inserts
P22	3	PTFE (Poly-tetra-fluoro-ethylene)	Lip seals, back-up ring and seal inserts
P41	1	Polyethylene piping	Pipes, fittings, flanges, and welded products
		Austenitic stainless steel type 6Mo	
R11	5	A 312 UNS S31254, UNS N08367, N08926	Seamless pipes
R12	5	A 358 UNS S31254, UNS N08367, N08926	Welded pipes
R13	5	A 403 UNS S31254, N08367, N08926	Wrought fittings
R14	5	A 182 Grade F44, UNS N08367, N08926	Forgings
R15	5	A 240 UNS S31254, N08367, N08926	Plates
R16	5	A 351 Grade CK-3MCuN, CN-3MN	Castings
R17	5	A 479 UNS S31254, N08367, N08926	Bars
R18	5	A 269 UNS S31254, N08367, N08926	Tubes
		Austenitic stainless steel type 565	
R21	2	A 312 UNS S34565	Seamless pipes
R22	2	A 358 UNS S34565	Welded pipes
R23	2	A 403 UNS S34565	Wrought fittings
R24	2	A 182 Grade F49	Forgings
R25	2	A 240 UNS S34565	Plates
R27	2	A 479 UNS S34565	Bars
		Austenitic stainless steel type 316	
S01	5	A 312 Grade TP316	Seamless and welded pipes
		A 358 Grade 316	Welded pipes
		A 403 Grade WP316	Wrought fittings
		A 182 Grade F316	Forgings
		A 240 Grade 316	Plates
		A 479 Grade 316	Bars
		A 269 Grade 316	Tubes
S02	5	A 351 Grade CF3M, CF8M	Castings
S03	1	A 320 Grade B8M	Studs, bolts, screws and nuts
		Titanium Grade 2	
T01	5	B 861 Grade 2	Seamless pipes
		B 862 Grade 2	Welded pipes
		B 363 Grade WPT2/WPT2W	Wrought fittings
		B 381 Grade F2	Forgings
		B 265 Grade 2	Plates

MDS No.	Rev. No.	Standard and grade (see NOTE)	Products
		B 348 Grade 2	Bars
		B 338 Grade 2	Tubes
T02	5	B 367 Grade C2	Castings
		High strength low alloy steel	
X01	3	A 519 AISI 4130	Seamless pipes
		A 234 AISI 4130	Wrought fittings (seamless)
X02	4	A 788 AISI 4140	Forgings
X03	4	A 487 Grade 2B	Castings
X04	3	ISO 10423/API 6A 60K (AISI 4130)	Forgings
X05	3	A 182 F22	Forgings
X06	3	A 487 Grade 2B, 2C	Castings
X07	2	A 320 Grade L7, L7M A 194 Grade 4, 7 and 7M	Studs, bolts, screws Nuts

5 Element data sheets (EDSs)

The EDSs are established to specify requirements for

- cold forming,
- hot induction bending of pipe,
- thermal spray coatings,
- weld overlay applications,
- solid tungsten carbide material,
- body/bonnet bolting for valves,
- material selection of valve trim parts for valves with carbon and stainless steel bodies,
- metallic seal rings.

All EDSs established to specify the requirements defined in connection with fabrication of valves and piping systems are listed in Table 3 and are collected in Annex B.

These EDSs are reference to by valve data sheets and piping classes enclosed by NORSOK Standard L-001. However, these documents may be specified and used in other connections as found applicable by responsible designer.

EDS No.	Rev. No.	Title	
NBE1	5	Cold bending	
NBE2	2	Hot induction bending	
NBO2	3	Body/bonnet bolting for valves	
NHF1	5	Hard facing by overlay welding	
NHF2	5	Hard facing by thermal spraying of tungsten carbide	
NHF7	2	Corrosion resistant overlay welding	
NHF8	2	Solid tungsten carbide material	
NSR1	1	Metallic seal ring	
NTR1	2	Trim materials for valves with body/bonnet in carbon steel	
NTR2	2	Trim materials for valves with body/bonnet in SS Type 316	

Table 3 – List of EDSs collected in Annex B

Annex A (normative) Material data sheets (MDSs)

MATERIAL I	MATERIAL DATA SHEET MDS C01 Rev. 5					
TYPE OF MATERI	AL: Carbon Steel Ty	ype 235				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.		
Wrought fittings	ASTM A 234	WPB	-	S3		
Welded pipes	ISO 3183 (API 5L)	L245 (B) SAWL	PSL 1	-		
Welded pipes	ASTM A 672	C60, C70	t <u><</u> 19 mm: Cl. 12	-		
			t > 19 mm: Cl. 22, 32,	-		
Seamless pipes	ASTM A 106 B 42 S6					
Forgings	ASTM A 105 S4					
Plates	ASTM A 516 60, 70					
	Page 1 of 1					
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	Forgings to A 105: Normalized.					
	Welded pipes to ISO 3183: Stress relieved when the nominal thickness t \leq 19,0 mm.					
3. CHEMICAL	All products: $C \le 0.20$ %; $S \le 0.025$ %; $P \le 0.030$ %.					
COMPOSITION	$CE_{(IIW)} = C +$	- Mn/6 + (Cr + Mo + \	/)/5 + (Cu + Ni)/15 ≤ 0,43.			
4. MECHANICAL PROPERTIES	All products: Elongation, A > 20 %.					
5. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual component.					
6. NON DESTRUCTIVE TESTING	Pipes to ISO 3183: RT of weld seam or RT at ends and UT/Eddy Current of the remaining weld.					
	Fittings to A 234: UT is	not acceptable as re	eplacement of RT.			
	All products: NDT	operators shall be ce	ertified in accordance with IS	O 9712 or equivalent.		
7. REPAIR OF DEFECTS	Weld repair of base mate	rial is not acceptable.				
8. CERTIFICATION			system certified in accordar ic assessment for the relevant			
	The material certificate sh the following information:	nall be issued in acco	rdance with EN 10204 Type	3.1, and shall include		
		dition (For QT condit dium shall be stated.	ion austenitisation and temp)	ering temperature		

MATERIAL DATA SHEET **MDS C02** Rev. 5 TYPE OF MATERIAL: Carbon Steel Type 235 GRADE ACCEPT. CLASS PRODUCT STANDARD SUPPL. REQ. Castings **ASTM A 216 WCB** Page 1 of 1 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 $C \le 0,22$ % and $CE_{(IIW)} = C + Mn/6 + (Cr + Mo + V)/5 + (Cu + Ni)/15 \le 0,43$ COMPOSITION 3. EXTENT OF One set of tensile test is required for each melt and heat treatment load. TESTING 4. TEST SAMPLING Samples for mechanical testing shall realistically reflect the properties in the actual components. For castings with weight 250 kg or more the test blocks shall be integrally cast or gated onto the casting and shall not be removed from the castings until after the final quality heat treatment. 5. NON DESTRUCTIVE NDT operators shall be certified in accordance with ISO 9712 or equivalent. TESTING Magnetic particle testing: All accessible surfaces (including internal surfaces) of all castings shall be examined with Magnetic Particle (MT). Surface examination of steel castings shall be in accordance with ASME VIII Div. 1 Appendix 7. The testing shall be carried out after final machining. Nonmachined surfaces shall be pickled prior to the testing. Radiographic testing (RT): Method of radiography and acceptance criteria shall be in accordance with ASME VIII Div. 1 Appendix 7. Extent of radiographic examination (RT) for valve castings shall be according to table. Extent of RT based on pressure class and nominal outside diameter: Pressure Class: ≤150 300 600 900 1500 ≥2500 ≥ 2" Extent 10 % ≥ 10" ≥ 10" ≥ 2" ≥ 2" ≥ 2" of RT 100 % Not Not ≥ 20" ≥ 16" ≥ 6" ≥ 6" applicable applicable Valve castings shall be examined in the areas as defined by ASME B16.34 for special class valves and other critical areas as defined by designer. In addition castings shall be examined at abrupt changes in sections and at the junctions of risers, gates or feeders to the castings. When random examination (10 %) is specified, minimum one casting of each pattern including feeder and riser system in any purchase order with the foundry shall be examined. If defect outside acceptance criteria is detected, two more castings shall be tested, and if any of these two fails all items represented shall be tested. Other type of castings: Each casting shall be examined unless agreed otherwise. Testing shall be at abrupt changes in sections and at the junctions of risers, gates or feeders to the castings and other critical areas as defined by designer. Sketches of the areas to be tested shall be established and agreed. 6. CERTIFICATION The material manufacturer shall have a quality system certified in accordance with ISO 9001 and the system shall have undergone a specific assessment for the relevant materials. The material certificate shall be issued in accordance with EN 10204 Type 3.1, and shall include the following information: Heat treatment condition (For QT condition austenitisation and tempering temperature and quenching medium shall be stated.)

MATERIAL	DATA SHE	ET	MDS C11	Rev. 5	
TYPE OF MATERI	AL: Carbon Stee	el Type 235LT			
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.	
Wrought fittings Welded pipes	ASTM A 420 ASTM A 671	WPL6 CC60, CC70	- t ≤ 19 mm: Class 12 t > 19 mm: Class 22, 32, 42	S51, S53, S69 S2, S7, S14 S2, S7, S14	
Seamless pipes Forgings Plates	ASTM A 333 6 - - ASTM A 350 LF2 Class 1 S6, S55 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	<i>Fittings and forgings:</i> During heat treatment components shall be placed in such a way as to ensure free circulation around each component during the heat treatment process including possible quenching operation.				
3. CHEMICAL COMPOSITION	$ \begin{array}{l} \textit{All products: C \leq 0,20 \ \%; S \leq 0,025 \ \%; P \leq 0,025 \ \%; \\ CE_{(IIW)} = C + Mn/6 + (Cr + Mo + V)/5 + (Cu + Ni)/15 \leq 0,43. \\ \textit{Seamless pipes to A 333: } Cr \leq 0,40 \ \%; Ni \leq 0,40 \ \%; Mo \leq 0,15 \ \%; Cu \leq 0,40 \ \%; \\ (Nb + V + Ti) \leq 0,10. \\ \end{array} $				
4. IMPACT TESTING	Charpy V-notch testing at - 46 °C is required for the thickness \geq 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: 7,5 mm - 5/6 and 5 mm - 2/3. For flanges test specimens shall be taken in axial direction to the bore of the flange, see fig. 1, position 1.				
5. EXTENT OF TESTING	Im Pipes to A 671: Su Su te Forgings to A 350:O	apact testing shall be upplementary require upplementary require sting. ne set of tensile and	entary requirement S51 shall apply carried out to the same extent as ment S14 shall apply. ment S2 shall apply to the same e impact testing shall be carried out	tensile testing. extent as for tensile for each heat and	
			test lot shall not exceed 2000 kg f and 5000 kg for forgings with as for		

MATERIAL [DATA SHEI	ET	MDS C11	Rev. 5
TYPE OF MATERIA	AL: Carbon Steel	Type 235LT		
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Wrought fittings Welded pipes Seamless pipes Forgings Plates	ASTM A 420 ASTM A 671 ASTM A 333 ASTM A 350 ASTM A 516	WPL6 CC60, CC70 6 LF2 60, 70	- t ≤ 19 mm: Class 12 t > 19 mm: Class 22, 32, 42 - Class 1	S51, S53, S69 S2, S7, S14 S2, S7, S14 - S6, S55 S5 Page 2 of 3
6. TEST SAMPLING	Wrought fittings Sketches shall be esta shall be given a docur Forgings For products forged by sacrificial product. TB TC	ablished showing lo ment identification r y the closed die me $T_B/2$ s. 2 s. 1 $T_B/2$ or min. 50mm 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	 ethod, the test specimen shall be of For products forged by the op rolling method, the test specim obtained from a sacrificial forg integral prolongation. For flam, the prolongation shall minimum hub thickness (T_H) as shown i Integrated test blocks shall be components manufactured by <u>Test location flanges</u>: The bas mid-thickness of hub (T_H) in a minimum 50 mm from weld er position 1. If test specimens cannot be exposition 1. If test specimens are used shall be taken in a distance T_H 50 mm from the second heat the second heat for the	mens. The sketch btained from a en die or by the ring nen shall be ging or from an ges the thickness of m be equal to the in fig. 1. used for HIP. sic test location is distance $T_B/2$ or nd, see fig. 1, xtracted from II be extracted from test specimens B/2 or minimum treated surface. m section thickness, ength shall be at surfaces. mens shall be taken east T or 100 mm, t samples and nent identification

MATERIAL DATA SHEET			MDS C11	Rev. 5
TYPE OF MATERI	AL: Carbon Stee	el Type 235LT		
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Wrought fittings Welded pipes	ASTM A 420 ASTM A 671	WPL6 CC60, CC70	- t ≤ 19 mm: Class 12 t > 19 mm: Class 22, 32, 42	S51, S53, S69 S2, S7, S14 S2, S7, S14
Seamless pipes Forgings Plates	ASTM A 333 ASTM A 350 ASTM A 516	6 LF2 60, 70	- Class 1	- S6, S55 S5
7. NON DESTRUCTIVE TESTING	Page 3 of 3			
8. REPAIR OF DEFECTS	Weld repair of base r	naterial is not accep	table.	
9. MARKING	Heat treatment load required per heat treater		nanently marked on the component	nt where testing is
10. CERTIFICATION	 The material manufacturer shall have a quality system certified in accordance with ISO 9001 and the system shall have undergone a specific assessment for the relevant materials. The material certificate shall be issued in accordance with EN 10204 Type 3.1, and shall include the following information: Heat treatment condition (For QT condition, austenitisation and tempering temperature and quenching medium shall be stated.) Forgings and fittings: Copy of test sampling sketch 			

MATERIAL	DATA SHE	ET	MDS C12	Rev. 5	
TYPE OF MATER	IAL: Carbon Steel	Type 235LT			
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.	
Castings	ASTM A 352	LCC	-	S4	
				Page 1 of 2	
1. SCOPE			he referred standard and addition and addition the referred standard and the requirements in the reference of the standard stand		
2. CHEMICAL COMPOSITION	C ≤ 0,22 %; S ≤ 0,025	%; P ≤ 0,030 %; CE =	= C + Mn/6 + (Cr + Mo + V)/5 +	(Cu + Ni)/15 ≤ 0,43	
3. HEAT TREATMENT			placed in such a way as to ensi atment process including possit		
4. IMPACT TESTING	The minimum absorbe	ed energy for full size s	specimens shall be 27 J averag	e and 20 J single.	
5. EXTENT OF TESTING			d for each melt and heat treatm	ent load.	
6. TEST SAMPLING	For castings with weig castings and shall not Thickness of the test b maximum thickness of ruling section. Dimensions of test blo figures 1 and 2 for inter within the cross hatcher minimum be T/4.	Dimensions of test blocks and location of test specimens within the test blocks are shown in figures 1 and 2 for integral and gated test blocks respectively. The test specimens shall be take within the cross hatched area. Distance from end of test specimen to end of test block shall minimum be T/4. During any PWHT the test block shall be tack welded onto the casting.			
	Fig.1 - Integral test block	Fig	g. 2 - Gated test block		

MATERIAL	DATA S	HEET	Г	N		:12	Re	v. 5
TYPE OF MATER	AL: Carbon	Steel Ty	/pe 235LT					
PRODUCT	STANDAR		GRADE	A	CEPT.	CLASS	SUPP	L. REQ.
Castings	ASTM A 352		LCC	-			S4	
							Page 2 d	of 2
7. NON DESTRUCTIVE TESTING	Magnetic F ASME VIII machined Radiographic to - Method of Appendix - Extent of r below. Extent of F Pressure 0 Extent of RT - Valve cast valves and examined the casting pattern ind examined. tested, and - Other type shall be at castings ar shall be es	cle testing: ible surface Particle (M Div. 1 App surfaces sl esting (RT) radiograph 7. adiograph	es (including ir T). Surface exa- bendix 7. The t hall be pickled by and accepta c examination on pressure cla ≤ 150 $\geq 10^{\circ}$ Not applicable be examined ir cal areas as do hanges in secto andom examined for and riser sy utside accepta hese two fails s: Each casting anges in sectio itical areas as and agreed.	ternal surface amination of s esting shall be prior to the tern (RT) for valve (RT) for valve (RT) for valve 300 $\geq 10^{"}$ Not applicable on the areas as effined by valve tions and at the ation (10 %) if ystem in any p ince criteria is all items repro- g shall be exa ns and at the defined by de	es) of all cast teel casting carried ou sting. hall be in ac castings s size: 600 $\geq 2^{\circ}$ $\geq 20^{\circ}$ defined by e designer. te junctions s specified, purchase or detected, t esented sha mined unle junctions of signer. Ske	stings shall s shall be after final coordance hall be acc 900 $\geq 2^n$ $\geq 16^n$ In addition of risers, g minimum der with th wo more c all be tester ss agreed of f risers, gain tches of th	be exami in accorda I machinin with ASMI ording to t 1500 $\ge 2^{"}$ $\ge 6^{"}$ 6.34 for sp castings gates or fe one castin e foundry astings sh d. otherwise. tes or feed	ance with g. Non- \equiv VIII Div. 1 able ≥ 2500 $\ge 2^{\circ}$ $\ge 6^{\circ}$ becial class shall be eeders to og of each shall be all be Testing ders to the
DEFECTS	A cast plate sh	All major repairs shall be documented according to ASTM A 703 SR S20. A cast plate shall be used in the qualification of the repair welding procedure. The repair welding procedure shall be qualified in accordance with ASTM A 488 or ISO 11970 and this MDS						
9. MARKING	The componen	it shall be r	marked to ensu	ure full traceal	pility to mel	and heat	treatment	lot.
10. CERTIFICATION		n shall have ertificate sh formation: nent condit	e undergone a	specific asse n accordance ondition auste	ssment for with EN 10	the relevar 204 Type :	it material 3.1, and sl	s. hall include

MATERIAL	DATA SHEET		MDS C21	Rev. 5	
TYPE OF MATER	IAL: Carbon Steel Ty	pe 360LT			
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.	
Forgings	ASTM A 694	F52		S55	
				Page 1 of 2	
1. SCOPE			eferred standard and addition of the requirements in the r		
2. HEAT TREATMENT	For products delivered in c 19.0 mm the minimum tem		ed condition and with weld e hall be 620 °C.	end thickness >	
	Components shall be place during the heat treatment p		o ensure free circulation aro enching.	und each component	
3. CHEMICAL COMPOSITION	C ≤ 0,20 %; Mn = 0,90 - 1, Nb ≤ 0,04 %; Al ≤ 0,06 %; CE = C + Mn/6 + (Cr + Mo	N ≤ 0,015 %; (V + Nb		5 %; Ti ≤ 0,05 %;	
4. 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. For flanges test specimens shall be taken in axial direction to the bore of the flange, see fig. 1, position 1.				
5. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual components. For products forged by the closed die method, the test specimen shall be obtained from a sacrificial product. T _B For products forged by the open die or by the ring rolling method, the test specimen shall be				
	$T_{B/2}$ is the prolongation shall minimum be equal to the hub thickness (T _H) as shown in fig. 1.				
	-Pos. 2	cc	tegrated test blocks shall be omponents manufactured by	HIP.	
	FLANGE BODY Pos. 1	min. 50mm mi	e <u>st location flanges:</u> The bas id-thickness of hub (T _H) in a inimum 50 mm from weld er osition 1.	distance T _B /2 or	
	FLANGE HUB		If test specimens cannot be extracted from position 1 test specimens shall be extracted from flange body position 2.		
	Fig. 1 - Location of test specimens for flanges 50 when prolongations are used test specimens shall be taken in a distance $T_B/2$ or minimum 50 mm from the second heat treated surface.				
	<u>Test location other forgings and HIP products:</u> For forgings having maximum section thickness, $T \le 50$ mm, the test specimen shall be taken at mid thickness and its mid length shall be at least 50 mm from any second surface or at equal distance from the second surfaces.				
	For forgings having maximum section thickness, $T > 50$ mm, the test specimens shall be take at least $\frac{1}{4}$ T from the nearest surface and mid-length of test specimens at least T or 100 mm whichever is less, from any second surface.				
			nowing type, and size of test actch shall be given a docun		
	alternative test may be use	ed. Such alternative to	langes exceeding 80 kg it is est sampling shall be qualific ngs and the proposed altern	ed and shall	

MATERIAL DATA SHEET

MDS C21

21 Rev. 5

TYPE OF MATERIAL: Carbon Steel Type 360LT

TTE OF MATERIAL. Carbon Steer Type Soult						
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.		
Forgings	ASTM A 694	F52		S55		
				Page 2 of 2		
6. EXTENT OF TESTING	A test lot shall not exceed 2000 kg for forgings with as forged weight \leq 50 kg, and 5000 kg for forgings with as forged weight > 50 kg.					
7. NON DESTRUCTIVE TESTING	Supplementary requirement A 961 S55, magnetic particle testing, shall apply to 10 % of all forgings NPS 2 and above per lot, The testing shall be carried out after final machining.					
	The acceptance criteria	a shall be to ASME VI	II Div. 1, Appendix 6.			
	NDT operators shall be	e certified in accordan	ce with ISO 9712 or equivalent			
8. REPAIR OF DEFECTS	Weld repair of base ma	aterial is not acceptab	le.			
9. MARKING	The component shall b	e marked to ensure f	ull traceability to melt and heat t	treatment lot.		
10. CERTIFICATION		The material manufacturer shall have a quality system certified in accordance with ISO 9001 and the system shall have undergone a specific assessment for the relevant materials.				
	The material certificate shall be issued in accordance with EN 10204 Type 3.1, and shall include the following information:					
	- Heat treatment condition (For QT condition, austenitisation and tempering temperature an quenching medium shall be stated.)					
	- Copy of test samp	ling sketch				

MATERIAL DATA SHEET **MDS C22** Rev. 5 TYPE OF MATERIAL: Carbon Steel Type 360LT GRADE PRODUCT ACCEPT. CLASS SUPPL. REQ. STANDARD PSL 2 ISO 3183 (API 5L) L360N (X52N) Seamless pipes L360Q (X52Q) Page 1 of 1 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. Fine grain treatment shall be carried out. 2. STEEL MAKING 3. HEAT TREATMENT For pipes delivered in guenched and tempered condition and with thickness > 19.0 mm the minimum tempering temperature shall be minimum 620 °C. $C \le 0.16$ %; Ti ≤ 0.05 %; Nb ≤ 0.04 %; Al ≤ 0.06 %; N ≤ 0.015 %; (V + Nb + Ti) ≤ 0.10 %; 4. CHEMICAL COMPOSITION 5. IMPACT TESTING Charpy V-notch testing according to ASTM A 370 at - 46 °C is required for the thickness \geq 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. 6. TEST SAMPLING Samples for production testing shall realistically reflect the properties in the actual component. 100 % ultrasonic surface testing (UT) with notch calibration on N5 notch shall be carried out. 7. NON DESTRUCTIVE TESTING Electro magnetic testing shall not be used in lieu of UT. Acceptance criteria for surface examination by ultrasonic method shall be: Defects, with depths exceeding 5 % of the nominal wall thickness or 1,5 mm, whichever is the less, are not acceptable. Cracks or linear defects are not acceptable regardless of dimensions.

over a large area in excess of what is considered a workmanlike finish.

Shall be in accordance with ISO 3183 PSL 2.

Weld repair is not acceptable.

the following information:

Melting and refining practice,

quenching medium shall be stated.)

NOTE: Pipes shall be subject to rejection if acceptable surface imperfection are not scattered, but appear

The material manufacturer shall have a quality system certified in accordance with ISO 9001 and the system shall have undergone a specific assessment for the relevant materials.

The material certificate shall be issued in accordance with EN 10204 Type 3.1, and shall include

Heat treatment conditions (For QT condition austenitisation and tempering temperature and

8. SURFACE FINISH

10. CERTIFICATION

9. REPAIR OF

DEFECTS

MATERIAL DATA SHEET			MDS C23	Rev. 2	
TYPE OF MATER	IAL: Carbon Steel Ty	/pe 360LT			
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.	
Wrought fittings	ASTM A 860	WPHY52	Seamless and welded	S53, S69	
	-			Page 1 of 1	
1. SCOPE			referred standard and addit oonding requirements in the		
2 HEAT TREATMENT	For products delivered in temperature shall be 620		red condition the minimum	tempering	
	Components shall be plac during the heat treatment		to ensure free circulation are enching.	ound each component	
3. CHEMICAL COMPOSITION	(V + Nb + Ti) ≤ 0,10 %				
4. WELDING	Welding shall be carried of a 3 rd party organization.	out by qualified welde	rs according to qualified pro	cedures approved by	
	The WPQ shall be qualified	ed in accordance with	ASME IX or ISO 15614-1.		
5. TEST SAMPLING			y reflect the properties in the	e actual component.	
	The impact test specimen		•	mana. Tha alkatah	
	shall be given a documen		n for extraction of test specir er.	nens. The sketch	
6. HARDNESS TESTING	Hardness test shall be ma	ade for each test lot.			
7. NON DESTRUCTIVE TESTING	of all fittings (same test lo	Supplementary requirement 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 of dimensions			
	NDT operators shall be ce	ertified in accordance	with ISO 9712 or equivalen	t.	
8. MARKING	The component shall be r	marked to ensure full	traceability to melt and heat	treatment lot.	
9. CERTIFICATION			system certified in accordance c assessment for the relevance c assessment for c assessment for c assessment for c assessment c assessment for c asse		
	The material certificate shall be in accordance with EN 10204 Type 3.1, and shall include th following information:				
	- Manufacturer of the s certificate.	tarting material for the	e finished product shall be s	tated on the	
	quenching medium sl	hall be stated.)	on, austentisation and tempe	ering temperature and	
	- Copy of test sampling	g sketch			

MATERIAL	DATA SHE	ET	MDS D41	Rev. 5		
TYPE OF MATER	IAL: Ferritic/Auste	nitic Stainless Steel	l, Type 22Cr duplex			
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.		
Seamless pipes	ASTM A 790	UNS S31803 UNS S32205	-	-		
				Page 1 of 2		
1. SCOPE			eferred standard and addition anding requirements in the r			
2. QUALIFICATION		e manufacturing process u ccordance with NORSOK \$	sed for manufacturing of pr Standard M-650.	oduct to this MDS		
3. MANUFACTURING PROCESS	The manufacturing of 650 qualified Manufac		MDS shall be carried out a	ccording to the M-		
4. HEAT TREATMENT	Pipes shall be placed	The pipes shall be solution annealed followed by accelerated cooling. Pipes shall be placed in such a way as to ensure free circulation of heating and cooling media around each pipe during the heat treatment process including guenching.				
5. STEEL MAKING	The steel melt shall be	e refined with AOD or equi	valent.			
6. CHEMICAL COMPOSITION	<i>UNS S31803:</i> N = 0,1	4 - 0,20 %				
7. TENSILE TESTING	R _{p0.2} ≥ 450 MPa; R _m ≥	2 620 MPa; A ≥ 25 %				
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. Impact test specimens shall be taken from mid-thickness position.					
9. MICROGRAPHIC	General					
9. MICROGRAPHIC EXAMINATION	The test specimen sha	ished and etched in 20 %	and mid-thickness area of NaOH electrolyte or anothe			
	Intermetallic phases a	nd nitride precipitates				
		00 to 500 X magnification.	be free from detrimental int Any presence of intermeta			
	In case intermetallic phases and/or precipitations are detected the acceptance of product shall be based upon the corrosion and Charpy V-notch test results.					
			counting according to ASTN e accuracy shall be less tha			
	The ferrite content sha	all be within 35 - 55 %.				
10. CORROSION TEST	The ferrite content shall be within 35 - 55 %. Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 25 °C and the exposure time 24 hours. The test shall expose the external and internal surfaces and a cross section surface in full wall thickness. Cut edges shall be prepared according to ASTM G 48. The complete specimen shall be pickled before weighed and tested. Pickling may be performed for 5 minutes at 60 °C in a solution of 20 % HNO ₃ + 5 % HF.					
	The acceptance criter	ia are:				
	 No pitting 20 X ma The weight loss s 	agnification. hall be less than 4,0 g/m².				
11. EXTENT OF TESTING	Charpy V-notch impact, microstructure, corrosion, hardness and tensile testing shall be carried out for each lot.					
12. SURFACE FINISH	White pickled or bright annealed.					
13. REPAIR OF DEFECTS	Weld repair is not acc	eptable.				
14. MARKING	The component shall	be marked to ensure full tr	aceability to melt and heat t	reatment lot.		

MATERIAL DATA SHEET			MDS D41	Rev. 5
TYPE OF MATER	AL: Ferritic/Austen	iitic Stainless Steel	, Type 22Cr duplex	
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Seamless pipes	ASTM A 790	UNS S31803 UNS S32205	-	-
				Page 2 of 2
15. CERTIFICATION	 The material manufacturer shall have a quality system certified in accordance with ISO 9001 and the system shall have undergone a specific assessment for the relevant materials. The material certificate shall be in accordance with EN 10204 Type 3.1, and shall include the following information: NORSOK M-650 Manufacturing Summary identification or QTR No. used ; Steel manufacturer; Steel melting and refining practice; Heat treatment condition (Solution annealing temperature, holding time and quench mediu shall be stated. Holding time is not applicable for pipes produced hot finished/ direct quenched.) 			

MATERIAL	DATA SHEE	Г	MDS D42	Rev. 5		
TYPE OF MATER	IAL: Ferritic/Austenit	ic 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		
	·			Page 1 of 2		
1. SCOPE			eferred standard and addition			
2. QUALIFICATION	Manufacturers and the ma shall be qualified in accor		sed for manufacturing of protandard M-650.	oduct to this MDS		
3. STEEL MAKING	The steel melt shall be re-	fined with AOD or equiv	valent.			
4. MANUFACTURING PROCESS	The manufacturing of pro 650 qualified Manufacturi		MDS shall be carried out a	ccording to the M-		
5. HEAT TREATMENT	The pipes shall be solutio	n annealed followed by	water quenching.			
	Pipes shall be placed in s around each pipe during t		e free circulation of heating ess including quenching.	and cooling media		
6. CHEMICAL COMPOSITION	UNS S31803: N = 0,14 - 0	0,20 %				
7. TENSILE TESTING	Base material properties:	$R_{p0.2} \geq 450 \ MPa; \ R_m \geq$	620 MPa; A ≥ 25 %.			
EXAMINATION	The test specimen shall cover the near surfaces and mid-thickness area of the pipe inclu the weld zone. The specimen shall be polished and etched in 20 % NaOH electrolyte or etchant qualified by the M-650 qualification program. <i>Intermetallic phases and nitride precipitates</i> The microstructure shall be examined and shall be free from detrimental intermetallic phases and precipitations at 400 to 500 X magnification. Any presence of intermetallic phases and precipitates shall be reported.					
	be based upon the corros		are detected the acceptant in test results.			
	analysis according to AST	TM E 1245. The relative	counting according to ASTM accuracy shall be less that	n 20 %.		
			ase material and 35 - 65 %			
9. 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 base material and weld metal, respectively. Reduction factors for sub-size specimens shall be: 7,5 mm - 5/6 and 5 mm - 2/3.					
10. CORROSION TEST						
	The acceptance criteria a					
	 No pitting 20 X magnification. The weight loss shall be less than 4,0 g/m². 					
11. EXTENT OF TESTING	Tensile test, impact test, of carried out for each lot.		s test and microstructure ex ws:	amination shall be		
	 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 t	reatment furnace the lo	t definition in the ASTM sta	andard shall apply.		

MATERIAL	DATA SHEET	MDS D42	Rev. 5				
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			
				Page 2 of 2			
12. WELDING	The WPS shall be qualified in accordance with ASME IX or ISO 15614-1 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. NON DESTRUCTIVE TESTING	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 operators shall be qu	ualified in accordance v	vith ISO 9712 or equivalent				
14. REPAIR OF DEFECTS	Weld repair of base mater of qualified WPS shall app		or repair of welds the same elding.	e requirements to use			
15. MARKING	The component shall be n	narked to ensure full tra	aceability to melt and heat t	reatment lot.			
16. CERTIFICATION			ystem certified in accordane assessment for the relevan				
	The material certificate shall be in accordance with EN 10204 Type 3.1, and shall include the following information:						
	- NORSOK M-650 Manufacturing Summary identification or QTR No. used;						
	- Steel manufacturer of the starting material;						
	- Steel melting and refini	ng practice;					
	 Heat treatment condition shall be stated.) 	on (Solution annealing to	emperature, holding time a	nd quench medium			

MATERIAL DATA SHEET **MDS D43** Rev. 5 TYPE OF MATERIAL: Ferritic / Austenitic Stainless Steel, Type 22Cr duplex PRODUCT STANDARD GRADE ACCEPT. CLASS SUPPL. REQ. Wrought fittings **ASTM A 815 UNS S31803** WP-W, WP-S or WP-WX **S**7 **HIP Products ASTM A 988** UNS S32205 Page 1 of 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. 2. QUALIFICATION Manufacturers and the manufacturing process used for manufacturing of product to this MDS shall be qualified in accordance with NORSOK Standard M-650. The steel melt shall be refined with AOD or equivalent. 3. STEEL MAKING 4. MANUFACTURING The manufacturing of products according to this MDS shall be carried out according to the M-650 PROCESS qualified Manufacturing Procedure. The Hot Isostatic Pressed (HIP) process is an acceptable alternative manufacturing process. 5. HEAT TREATMENT The fittings shall be solution annealed followed by water quenching. Fittings shall be placed in such a way as to ensure free circulation of heating and cooling media around each fitting during the heat treatment process including quenching. UNS S31803: N = 0,14 - 0,20 % 6.CHEMICAL COMPOSITION 7. MICROGRAPHIC General **EXAMINATION** The test specimen shall cover the near surfaces and mid-thickness region of the fittings including the weld zone if relevant. The specimen shall be polished and etched in 20 % NaOH electrolyte or another etchant qualified by the M-650 qualification program. Intermetallic phases and nitride precipitates The microstructure shall be examined and shall be free from detrimental intermetallic phases and precipitations at 400 to 500 X magnification. Any presence of intermetallic phases and/or precipitates shall be reported. In case intermetallic phases and/or precipitations are detected the acceptance of product shall be based upon the corrosion and Charpy V-notch test results. Ferrite content The ferrite content shall be determined by point counting according to ASTM E 562 or by image analysis according to ASTM E 1245. The relative accuracy shall be less than 20 %. The ferrite content shall be within 35 - 55 % for base material and 35 - 65 % for weld metal. For HIP product the ferrite content shall be within 40 -60%. 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. Reduction factors for subsize specimens shall be: 7,5 mm - 5/6 and 5 mm - 2/3. The notch location and number of specimen shall be: Seamless fittings: One set, 3 specimens. Welded fittings: Two sets, each 3 specimens, one located in base material and one in weld metal. 9. CORROSION TEST Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 25 °C and the exposure time 24 hours. The test shall expose the external and internal surfaces and a cross section surface in full wall thickness. Cut edges shall be prepared according to ASTM G 48. The complete specimen shall be pickled before weighed and tested. Pickling may be performed for 5 minutes at 60 °C in a solution of 20 % HNO₃ + 5 % HF. The acceptance criteria are: No pitting 20 X magnification. The weight loss shall be less than $4,0 \text{ g/m}^2$.

MATERIAL DATA SHEET MDS D43 Rev. 5

TYPE OF MATERIAL: Ferritic / Austenitic Stainless Steel, Type 22Cr duplex						
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.		
Wrought fittings	ASTM A 815	UNS S31803	WP-W, WP-S or WP-WX	S7		
HIP Products	ASTM A 988	UNS S32205				
				Page 2 of 2		
10. EXTENT OF TESTING			ess test and microstructure exa within a wall thickness range o			
11. TEST SAMPLING	Samples for production	testing shall realisticall	y reflect the properties in the a	ctual components.		
	Test sampling shall be	made from an actual fit	ting or from a prolongation the	reof.		
	Sketches shall be estat be given a document id		n for extraction of test specime	ns. The sketch shall		
12. WELDING	same examinations as same material grade (U	The WPS shall be qualified in accordance with ASME IX or ISO 15614-1 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.				
13. NON DESTRUCTIVE TESTING	the test lot as defined a	bove) and 100 % of we tion and pickling. For w	nt testing, shall apply to 10 % o Ided fittings above NPS 2. The elded fittings the testing shall o v. 1, Appendix 8.	e testing shall be		
	NDT operators shall be	certified in accordance	with ISO 9712 or equivalent.			
14. SURFACE FINISH	White pickled. Machine	d surfaces do not requi	re pickling.			
15. REPAIR OF DEFECTS	Weld repair of base ma WPS shall apply as for		For repair of welds the same	requirements to		
16. MARKING	The component shall be	e marked to ensure full	traceability to melt and heat tre	eatment lot.		
17. CERTIFICATION			system certified in accordance sessment for the relevant mate			
	The material certificate following information:	The material certificate shall be in accordance with EN 10204 Type 3.1, and shall include the				
	- NORSOK M-650 Ma	- NORSOK M-650 Manufacturing Summary identification or QTR No. used;				
	- Steel manufacturer o	f the starting material for	or the finished product;			
	- Steel melting and ref	ining practice;				
	Heat treatment condi shall be stated.)	tion (Solution annealing	g temperature, holding time an	d quench medium		
	Copy of test sampling	g sketch				

MATERIAL	DATA SHEE1	Г	MDS D44	Rev. 5		
TYPE OF MATER	AL: Ferritic / Austen	itic Stainless Ste	el, Type 22Cr duplex			
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ		
Forgings	ASTM A 182	F51, UNS S31803	-	S56		
HIP Products	ASTM A 988	F60, UNS S32205				
	1			Page 1 of 4		
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 thickness special agreem		imum section thickness of 30 each case.	00 mm. For larger		
2. QUALIFICATION	Manufacturers and the ma shall be qualified in accor		used for manufacturing of pro Standard M-650.	oduct to this MDS		
3. STEEL MAKING	The steel melt shall be ref	fined with AOD or equ	ivalent.			
4. MANUFACTURING PROCESS	650 qualified Manufacturi	ng Procedure.	s MDS shall be carried out a	C C		
5. HEAT TREATMENT			owed by water quenching.	-		
	Components shall be place	ced in such a way as t	o ensure free circulation of h treatment process including			
6. CHEMICAL COMPOSITION	<i>F51:</i> N = 0,14 - 0,20 %					
	sacrificial product. TB TB TB TB TB TB TB TB TB TB	For the stablished side st specimens and flanges	the test specimen shall be of or products forged by the ope- obling method, the test specim balaned from a sacrificial forg tegral prolongation. For flang e prolongation shall minimur ub thickness (T _H) as shown in tegrated test blocks shall be opponents manufactured by <u>est location flanges</u> : The bas id-thickness of hub (T _H) in a inimum 50 mm from weld en obsition 1. test specimens cannot be ex- obsition 1 test specimens shall ange body position 2. //hen prolongations are used hall be taken in a distance T _E For forgings having maximur mid thickness and its mid lei al distance from the second s, T > 50 mm, the test specimens at lei howing type, and size of test ketch shall be given a docum s exceeding 80 kg it is recognize qualified and shall comprise com	en die or by the ring ing or from an ges the thickness of n be equal to the n fig. 1. used for HIP. ic test location is distance $T_B/2$ or d, see fig. 1, tracted from I be extracted from I be extracted from test specimens /2 or minimum n section thickness, ngth shall be at surfaces. nens shall be taken wast T or 100 mm, samples and nent identification		

MATERIAL	DATA SHEE	Γ	MDS D44	Rev. 5
TYPE OF MATERIAL: Ferritic / Austenitic Stainless Steel, Type 22Cr duplex				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Forgings	ASTM A 182	F51, UNS S31803	-	S56
HIP Products	ASTM A 988	F60, UNS S32205		
				Page 2 of 3
8. EXTENT OF TESTING	One set of impact test, tensile test, corrosion 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 \leq 50 kg, and 5000 kg for forgings with as forged weight > 50 kg.			
9. MICROGRAPHIC EXAMINATION	General			
	The test specimen shall be taken in same area as of tensile test specimen. The test area shall be minimum 10 x 10 mm. The specimen shall be polished and etched in 20 % NaOH electrolyte or another etchant qualified by the M-650 qualification program.			
	Intermetallic phases and nitride precipitates			
	The microstructure shall be examined and shall be free from detrimental intermetallic phases and precipitations at 400 to 500 X magnification. Any presence of intermetallic phases and/or precipitates shall be reported.			
	In case intermetallic phases and/or precipitations are detected the acceptance of product shall be based upon the corrosion and Charpy V-notch test results.			
	Ferrite content			
	The ferrite content shall be determined by point counting according to ASTM E 562 or by image analysis according to ASTM E 1245. The relative accuracy shall be less than 20 %.			
	For forgings the ferrite content shall be within 35 - 55 % and for HIP products 40-60%.			
10. IMPACT TESTING	Charpy V-notch testing according to ASTM A 370 at – 46 °C is required for the thickness \geq 6 mm (thickness at the weld neck). 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. For flanges test specimens shall be taken in axial direction to the bore of the flange, see fig. 1, position 1.			
11. CORROSION TEST	Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 25 °C and the exposure time 24 hours. The corrosion test specimen shall be taken from the same location as the mechanical test specimens. For forgings with wall thickness less than 100 mm the test specimen shall expose a cross section from surface to mid-thickness. For greater wall thickness the specimen shall expose a cross section from surface to a depth of 50 mm. Cut edges shall be prepared according to ASTM G 48. The complete specimen shall be pickled before weighed and tested. Pickling may be performed for 5 minutes at 60 °C in a solution of 20 % HNO ₃ + 5 % HF. The acceptance criteria are:			
	 The weight loss shall be less than 4,0 g/m². 			
12. NON DESTRUCTIVE TESTING	ASTM A 961 supplementary requirement 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 operators shall be certified in accordance with ISO 9712 or equivalent.			
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.			

MATERIAL DATA SHEET			MDS D44	Rev. 5		
TYPE OF MATERI	TYPE OF MATERIAL: Ferritic / Austenitic Stainless Steel, Type 22Cr duplex					
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.		
Forgings	ASTM A 182	F51, UNS S31803	-	S56		
HIP Products	ASTM A 988	F60, UNS S32205				
				Page 3 of 3		
16. CERTIFICATION	The material manufacturer shall have a quality system certified in accordance with ISO 9001 and the system shall have undergone a specific assessment for the relevant materials.					
	The material certificate shall be in accordance with EN 10204 Type 3.1, and shall include the following information:					
	- NORSOK M-650 Manu	facturing Summary ide	ntification or QTR No. used			
	- Steel manufacturer of t	he starting material;				
	 Steel melting and refini 	ing practice;				
	 Heat treatment condition. (Solution annealing temperature, holding time and quench medium shall be stated.) 					
	- Copy of test sampling s	sketch				

MATERIAL	DATA SHEET	Γ	MDS D45	Rev.	5	
TYPE OF MATER	IAL: Ferritic / Austen	itic Stainless Ste	el, Type 22Cr duplex			
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL.	REQ.	
Plates	ASTM A 240	UNS S31803 UNS S32205	-	S1		
				Page 1 of	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.				
2. QUALIFICATION	Manufacturers and the ma shall be qualified in accor		ised for manufacturing of pro Standard M-650.	oduct to this	MDS	
3. MANUFACTURING PROCESS	The manufacturing of pro- 650 qualified Manufacturi		MDS shall be carried out a	ccording to t	the M-	
4. STEEL MAKING	The steel melt shall be re-	fined with AOD or equi	valent.			
5. HEAT TREATMENT	Plates shall be placed in s	The plates shall be solution annealed followed by water quenching. Plates shall be placed in such a way as to ensure free circulation of heating and cooling media around each plate during the heat treatment process including quenching				
6. CHEMICAL COMPOSITION	UNS S 31803: N = 0,14 -	UNS S 31803: N = 0,14 - 0,20 %				
7. MICROGRAPHIC EXAMINATION	General The test specimen shall cover the near surfaces and mid-thickness area. The specimen shall be polished and etched in 20 % NaOH electrolyte or another etchant qualified by the M-650 qualification program. Intermetallic phases and nitride precipitates The microstructure shall be examined and shall be free from detrimental intermetallic phases and/or precipitates shall be reported. In case intermetallic phases and/or precipitations are detected the acceptance of product shall be based upon the corrosion and Charpy V-notch test results. Ferrite content The ferrite content shall be determined by point counting according to ASTM E 562 or by image analysis according to ASTM E 1245. The relative accuracy shall be less than 20 %. The ferrite content shall be within 35 - 55 %.				0 nases and/or ct shall by image	
8. IMPACT TESTING	Charpy V-notch testing according to ASTM A 370 at – 46 °C is required for the thickness \geq 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.					
9. CORROSION TEST	Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 25 °C and the exposure time 24 hours. The test shall expose the external and internal surfaces and a cross section surface in full wall thickness. Cut edges shall be prepared according to ASTM G 48. The complete specimen shall be pickled before weighed and tested. Pickling may be performed for 5 minutes at 60 °C in a solution of 20 % HNO ₃ + 5 % HF. The acceptance criteria are: - No pitting 20 X magnification. The weight loss shall be less than 4,0 g/m ² .					
10. EXTENT OF TESTING	Impact test, tensile test, c carried out for each heat, continuous furnace a hea	orrosion test, hardness nominal thickness and t treatment load is defi e heat and nominal thi	s test and micrographic exa I heat treatment load. For he ned as all plates heat treate ckness. For coils a complet	eat treatmer d continuou	nt in sly in the	

MATERIAL	DATA SHEE	MDS D45	Rev. 5				
TYPE OF MATER	TYPE OF MATERIAL: Ferritic / Austenitic Stainless Steel, Type 22Cr duplex						
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.			
Plates	ASTM A 240	UNS S31803 UNS S32205	-	S1			
				Page 2 of 2			
11. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual components. Tensile test specimens shall be sampled in transverse direction and shall be located in mid- thickness for thickness (t) ≤ 40mm and in location t/4 for thicknesses (t) > 40 mm, ref. ASTM E 8. Impact specimens shall be taken at mid-thickness position in transverse direction. For coils a complete set of tests shall be carried out at both ends of the coil.						
12. SURFACE FINISH	White pickled.						
13. REPAIR OF DEFECTS	Weld repair is not acceptable.						
14. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.						
15. CERTIFICATION	The material manufacturer shall have a quality system certified in accordance with ISO 9001 and the system shall have undergone a specific assessment for the relevant materials.						
	following information:	nail be in accordance w	ith EN 10204 Type 3.1, and	a shall include the			
	- NORSOK M-650 Manu	Ifacturing Summary ide	ntification or QTR No. used	l;			
	- Steel manufacturer;						
	- Steel melting and refini						
	- Heat treatment condition shall be stated.)	on (Solution annealing t	emperature, holding time a	nd quench medium			

MATERIAL	DATA SHE	ET	MDS D46	Rev.	5	
TYPE OF MATER	IAL: Ferritic / Aus	tenitic Stainless Ste	el, Type 22Cr duplex	(
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS		REQ.	
Castings	ASTM A 995	4A (UNS J92205)	-	S6, S8, S	20	
<u> </u>				Page 1 of 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. QUALIFICATION		Manufacturers and the manufacturing process used for manufacturing of product to this MDS shall be qualified in accordance with NORSOK standard M-650.				
3. MANUFACTURE	The manufacturing of products according to this MDS shall be carried out according to the M-650 qualified Manufacturing Procedure.					
4. STEEL MAKING	The steel melt shall b	e with AOD or equivalent	refining.			
5. HEAT TREATMENT	The castings shall be	solution annealed followe	d by water quenching.			
			o ensure free circulation of h treatment process including		cooling	
6. CHEMICAL COMPOSITION	N = 0,14 - 0,30 %					
7. IMPACT TESTING	CT TESTING Charpy V-notch testing is required according to ASTM A 370 at - 46 °C.					
	The minimum absorbed energy shall be 45 J average and 35 J single.					
8. MICROGRAPHIC EXAMINATION	<i>General</i> The test specimen shall be taken from the cross hatched area shown in Fig. 1 and 2. The specimen shall be polished and etched in 20 % NaOH electrolyte or another etchant qualified by the M-650 qualification program.					
		and nitride precipitates				
	The microstructure shall be examined and shall be free from detrimental intermetallic phases and precipitations at 200 X magnification Any presence of intermetallic phases and/or precipitates shall be reported.					
	In case intermetallic phases and/or precipitations are detected the acceptance of product shall be based upon the corrosion and Charpy V-notch test results. <i>Ferrite content</i>					
	The ferrite content shall be determined by point counting according to ASTM E 562 or by image analysis according to ASTM E 1245. The relative accuracy shall be less than 20 %.					
	The ferrite content sh	all be within 35 - 55 %.				
9. CORROSION TEST	and the exposure tim location as the mecha G 48. The complete s performed for 5 minu	e 24 hours. The corrosion anical test specimens. Cut specimen shall be pickled tes at 60 °C in a solution o	A is required. Test temperatest specimen shall be taken edges shall be prepared ac before weighed and tested. I of 20 % HNO ₃ + 5 % HF.	n from the sa cording to A	ame STM	
	The acceptance criteria are:					
	 No pitting 20 X magnification. The weight loss shall be less than 4,0 g/m². 					
10. TEST SAMPLING	Samples for mechanical testing shall realistically reflect the properties in the actual components.					
	For castings with weight 250 kg or more the test block shall be integrally cast or gated onto the castings and shall not be removed from the castings until after the heat treatment.					
	During any reheat treatment the test block shall be tack welded onto the casting.					
	flanged components	the largest flange thicknes	•			
	Dimensions of test blocks and location of test specimens within the test blocks are shown in figures 1 and 2 for integral and gated test blocks, respectively. The test specimens shall be taken within the cross hatched area and in a distance of T/4 from the ends. When thickness T of test block is \leq 50 mm the longitudinal axis of test specimens shall be located in the centre of test blocks.					

L: Ferritic / Aus STANDARD ASTM A 995 T T/4 T/4 T/4 T/4 Fig.1 - Integral test block A full set of tensile, in made for each heat a 5000 kg. NDT operators shall	GRADE 4A (UNS J9)	AC 2205) - T or min. 5 1/4 Fig. 2 - Gated hardness tests a t load including	CEPT. C	⇒=T+X ucture exa A test lot	SUPPI S6, S8, Page 2 o Page 2 o	of 3
ASTM A 995	→=T/2 →=T/2 ↓ x mpact, corrosion, l and heat treatmen	2205) -	i0mm T/4 T/2 X = T/2 I test block and microstrue any PWHT.	→=T+X ucture exa A test lot	S6, S8, Page 2 of aminations shall not e	S20 of 3
Fig.1 - Integral test block A full set of tensile, in made for each heat a 5000 kg.	→=T/2 → X → mpact, corrosion, I and heat treatmen	Fig. 2 - Gated	T/4 T/2 X > T/2 T/2 test block and microstru any PWHT.	ucture exa A test lot	Page 2 o aminations shall not e	of 3
Fig.1 - Integral test block A full set of tensile, in made for each heat a 5000 kg.	mpact, corrosion, l and heat treatmen	Fig. 2 - Gated	T/4 T/2 X > T/2 T/2 test block and microstru any PWHT.	ucture exa A test lot	aminations shall not e	s shall be
Fig.1 - Integral test block A full set of tensile, in made for each heat a 5000 kg.	mpact, corrosion, l and heat treatmen	Fig. 2 - Gated	T/4 T/2 X > T/2 T/2 test block and microstru any PWHT.	ucture exa A test lot	shall not e	
A full set of tensile, in made for each heat a 5000 kg.	and heat treatmen	hardness tests a t load including	and microstri any PWHT.	A test lot	shall not e	
nade for each heat a 5000 kg.	and heat treatmen	t load including	any PWHT.	A test lot	shall not e	
NDT operators shall	be certified in acc	ordonoo with IS	0 9712 or o	quivalent.		
All accessible su Liquid Penetran ASME VIII Div. machined surfac Radiographic testing Method of radiog Appendix 7.	urfaces (including t (PT). Surface exa 1 Appendix 7. The ces shall be pickle t (<i>RT</i>): graphy and accept	internal surface amination of ste testing shall be d prior to the tes tance criteria sh	s) of all casti el castings s carried out sting. all be in acc	ings shall shall be in after final cordance v	accordan machining with ASME	ce with g. Non- E VIII Div. ⁻
	sed on pressure c	lass and valve s	size:			
		300	600	900	1500	≥ 2500
	% ≥ 10"	≥ 10"	≥ 2"	≥ 2"	≥ 2"	≥ 2"
RT 100	0 % Not applicable	Not applicable	≥ 20"	≥ 16"	≥ 6"	≥ 6"
valves and othe examined at abr the castings. Wh pattern in any pr acceptance crite fails all items rep Other type of ca shall be at abrup castings and oth	r critical areas as of rupt changes in se nen random exami urchase order with eria is detected, two presented shall be stings: Each castin ot changes in section ner critical areas as	defined by desig ctions and at th ination (10%) is the foundry sha o more castings tested. ng shall be exar ons and at the j	gner. In addit e junctions of specified, m all be examit s shall be tes nined unless unctions of r	tion castir of risers, g ninimum o ned. If def sted, and s agreed c risers, gat	ngs shall b gates or feo fect outsid if any of th otherwise.	ee eders to g of each le nese two Testing lers to the
	All accessible su Liquid Penetran ASME VIII Div. machined surface Radiographic testing Method of radiog Appendix 7. Extent of radiog below. Extent of RT ba Pressure Class: Extent of 100 RT 100 Valve castings su valves and othe examined at abut the castings. Wh pattern in any pr acceptance crites fails all items rep Other type of ca shall be at abrup castings and oth	Liquid Penetrant (PT). Surface exa ASME VIII Div. 1 Appendix 7. The machined surfaces shall be pickle Radiographic testing (RT): Method of radiography and accept Appendix 7. Extent of radiographic examination below. Extent of RT based on pressure c Pressure Class: ≤ 150 Extent of 10 % $\geq 10^{\circ}$ RT 100 % Not applicable Valve castings shall be examined valves and other critical areas as examined at abrupt changes in set the castings. When random exami pattern in any purchase order with acceptance criteria is detected, tw fails all items represented shall be Other type of castings: Each castin shall be at abrupt changes in secti castings and other critical areas as shall be established and agreed.	All accessible surfaces (including internal surface Liquid Penetrant (PT). Surface examination of ster ASME VIII Div. 1 Appendix 7. The testing shall be machined surfaces shall be pickled prior to the test Radiographic testing (RT): Method of radiography and acceptance criteria sh Appendix 7. Extent of radiographic examination (RT) for valve below. $Extent of RT based on pressure class and valvessPressure Class: \leq 150 300Extent of 10\% \geq 10" \geq 10"RT 100\% Not Notapplicable applicableValve castings shall be examined in the areas asvalves and other critical areas as defined by desigexamined at abrupt changes in sections and at thethe castings. When random examination (10%) ispattern in any purchase order with the foundry shacceptance criteria is detected, two more castingsfails all items represented shall be tested.Other type of castings: Each casting shall be exarshall be at abrupt changes in sections and at the jcastings and other critical areas as defined by desigshall be established and agreed.$	All accessible surfaces (including internal surfaces) of all cast Liquid Penetrant (PT). Surface examination of steel castings of ASME VIII Div. 1 Appendix 7. The testing shall be carried out machined surfaces shall be pickled prior to the testing. Radiographic testing (RT): Method of radiography and acceptance criteria shall be in acc Appendix 7. Extent of radiographic examination (RT) for valve castings shall below. $\boxed{Extent of RT based on pressure class and valve size:}$ $\boxed{Pressure Class: \leq 150 \qquad 300 \qquad 600}$ $\boxed{Extent of 10 \% \geq 10" \qquad \geq 10"} \geq 2"$ $\boxed{RT \qquad 100 \% \qquad Not \qquad Not \qquad 20"}$	All accessible surfaces (including internal surfaces) of all castings shall Liquid Penetrant (PT). Surface examination of steel castings shall be in ASME VIII Div. 1 Appendix 7. The testing shall be carried out after final machined surfaces shall be pickled prior to the testing. Radiographic testing (RT): Method of radiography and acceptance criteria shall be in accordance of Appendix 7. Extent of radiographic examination (RT) for valve castings shall be accepted below. Extent of RT based on pressure class and valve size: Pressure Class: ≤ 150 300 600 900 Extent of $10 \% \geq 10^{\circ} \geq 10^{\circ} \geq 2^{\circ} \geq 2^{\circ}$ RT 100 % Not Not $\geq 20^{\circ} \geq 16^{\circ}$ valve castings shall be examined in the areas as defined by ASME B10 valves and other critical areas as defined by designer. In addition casting examined at abrupt changes in sections and at the junctions of risers, get the castings. When random examination (10%) is specified, minimum of pattern in any purchase order with the foundry shall be tested, and fails all items represented shall be tested. Other type of castings: Each casting shall be examined unless agreed of shall be at abrupt changes in sections and at the junctions of risers, get castings and other critical areas as defined by designer. Sketches of the shall be established and agreed.	All accessible surfaces (including internal surfaces) of all castings shall be examination of steel castings shall be in accordant ASME VIII Div. 1 Appendix 7. The testing shall be carried out after final machining machined surfaces shall be pickled prior to the testing. Radiographic testing (RT): Method of radiography and acceptance criteria shall be in accordance with ASME Appendix 7. Extent of radiographic examination (RT) for valve castings shall be according to the below. Extent of RT based on pressure class and valve size: Pressure Class: ≤ 150 300 600 900 1500 Extent of $10 \% \geq 10^{\circ} \geq 10^{\circ} \geq 2^{\circ} \geq 2^{\circ} \geq 2^{\circ}$ RT 100 % Not Not Not $\geq 20^{\circ} \geq 16^{\circ} \geq 6^{\circ}$ Valve castings shall be examined in the areas as defined by ASME B16.34 for spontates and other critical areas as defined by designer. In addition castings shall be examined at abrupt changes in sections and at the junctions of risers, gates or fer the castings. When random examination (10%) is specified, minimum one casting pattern in any purchase order with the foundry shall be examined. If defect outsid acceptance criteria is detected, two more castings shall be tested, and if any of the fails all items represented shall be tested. Other type of castings: Each casting shall be examined unless agreed otherwise. shall be at abrupt changes in sections and at the junctions of risers, gates or fer details all items represented shall be tested.

MATERIAL I	DATA SHEE	MDS D46	Rev. 5	
TYPE OF MATERI	AL: Ferritic / Auste	nitic Stainless Stee	el, Type 22Cr duplex	<u> </u>
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Castings	ASTM A 995	4A (UNS J92205)	-	S6, S8, S20
				Page 3 of 3
15. REPAIR OF DEFECTS	 All major repairs shall be documented according to ASTM A 703 SR S20. Post weld heat treatment (PWHT) is required after all weld repairs. For minor weld repairs, as defined by ASTM A 995, the PWHT may be excluded provided the welding procedure qualification shows that all specified properties, as specified in this MDS, are be fulfilled. The repair welding procedure shall be qualified in accordance with ASTM A 488 or ISO 11970 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 for SMAW and FCAW processes. 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 			
16. MARKING	Iocated in weld metal and fusion line, respectively. The component shall be marked to ensure full traceability to melt and heat treatment lot.			
17. CERTIFICATION	 The component shall be marked to ensure full traceability to melt and heat treatment lot. The material manufacturer shall have a quality system certified in accordance with ISO 9001 and the system shall have undergone a specific assessment for the relevant materials. The material certificate shall be in accordance with EN 10204 Type 3.1, and shall include the following information: NORSOK M-650 Manufacturing Summary identification or QTR No. used; Steel melting and refining practice; Heat treatment condition. (Solution annealing temperature, holding time and quench medium shall be stated.) 			

MATERIAL	DATA SHE	ET	MDS D47	Rev. 5	
TYPE OF MATER	RIAL: Ferritic / Aust	tenitic Stainless S	Steel, Type 22Cr duplex	(
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.	
Bars	ASTM A 479	UNS S31803 UNS S32205	-	-	
	-			Page 1 of 2	
1. SCOPE	which shall be added This MDS is intended	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 and the manufacturing process used for manufacturing of product to this MDS shall be qualified in accordance with NORSOK Standard M-650.			
3. STEEL MAKING	The steel melt shall be	e refined with AOD or e	equivalent.		
4. MANUFACTURING PROCESS	The manufacturing of products according to this MDS shall be carried out according to the M 650 qualified Manufacturing Procedure. Machining of components as valves, fittings and hollow sections from bar:				
	-	hined from bar under t ptance shall be obtaine	he following conditions:		
		ested and certified acc			
	 When bar with outside diameter 100 mm or greater is used, tensile and impact shall be taken in both longitudinal and transverse direction. Acceptance criteria same in both directions. For valves and fittings without welding ends 27 J aver acceptable in transverse direction. 				
	acceptance criter		SR S56 shall apply to all finish Div. 1, Appendix 8. NDT operat ent.		
5. HEAT TREATMENT			l by water quenching. The solut 182 for the actual grade/UNS n		
		Bars shall be placed in such a way as to ensure free circulation of heating and cooling media around each bar during the heat treatment process including quenching.			
6. CHEMICAL COMPOSITION	UNS S31803: N = 0,14 - 0,20 %				
7. MICROGRAPHIC	General				
EXAMINATION	The test specimen shall be taken in transverse direction to the main working direction in same area as of tensile test specimen. The specimen shall be polished and etched in 20 % NaOH electrolyte or another etchant qualified by the M-650 qualification program.				
	Intermetallic phases and nitride precipitates				
	The microstructure shall be examined and shall be free from detrimental intermetallic phases and precipitations at 400 to 500 X magnification. Any presence of intermetallic phases and/or precipitates shall be reported.				
	In case intermetallic phases and/or precipitations are detected the acceptance of product shall be based upon the corrosion and Charpy V-notch test results.				
	Ferrite content				
	The ferrite content shall be determined by point counting according to ASTM E 562 or by image analysis according to ASTM E 1245. The relative accuracy shall be less than 20 %.				
		all be within 35 - 55 %.			
8. IMPACT TESTING			g to ASTM A 370 at - 46 °C.		
	The minimum absorbe	ed energy shall be 45 .	J average and 35 J single.		

h

71

MATERIAL	DATA SHEE	Т	MDS D47	Rev. 5
TYPE OF MATER	IAL: Ferritic / Auste	enitic Stainless Stee	el, Type 22Cr duplex	(
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Bars	ASTM A 479	UNS S31803 UNS S32205	-	-
				Page 2 of 2
9. CORROSION TEST	Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 25 °C and the exposure time 24 hours. The corrosion test specimen shall be taken from the same location as the mechanical test specimens. For bars with diameter less than 100 mm the test specimen shall expose a cross section from surface to mid-thickness. For greater wall thickness the specimen shall expose a cross section from surface to a depth of 50 mm. Cut edges shall be prepared according to ASTM G 48. The complete specimen shall be pickled before weighed and tested. Pickling may be performed for 5 minutes at 60 °C in a solution of 20 % HNO ₃ + 5 % HF. The acceptance criteria are: – No pitting 20 X magnification. The weight loss shall be less than 4,0 g/m ² .			
10. EXTENT OF TESTING	One set of impact test, tensile test, corrosion test, hardness test and microstructure examination shall be carried out for each heat and heat treatment load.			
11. TEST SAMPLING	 Samples for production testing shall realistically reflect the properties in the actual components. Test location shall be: For bars having section thickness, T ≤ 50 mm, the test specimens shall be taken in longitudinal direction at mid thickness and its mid length shall be at least 50 mm from any second surface. For bars having section thickness, T > 50 mm, the test specimen shall be taken in longitudinal direction at least ¼ T from the nearest surface and at least T or 100 mm, whichever is less, from any second surface. 			
12. SURFACE FINISH	Finished products shall be white pickled. Machined surfaces do not require pickling.			
13. REPAIR OF DEFECTS	Weld repair is not accept	otable.		
14. MARKING	The bar and/or finished product shall be marked to ensure full traceability to melt and heat treatment lot.			
15. CERTIFICATION				

MDS D48 Rev. 5

PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.		
Tubes	ASTM A 789	UNS S31803	-	-		
		UNS S32205				
				Page 1 of 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.				
2. QUALIFICATION		Manufacturers and the manufacturing process used for manufacturing of product to this MDS shall be qualified in accordance with NORSOK Standard M-650.				
3. MANUFACTURING PROCESS	The manufacturing of p 650 qualified Manufact		MDS shall be carried out a	ccording to the M-		
4. STEEL MAKING	The steel melt shall be	refined with AOD or equi	valent.			
5. HEAT TREATMENT	The tubes shall be solu	ution annealed followed by	y accelerated cooling.			
			re free circulation of heating cess including accelerated of			
6. CHEMICAL COMPOSITION	UNS S31803: N = 0,14	4 - 0,20 %				
7. MICROGRAPHIC	General					
EXAMINATION	The test specimen shall be taken in transverse direction to the main working direction across the full wall thickness. The specimen shall be polished and etched in 20 % NaOH electrolyte or another etchant qualified by the M-650 qualification program.					
	Intermetallic phase and nitride precipitates					
	The microstructure shall be examined and shall be free from detrimental intermetallic phases and precipitations at 400 to 500 X magnification. Any presence of intermetallic phases and/or precipitates shall be reported.					
	In case intermetallic phases and/or precipitations are detected the acceptance of product shall be based upon the corrosion and Charpy V-notch test results.					
	The ferrite content shall be determined by point counting according to ASTM E 562 or by image analysis according to ASTM E 1245. The relative accuracy shall be less than 20 %.					
	The ferrite content shall be within 35 - 55 %.					
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.					
9. CORROSION TEST	and the exposure time cross section surface in G 48. The complete sp performed for 5 minute	² 4 hours. The test shall e n full wall thickness. Cut e becimen shall be pickled b as at 60 °C in a solution of	A is required. Test temperatexpose the external and intered shall be prepared according to the weighed and tested. If 20% HNO ₃ + 5 % HF.	ernal surfaces and a cording to ASTM		
	The acceptance criteria are:					
	 No pitting 20 X magnification. The weight loss shall be less than 4,0 g/m². 					
10. EXTENT OF TESTING	Microstructure, hardne	ss, corrosion, impact and	tensile testing shall be carr	ied out for each lot.		
11. TEST SAMPLING	Samples for production	n testing shall realistically	reflect the properties in the	actual components.		
12. SURFACE FINISH	White pickled or bright	White pickled or bright annealed.				
13. MARKING		e marked to ensure full tr	aceability to melt and heat t	reatment lot		

MATERIAL DATA SHEET MDS D48 Rev. 5

TYPE OF MATERIAL: Ferritic / Austenitic Stainless Steel, Type 22Cr duplex						
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.		
Tubes	ASTM A 789	UNS S31803 UNS S32205	-	-		
	Page 2 of 2					
14. CERTIFICATION	The material manufacturer shall have a quality system certified in accordance with ISO 9001 and the system shall have undergone a specific assessment for the relevant materials. The material certificate shall be in accordance with EN 10204 Type 3.1, and shall include the					
	 following information: NORSOK M-650 Manufacturing Summary identification or QTR No. used; Steel manufacturer of the starting material; 					
	 Steel melting practice and refining method; Heat treatment condition (Solution annealing temperature, holding time and quench medium shall be stated.) 					

MDS D51

Rev. 5

TYPE OF MATERIAL: Ferritic / Austenitic Stainless Steel, Type 25Cr duplex					
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.	
Seamless pipes	ASTM A 790	UNS S32550	-	-	
		UNS S32750			
		UNS S32760			
		UNS S39274			
		UNS S39277			
				Page 1 of 2	
1. SCOPE	which shall be added		eferred standard and addition onding requirements in the r s of UNS S32760.		
2. QUALIFICATION		e manufacturing process u ccordance with NORSOK S	ised for manufacturing of pr Standard M-650.	oduct to this MDS	
3. MANUFACTURING PROCESS	The manufacturing of 650 qualified manufacturing of 650 qualified manufacture for the first sector of the		MDS shall be carried out a	ccording to the M-	
4. STEEL MAKING	The steel melt shall b	e refined with AOD or equi	valent.		
5. HEAT TREATMENT	The pipes shall be solution annealed followed by accelerated cooling. Pipes shall be placed in such a way as to ensure free circulation of heating and cooling media around each pipe during the heat treatment process including accelerated cooling.				
6. CHEMICAL	C ≤ 0.03 %				
COMPOSITION	PREN = (% Cr + 3,3 % Mo + 16 % N) ≥ 40,0				
7. TENSILE TESTING	$R_{p0.2} \ge 550 \text{ MPa}; R_m \ge 750 \text{ MPa}; A \ge 25 \%$				
8. MICROGRAPHIC	General				
EXAMINATION	The test specimen taken in transverse direction to the main working direction in mid-thickness location. The specimen shall be polished and etched in 20 % NaOH electrolyte or another etchant qualified by the M-650 qualification program.				
	Intermetallic phases and nitride precipitates				
	The microstructure shall be examined and shall be free from detrimental intermetallic phases and precipitations at 400 to 500 X magnification. Any presence of intermetallic phases and/or precipitates shall be reported.				
	In case intermetallic phases and/or precipitations are detected the acceptance of product shall be based upon the corrosion and Charpy V-notch test results.				
	Ferrite content				
	The ferrite content shall be determined by point counting according to ASTM E 562 or by image analysis according to ASTM E 1245. The relative accuracy shall be less than 20 %. The ferrite content shall be within 35 - 55 %.				
9. IMPACT TESTING			10 at 40 °C is required for t		
9. IMFACT TESTING	The minimum absorb		′0 at - 46 °C is required for t erage / 35 J single. Reducti n - 2/3.		
10. CORROSION TEST	and the exposure time cross section surface G 48. The complete s performed for 5 minut	e 24 hours. The test shall e in full wall thickness. Cut e pecimen shall be pickled b es at 60 °C in a solution of	A is required. Test temperates expose the external and integrates shall be prepared according to the shall be prepared to the shall be	ernal surfaces and a cording to ASTM	
	The acceptance criteria are: - No pitting at 20 X magnification				
		s shall be less than 4,0 g/m	2 ²		

MDS D51 Rev. 5

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

PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.		
Seamless pipes	ASTM A 790	UNS S32550	-	-		
		UNS S32750				
		UNS S32760				
		UNS S39274				
		UNS S39277				
				Page 2 of 2		
11. EXTENT OF TESTING	Charpy V-notch impa out for each lot.	act, microstructure, hard	ness, corrosion and tensile tes	ting shall be carried		
12. TEST SAMPLING	Samples for producti	Samples for production testing shall realistically reflect the properties in the actual components.				
13. SURFACE FINISH	White pickled or bright annealed.					
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		The material manufacturer shall have a quality system certified in accordance with ISO 9001 and the system shall have undergone a specific assessment for the relevant materials.				
		The material certificate shall be accordance with EN 10204 Type 3.1, and shall include the following information:				
	- NORSOK M-650 M	Manufacturing Summary	identification or QTR No. used	d;		
	- Steel producer of	the starting material;				
	- Steel melting prac	tice and refining method	l;			
	- Heat treatment condition (Solution annealing temperature, holding time and quench medium shall be stated. Holding time is not applicable for pipes produced hot finished/ direct quenched.)					

MDS D52 Rev. 5

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

PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.			
PRODUCI	STANDARD						
Welded pipes	ASTM A 928	UNS S32550	Class 1, 3 and 5 S3				
		UNS S32750					
		UNS S32760		Dage 1 of 2			
4 00005			formed of a standard and a dalifi	Page 1 of 2			
1. SCOPE	which shall be added or		eferred standard and addition and ing requirements in the re- s of A 240 UNS S32760.				
2. QUALIFICATION		manufacturing process us ordance with NORSOK S	sed for manufacturing of prostandard M-650.	oduct to this MDS			
3. STEEL MAKING	The steel melt shall be	refined with AOD or equiv	valent.				
4. MANUFACTURING PROCESS	The manufacturing of p 650 qualified manufactu		MDS shall be carried out a	ccording to the M-			
5. HEAT TREATMENT	The pipes shall be solut	tion annealed followed by	water quenching.				
	Pipes shall be placed in heat treatment process		free circulation around eac	ch pipe during the			
6. MANUFACTURING	Welding shall be carried a 3 rd party organization.	d out by qualified welders	according to qualified proc	edures approved by			
7. CHEMICAL	C ≤ 0,03 %						
COMPOSITION	PREN = % Cr + 3,3 % I	Mo + 16 % N ≥ 40,0					
8. TENSILE TESTING	$R_{p0.2} \geq 550 \text{ MPa}; R_m \geq 7$	750 MPa; A ≥ 25 %					
9. MICROGRAPHIC EXAMINATION	weld in mid-thickness lo electrolyte or another el	ocation. The specimen sh tchant qualified by the M-	nd weld zone and shall be ta all be polished and etched 650 qualification program.				
	Intermetallic phases an						
		0 to 500 X magnification.	be free from detrimental inter Any presence of intermeta				
	be based upon the corr	ases and/or precipitations osion and Charpy V-notcl	are detected the acceptant test results.	ce of product shall			
	The ferrite content shall be determined by point counting according to ASTM E 562 or by image analysis according to ASTM E 1245. The relative accuracy shall be less than 20 %.						
	The ferrite content shall	l be within 35 - 55 % for b	ase material and 35 - 65 %	for weld metal.			
10. IMPACT TESTING	The minimum absorbe specimens, shall be ca	d energy shall be 45 J av rried out with notch locate	70 at - 46 °C is required for erage / 35 J single. Two se ed in base material and we cimens shall be: 7,5 mm - 5	ts, each 3 d metal,			
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 test shall expose the external and internal surfaces and a cross section surface including weld zone in full wall thickness. Cut edges shall be prepared according to ASTM G 48. The complete specimen shall be pickled before being weighed and tested. Pickling may be performed for 5 minutes at 60 °C in a solution of 20 % HNO ₃ + 5 % HF						
	The acceptance criteria						
	- No pitting at 20 X magnification						
		all be less than 4,0 g/m ²					

MDS D52 Rev. 5

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

	t			
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Welded pipes	ASTM A 928	UNS S32550	Class 1, 3 and 5	S3
		UNS S32750		
		UNS S32760		
				Page 2 of 2
12. EXTENT OF TESTING	each lot. The lot is de	fined as follows:	structure examination shall t	
	- For batch furnace treatment charge		num 60 m of pipe of the sam	e heat, size and heat
	- For continuous hea	at treatment furnace the lo	ot definition in the ASTM star	ndard applies.
13. WELDING	The WPS shall be qualified in accordance with ASME IX or ISO 15614-1 and shall include the same examinations as for the production testing. The qualification shall be carried out on the same material grade (UNS number) as used in production. Change of specific make (brand name) of welding consumables requires requalification.			
14. NON DESTRUCTIVE TESTING	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 operators shall b	be certified in accordance	with ISO 9712 or equivalent	
15. SURFACE FINISH	White pickled.			
16. REPAIR OF DEFECTS		naterial is not acceptable. Il apply as for production v	For repair of welds the same welding.	e requirements to use
17. MARKING	The component shall	be marked to ensure full	traceability to melt and heat	treatment lot.
18. CERTIFICATION	The material manuface and the system shall	cturer shall have a quality have undergone a specifi	system certified in accordan c assessment for the relevar	ce with ISO 9001 It materials.
	The material certificat following information:		with EN 10204 Type 3.1, and	d include the
	- NORSOK M-650 M	lanufacturing Summary id	lentification or QTR No. used	l;
	- Manufacturer of the	e starting material for the f	finished product;	
		of the starting material;		
	• •	ice and refining method;		
	- Heat treatment cor shall be stated.)	dition. (Solution annealing	g temperature, holding time a	and quench medium

MATERIAL	DATA SHEE	T	MDS D53	Rev. 5
TYPE OF MATERI	AL: Ferritic/Austen	itic Stainless Steel	, Type 25Cr duplex	
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Wrought fittings	ASTM A 815	UNS S32550 UNS S32750 UNS S32760	WP-S, WP-WX and WP-W	S7
HIP products	ASTM A 988	UNS S32505		
	1			Page 1 of 2
1. SCOPE	which shall be added or		eferred standard and addition nding requirements in the m of UNS S32760.	
2. QUALIFICATION	Manufacturers and the shall be qualified in acc	manufacturing process us ordance with NORSOK S	sed for manufacturing of protein the set of	oduct to this MDS
3. STEEL MAKING	The steel melt shall be	refined with AOD or equiv	valent.	
4. MANUFACTURING PROCESS	650 qualified manufactu	iring procedure.	MDS shall be carried out a ceptable alternative manuf	-
5. HEAT TREATMENT	Solution annealing followed by water quenching. Fittings shall be placed in such a way as to ensure free circulation of heating and cooling media around each fitting during the heat treatment process including quenching.			
6. CHEMICAL COMPOSITION	C ≤ 0,03 % PREN = (% Cr + 3,3 %	Mo + 16 % N) ≥ 40,0		
7. TENSILE TESTING	Base material propertie	s: $R_{p0.2} \ge 550 \text{ MPa}; R_m \ge$	750 MPa; A ≥ 25 %	
8. MICROGRAPHIC EXAMINATION	General The test specimen shall be taken in mid-thickness location and shall include base material and weld zone if relevant. The specimen shall be polished and etched in 20 % NaOH electrolyte or another etchant qualified by the M-650 qualification program. Intermetallic phases and nitride precipitates The microstructure shall be examined and shall be free from detrimental intermetallic phases and precipitations at 400 to 500 X magnification. Any presence of intermetallic phases and/or precipitates shall be reported. In case intermetallic phases and/or precipitations are detected the acceptance of product shall be based upon the corrosion and Charpy V-notch test results. Ferrite content The ferrite content shall be determined by point counting according to ASTM E 562 or by image analysis according to ASTM E 1245. The relative accuracy shall be less than 20 %.			
9. IMPACT TESTING	The ferrite content shall be within 35 - 55 % for base material and 35 - 65 % for weld metal. 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 specimens) one located in base material and one in weld metal.			

MATERIAL	DATA SHEE	Т	MDS D53	Rev. 5	
TYPE OF MATER	AL: Ferritic/Austen	itic Stainless Steel	, Type 25Cr duplex		
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.	
Wrought fittings	ASTM A 815	UNS S32550 UNS S32750 UNS S32760	WP-S, WP-WX and WP-W	S7	
HIP products	ASTM A 988	UNS S32505			
				Page 2 of 2	
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 test shall expose the external and internal surfaces and a cross section including weld zone (if relevant) in full wall thickness. Cut edges shall be prepared according to ASTM G 48. The complete specimen shall be pickled before being weighed and tested. Pickling may be performed for 5 minutes at 60 °C in a solution of 20 % HNO ₃ + 5 % HF.				
	The acceptance criteria - No pitting at 20 X m - The weight loss sha				
11. EXTENT OF TESTING	Tensile testing, impact t examination shall be ca	esting, hardness testing,	corrosion testing and micro nd heat treatment load withi		
12. TEST SAMPLING	Test sampling shall be r	made from an actual fittin	reflect the properties in the g or from a prolongation the	ereof.	
		lished showing location free free free free free free free fre	or extraction of test specim	ens. The sketch	
13. WELDING	same examinations as f same material grade (U	or the production testing.	SME IX or ISO 15614-1 an The qualification shall be or roduction. Change of speci cation.	carried out on the	
14. NON DESTRUCTIVE		nents S7, penetrant testir e) and 100 % of welded fi	ng, shall apply to 10 % of s ittings above NPS 2.	eamless (from the	
TESTING	examination shall cover a length of 100 mm prio Appendix 8.	the weld only. The weld r to penetrant testing. Th	ation and pickling. For weld of each examined fitting sh e acceptance criteria shall	all be ground flush in be ASME VIII, Div. 1,	
		certified in accordance w	vith ISO 9712 or equivalent.		
15. SURFACE FINISH	White pickled.				
16. REPAIR OF DEFECTS		terial is not acceptable. F apply as for production we	or repair of welds the same elding.	e requirements to use	
17. MARKING	The component shall be	e marked to ensure full tra	aceability to melt and heat t	reatment lot.	
18. CERTIFICATION	and the system shall ha	ve undergone a specific	ystem certified in accordane assessment for the relevan	t materials.	
	following information:		ith EN 10204 Type 3.1, and		
		• •	ntification or QTR No. used	;	
	- Manufacturer of the s	-	inor		
		nelting and refining practi tion. (Solution annealing	ice; temperature, holding time a	and quench medium	
	- Copy of test sampling	g sketch			

MATERIAL	DATA SHE	ET	MDS D54	Rev. 5		
TYPE OF MATER	IAL: Ferritic/Auste	enitic Stainless Steel	, Type 25Cr duplex			
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.		
Forgings	ASTM A 182	F61 (UNS S32550) F53 (UNS S32750) F55 (UNS S32760)	-	S56		
HIP Products	ASTM A 988	F57 (UNS S39277) UNS S32505				
				Page 1 of 3		
1. SCOPE	which shall be added This MDS is intended	ne selected options in the re or supersede the correspon for components with maxir eements shall be made in e	nding requirements in the r num section thickness of 2	eferred standard.		
2. QUALIFICATION	Manufacturers and th	e manufacturing process us ccordance with NORSOK S	sed for manufacturing of pr	oduct to this MDS		
3. STEEL MAKING	The steel melt shall b	e refined with AOD or equiv	valent.			
4. MANUFACTURING PROCESS	650 qualified manufact	products according to this cturing procedure. Id be quenched in water aft		ccording to the M-		
	The Hot Isostatic Pre	ssed (HIP) process is an ac	cceptable alternative to forg	ing.		
5. HEAT TREATMENT	The components shall be solution annealing followed by water quenching. Components shall be placed in such a way as to ensure free circulation around each component during the heat treatment process including quenching.					
6. CHEMICAL COMPOSITION	C ≤ 0,03 %, PREN =	(% Cr + 3,3 % Mo + 16 % N	I) ≥ 40,0.			
7. TENSILE TESTING	$R_{p0.2} \geq 550 \text{ MPa; } R_m \geq$	≥ 750 MPa; A ≥ 25 %.				
8. MICROGRAPHIC EXAMINATION	be polished and etche qualification program.	all be taken in same area a ed in 20 % NaOH electrolyto and nitride precipitates				
	The microstructure shall be examined and shall be free from detrimental intermetallic phases and precipitations at 400 to 500 X magnification. Any presence of intermetallic phases and/or precipitates shall be reported.					
	In case intermetallic phases and/or precipitations are detected the acceptance of product shall be based upon the corrosion and Charpy V-notch test results.					
	Ferrite content					
	The ferrite content shall be determined by point counting according to ASTM E 562 or by image analysis according to ASTM E 1245. The relative accuracy shall be less than 20 %.					
		e content shall be within 35				
9. IMPACT TESTING	(thickness at the weld	ng according to ASTM A 370 I neck). The minimum abso tors for subsize specimens	rbed energy shall be 45 J a	average and 35 J		
	For flanges test speci position 1.	imens shall be taken in axia	I direction to the bore of the	e flange, see fig. 1,		
10. EXTENT OF TESTING	carried out for each h component with heav	nsile, hardness, corrosion to eat and heat treatment load iest wall thickness within th of weight \leq 50 kg, and 5000	d. The testing shall be carrie e load. A test lot shall not e	ed out on the exceed 2000 kg for		

MATERIAL I			MDS D54	Rev. 5		
TYPE OF MATERI	AL: Ferritic/Auste	enitic Stainless Steel	, Type 25Cr duplex	Γ		
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ		
Forgings	ASTM A 182	F61 (UNS S32550) F53 (UNS S32750) F55 (UNS S32760) F57 (UNS S39277)	-	S56		
HIP Products	ASTM A 988	UNS S32505				
				Page 2 of 3		
11. CORROSION TEST	and the exposure time location as the mecha the test specimen sha thickness the specime edges shall be prepar being weighed and te $20 \% HNO_3 + 5 \% HF$		est specimen shall be taken orgings with wall thickness om surface to mid-thicknes ction from surface to a dept 8. The whole specimen sha	n from the same less than 100 mm ss. For greater wall h of 50 mm. Cut all be pickled before		
	The acceptance criter					
	 No pitting at 20 X magnification; The weight loss shall be less than 4,0 g/m². 					
12. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual components.					
	sacrificial product ^{A)} . For products forged b TB = = = FLANGE BODY Fig. 1 - Location of test sp For forgings having m at least ¼ T from the f whichever is less, from For all forgings sketch location for extraction number. NOTE:	y the closed die method, the y the open die or by the rin $T_B/2$ Pos. 2 Pos. 1 $T_B/2$ or $T_B/2$ or FLANGE HUB pecimens for flanges maximum section thickness, nearest surface and mid-learn any second surface. The shall be established shall of test specimens. The skell	g rolling method, the test sp obtained from a sacrificia integral prolongation. For thickness of the prolongat be equal to the hub thickr in fig. 1. When prolongati specimens shall be taken minimum 50 mm from the <u>Test location flanges:</u> The is mid-thickness of hub (T T _B /2 or minimum 50 mm fig. 1, position 1. If full size test specimens from position 1 test speci extracted from flange boo <u>Test location other forgin</u> having maximum section \leq 50 mm, the test specim mid thickness and its mid least 50 mm from any sec equal distance from the s T > 50 mm, the test specim ngth of test specimens at lease powing type, and size of test	becimen shall be I forging or from an flanges the tion shall minimum hess (T_H) as shown ons are used test in a distance $T_{B/2}$ of e end. e basic test location T_H) in a distance from weld end, see cannot be extracted mens shall be dy position 2. <u>gs:</u> For forgings thickness, T en shall be taken a length shall be at cond surface or at econd surfaces. hens shall be taken a length shall be t		

MATERIAL	DATA SHEI	ET	MDS D54	Rev. 5			
TYPE OF MATERI	TYPE OF MATERIAL: Ferritic/Austenitic Stainless Steel, Type 25Cr duplex						
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.			
Forgings	ASTM A 182	F61 (UNS S32550) F53 (UNS S32750) F55 (UNS S32760) F57 (UNS S39277)	-	S56			
HIP Products	ASTM A 988	UNS S32505					
				Page 3 of 3			
13. NON DESTRUCTIVE TESTING	ASTM A 961 supplementary requirement of 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 and pickling. Non-machined surfaces shall be pickled prior to the testing. The acceptance criteria shall be ASME VIII, Div. 1, Appendix 8. NDT operators shall be certified in accordance with ISO 9712 or equivalent.						
14. SURFACE FINISH	Finished products sha	III be white pickled, includin	g machined surfaces.				
15. REPAIR OF DEFECTS	Weld repair is not acc	eptable.					
16. MARKING	The component shall	be marked to ensure full tra	aceability to melt and heat t	reatment lot.			
17. CERTIFICATION	 The component shall be marked to ensure full traceability to melt and heat treatment lot. The material manufacturer shall have a quality system certified in accordance with ISO 9001 and the system shall have undergone a specific assessment for the relevant materials. The material certificate shall be issued in accordance with EN 10204, Type 3.1, and shall include the following information: NORSOK M-650 Manufacturing Summary identification or QTR No. used; Steel manufacturer of the starting material, Steel melting and refining practice; Heat treatment conditions. (Solution annealing temperature, holding time and quench medium shall be stated.) Copy of test sampling sketch 						

MATERIAL	DATA SHEE	Т	MDS D55	Rev. 5		
TYPE OF MATER	IAL: Ferritic/Austen	iitic Stainless Steel	, Type 25Cr duplex			
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.		
Plates	ASTM A 240	UNS S32550 UNS S32750 UNS S32760	-	-		
		l		Page 1 of 2		
1. SCOPE	which shall be added or		eferred standard and addition nding requirements in the r s of UNS S32760.			
2. QUALIFICATION		manufacturing process us ordance with NORSOK S	sed for manufacturing of pr Standard M-650.	oduct to this MDS		
3. MANUFACTURING PROCESS	The manufacturing of p 650 qualified manufact		MDS shall be carried out a	according to the M-		
4. STEEL MAKING	The steel melt shall be	refined with AOD or equiv	valent.			
5. HEAT TREATMENT	Plates shall be placed in		e free circulation of heating cess including quenching	and cooling media		
6. CHEMICAL COMPOSITION	C ≤ 0,03 % PREN = (%Cr + 3,3 %	Mo + 16 % N) ≥ 40,0.				
7. TENSILE TESTING	$R_{p0.2} \ge 550 \text{ MPa}; R_m \ge 7$	750 MPa; A ≥ 25 %.				
8. MICROGRAPHIC EXAMINATION						
			be free from detrimental int of intermetallic phases an			
	In case intermetallic phases and/or precipitations are detected the acceptance of product shall be based upon the corrosion and Charpy V-notch test results. <i>Ferrite content:</i>					
	The ferrite content shall be determined by point counting according to ASTM E 562 or by image analysis according to ASTM E 1245. The relative accuracy shall be less than 20 %.					
	The ferrite content shall	be within 35 - 55 %.				
9. IMPACT TESTING	The minimum absorbed		0 at - 46 °C is required for t erage / 35 J single. Reducti 2/3.			
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 test shall expose both surfaces and a cross section in full wall thickness. Cut edges shall be prepared according to ASTM G 48. The complete specimen shall be pickled before being weighed and tested. Pickling may be performed for 5 minutes at 60 °C in a solution of 20 % HNO ₃ + 5 % HF.					
	The acceptance criteria are: - No pitting at 20 X magnification.					
		be less than 4,0 g/m ² .				
11. EXTENT OF TESTING	carried out for each hea continuous furnace a he	at, nominal thickness and eat treatment load is defir me heat and nominal thic	test and micrographic exa heat treatment load. For he hed as all plates heat treate ckness. For coils a complet	eat treatment in d continuously in the		

MATERIAL	DATA SHEE	Т	MDS D55	Rev. 5	
TYPE OF MATERI	AL: Ferritic/Austen	itic Stainless Steel	, Type 25Cr duplex		
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.	
Plates	ASTM A 240	UNS S32550 UNS S32750 UNS S32760	-	-	
				Page 2 of 2	
12. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual components. Tensile test specimens shall be sampled in transverse direction and shall be located in mid- thickness for thickness (t) ≤ 40mm and in location t/4 for thicknesses (t) > 40 mm, ref. ASTM E 8. Impact specimens shall be taken from mid-thickness position in transverse direction For coils a complete set of tests shall be carried out at both ends of the coil.				
13. SURFACE FINISH	White pickled.				
14. REPAIR OF DEFECTS	Repair welding is not ac	cceptable.			
15. MARKING	The component shall be	e marked to ensure full tra	aceability to melt and heat t	treatment lot.	
16. CERTIFICATION	 The material manufacturer shall have a quality system certified in accordance with ISO 9001 and the system shall have undergone a specific assessment for the relevant materials. The material certificate shall be in accordance with EN 10204 Type 3.1, and shall include the following information: NORSOK M-650 Manufacturing Summary identification or QTR No. used; Steel manufacturer of the starting material; Steel melting practice and refining method; Heat treatment condition (Solution annealing temperature, holding time and quench medium shall be stated.) Copy of test sampling sketch 				

MATERIAL	DATA SHE	ET	MDS D56	Rev. 5
TYPE OF MATERI	AL: Ferritic/Aust	enitic Stainless Steel	, Type 25Cr duplex	
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Castings	ASTM A 995	5A (UNS J93404) 6A (UNS J93380)	-	S6, S20
				Page 1 of 3
1. SCOPE		he selected options in the re I or supersede the correspo		
2. QUALIFICATION	Manufacturers and the shall be qualified in a	ne manufacturing process us accordance with NORSOK S	sed for manufacturing of pr Standard M-650.	oduct to this MDS
3. MANUFACTURE	The manufacturing o 650 qualified manufa	f products according to this acturing procedure.	MDS shall be carried out a	ccording to the M-
4. STEEL MAKING	The steel melt shall b	be refined with AOD or equiv	valent process.	
5. HEAT TREATMENT	Components shall be	5A (UNS J93404) or 6A (UN e placed in such a way as to ment process including quer	ensure free circulation arc	ound each component
6. CHEMICAL COMPOSITION	S ≤ 0.025 % ; P ≤ 0.0 PREN = (% Cr + 3.3	030 % 3 % Mo + 16 % N) ≥ 40,0.		
7. TENSILE TESTING		≥ 700 MPa; A ≥ 18 %.		
8. MICROGRAPHIC EXAMINATION	specimen shall be po the M-650 qualification		hatched area shown in Fig NaOH electrolyte or anothe	i. 1 and 2. The r etchant qualified by
	The microstructure s	and nitride precipitates hall be examined shall be fro X magnification. Any preser		
	In case intermetallic phases and/or precipitations are detected the acceptance of product shall be based upon the corrosion and Charpy V-notch test results.			
	Ferrite content			
	analysis according to	ASTM E 1245. The relative		
		nall be within 35 - 55 %.		
9. IMPACT TESTING		ng is required according to A average / 35 J single.	ASTM A 370 at - 46 °C. Th	e minimum absorbed
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 taken from the same location as the mechanical test specimens. Cut edges shall be prepared according to ASTM G 48. The complete specimen shall be pickled before being weighed and tested. Pickling may be performed for 5 minutes at 60 °C in a solution of 20 % $HNO_3 + 5$ % HF.			
	The acceptance crite			
	- No pitting at 20 X	•		
11. EXTENT OF TESTING	A full set of mechani	shall be less than 4,0 g/m². cal and corrosion tests and i reatment charge including a		

MATERIAL	DATA SH	EET	Γ		MDS D5	56	Rev.	5
TYPE OF MATER	RIAL: Ferritic/Au	Istenit	ic Stainles	s Steel,	Type 25Cr o	duplex		
PRODUCT	STANDARD	G	RADE		ACCEPT. C	LASS	SUPPL	. REQ.
Castings	ASTM A 995		A (UNS J934) A (UNS J933)		-		S6, S20	
							Page 2 of	3
12. TEST SAMPLING	Samples for mech For castings with v castings and shall During any reheat Thickness of the t flanged componer Dimensions of tes figures 1 and 2 for taken within the cr test block is \leq 50 r blocks.	weight 2 I not be t treatme est bloc nts the I t blocks r integra ross hat	250 kg or more removed from ent the test blo k shall be equ argest flange t and location o al and gated te cched area and longitudinal as	e the test to the castir ock shall b al to the th hickness i of test spe st blocks, I in a dista	block shall be int ngs until after the e tack welded or nickest part of is the ruling sect crimens within th respectively. Th ince of T/4 from specimens shall	egrally cases heat treat treat treat treat treat treat treat treat the casting ion. The test block e test spectifies the ends. The located be located by the ends	st or gated o itment. sting. ng represe cks are show cimens shal When thick	nted. For wn in I be ness T of
	Fig.1 - Integral test block Fig. 2 - Gated test block							
13. NON DESTRUCTIVE TESTING	Liquid Penetr ASME VIII, D machined sur <i>Radiographic testi</i> - Method of rad Div. 1, Appen - Extent of radi below.	esting: ant (PT iv. 1, Ap faces s ing (RT) diograph dix 7. ographi T basec	es (including ir). Surface exa opendix 7. The hall be pickled): ny and accepta	nternal sur mination c testing sh prior to th ance criter (RT) for v	faces) of all cast of steel castings nall be carried ou ne testing. ia shall be in acc ralve castings sh nominal size: 600	tings shall shall be in ut after fina cordance v	be examine accordance al machining with ASME ¹	e with g. Non- VⅢ,
		100 %	Not applicable	Not applica		≥ 16"	≥ 6"	≥ 6"

MATERIAL	DATA SHE	ET	MDS D56	Rev. 5			
TYPE OF MATER	IAL: Ferritic/Auste	enitic Stainless Stee	l, Type 25Cr duplex				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.			
Castings	ASTM A 995	5A (UNS J93404) 6A (UNS J93380)	-	S6, S20			
				Page 3 of 3			
13. NON DESTRUCTIVE TESTING continued	valves and critica abrupt changes in When random ex purchase order w detected, two mo represented shall - Other type of cas shall be at abrupt castings and other	 Valve castings shall be examined in the areas as defined by ASME B16.34 for special class valves and critical areas as defined by designer. In addition castings shall be examined at abrupt changes in sections and at the junctions of risers, gates or feeders to the castings. When random examination (10%) is specified, minimum one casting of each pattern in any purchase order with the foundry shall be examined. If defect outside acceptance criteria is detected, two more castings shall be tested, and if any of these two fails all items represented shall be tested. Other type of castings: Each casting shall be examined unless agreed otherwise. Testing shall be at abrupt changes in sections and at the junctions of risers, gates or feeders to the castings and other critical areas as defined by designer. Sketches of the areas to be tested shall be established and agreed. 					
14. SURFACE FINISH	White pickled shall be surfaces.	carried out after any blast	ing and shall include finishe	ed machined			
15. REPAIR OF	All major repairs shall	be documented according	to ASTM A 703 SR S20.				
DEFECTS	defined by ASTM A 9 qualification shows th The repair welding pro	95, the PWHT may be exc at all specified properties, pocedure shall be qualified i	ter all weld repairs. For min luded provided the welding as specified in this MDS, can n accordance with ASTM A alification shall include the f	procedure an be fulfilled. A 488 or ISO 11970			
		same grade (UNS numbe		onowing.			
	- Change of specific make of filler metal (brand names) requires requalification for SMAW and FCAW processes.						
	- 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.						
	located in weld m	etal and fusion line, respec					
	 Corrosion test as 	specified above. The spec	imen shall include weld zo	ne.			
16. MARKING	The component shall	be marked to ensure full tr	aceability to melt and heat	treatment lot.			
17. CERTIFICATION	and the system shall The material certificat	have undergone a specific	ystem certified in accordan assessment for the relevar with EN 10204 Type 3.1, a	nt materials.			
	following information: - NORSOK M-650 M	anufacturing Summary ide	entification or QTR No. used	4.			
				٨,			
	 Steel melting practice and refining method; Heat treatment condition. (Solution annealing temperature, holding time and quench medium shall be stated.) 						

MATERIAL DATA SHEET **MDS D57** Rev. 5 TYPE OF MATERIAL: Ferritic/Austenitic Stainless Steel, Type 25Cr duplex GRADE ACCEPT. CLASS PRODUCT **STANDARD** SUPPL. REQ. Bars **ASTM A 479** UNS S32550 UNS S32750 UNS S32760 Page 1 of 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. This MDS is based on the mechanical properties of UNS S32760. 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 and the manufacturing process used for manufacturing 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. 4. MANUFACTURING The manufacturing of products according to this MDS shall be carried out according to the M-PROCESS 650 qualified Manufacturing Procedure. Machining of components as valves, fittings and hollow sections from bar: Products may be machined from bar under the following conditions: Purchasers' acceptance shall be obtained in each case. The product shall be tested and certified according to this MDS. When bar with outside diameter 100 mm or greater is used, tensile and impact specimens shall be taken in both longitudinal and transverse direction. Acceptance criteria shall be the same in both directions. For valve and fittings without welding ends 27J average in transverse direction is acceptable. 100 % penetrant testing to ASTM A 961 SR S56 shall apply to all finished products. The acceptance criteria shall be ASME VIII, Div. 1, Appendix 8. NDT operators shall be certified in accordance with ISO 9712 or equivalent. The bars shall be solution annealed followed by water quenching. The solution annealing 5. HEAT TREATMENT temperature shall be as defined in ASTM A 182 for the actual grade/UNS number. Bars shall be placed in such a way as to ensure free circulation of heating and cooling media around each bar during the heat treatment process including quenching. 6. CHEMICAL C ≤ 0.03 % COMPOSITION PREN = (% Cr + 3,3 % Mo + 16 % N) ≥ 40,0. 7. TENSILE TESTING $R_{p0.2} \ge 550 \text{ MPa}; R_m \ge 750 \text{ MPa}; A \ge 25 \%.$ 9. MICROGRAPHIC General **EXAMINATION** The test specimen shall be taken in transverse direction to the main working direction in same area as of tensile test specimen. The specimen shall be polished and etched in 20 % NaOH electrolyte or another etchant qualified by the M-650 qualification program. Intermetallic phases and precipitates The microstructure shall be examined and shall be free from detrimental intermetallic phases and precipitations at 400 to 500 X magnification. Any presence of intermetallic phases and/or precipitates shall be reported. In case intermetallic phases and/or precipitations are detected the acceptance of product shall be based upon the corrosion and Charpy V-notch test results. Ferrite content The ferrite content shall be determined by point counting according to ASTM E 562 or by image analysis according to ASTM E 1245. The relative accuracy shall be less than 20 %. The ferrite content shall be within 35 - 55 %. Charpy V-notch testing is required according to ASTM A 370 at - 46 °C. The minimum absorbed 8. IMPACT TESTING energy shall be 45 J average / 35 J single.

MATERIAL	DATA SHEI	ET	MDS D57	Rev. 5	
TYPE OF MATERIAL: Ferritic/Austenitic Stainless Steel, Type 25Cr duplex					
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS SUPPL.		
Bars	ASTM A 479	UNS S32550 UNS S32750 UNS S32760	-	-	
				Page 2 of 2	
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 taken from the same location as the mechanical test specimens. For bars with diameter less than 100 mm the test specimen shall expose a cross section from surface to mid-thickness. For greater wall thickness the specimen shall expose a cross section from surface to a depth of 50 mm. Cut edges shall be prepared according to ASTM G 48. The complete specimen shall be pickled before being weighed and tested. Pickling may be performed for 5 minutes at 60 °C in a solution of 20 % HNO ₃ + 5 % HF.				
	The acceptance criter	ia 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.				
12. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual components.				
	Test location shall be:				
	 For bars having section thickness, T ≤ 50 mm, the test specimens shall be taken in longitudinal direction at mid thickness and its mid length shall be at least 50 mm from second surface. For bars having section thickness, T > 50 mm, the test specimen shall be taken in longitudinal direction at least ¼ T from the nearest surface and at least T or 100 mm, whichever is less, from any second surface. 				
13. SURFACE FINISH	Finished products including machined surfaces shall be white pickled.				
14. REPAIR OF DEFECTS	Weld repair is not acceptable.				
15. MARKING	The bar and/or finished product shall be marked to ensure full traceability to melt and heat treatment lot.				
16. CERTIFICATION	 and the system shall have undergone a specific assessment for the relevant materials. The material certificate shall be in accordance with EN 10204 Type 3.1, and shall include following information: NORSOK M-650 Manufacturing Summary identification or QTR No. used; Steel manufacturer of starting material; 				
		ctice and refining method;			
 Heat treatment condition (Solution annealing temperature, holding time and c shall be stated.) 				and quench medium	

Rev. 4 MATERIAL DATA SHEET **MDS D58** TYPE OF MATERIAL: Ferritic/Austenitic Stainless Steel, Type 25Cr duplex GRADE ACCEPT. CLASS SUPPL. REQ. STANDARD PRODUCT Tubes **ASTM A 789 UNS S32550 UNS S32750 UNS S32760 UNS S39274** Page 1 of 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. This MDS is based on the mechanical properties of UNS S32760. Manufacturers and the manufacturing process used for manufacturing of product to this MDS 2. QUALIFICATION shall be gualified in accordance with NORSOK Standard M-650. 3. MANUFACTURING The manufacturing of products according to this MDS shall be carried out according to the M-650 qualified manufacturing procedure. PROCESS 4. STEEL MAKING The steel melt shall be refined with AOD or equivalent. 5. HEAT TREATMENT The tubes shall be solution annealed followed by accelerated cooling. Tubes shall be placed in such a way as to ensure free circulation of gas and/or water around each tube during the heat treatment process including accelerated cooling. 6. CHEMICAL C ≤ 0.03 % COMPOSITION PREN = (% Cr + 3,3 % Mo + 16 % N) ≥ 40,0. 7. TENSILE TESTING $R_{p0.2} \ge 550 \text{ MPa}; R_m \ge 750 \text{ MPa}; A \ge 25 \%.$ 8. MICROGRAPHIC General **EXAMINATION** The test specimen shall be taken in transverse direction to the main working direction across the full wall thickness. The specimen shall be polished and etched in 20 % NaOH electrolyte or another etchant qualified by the M-650 qualification program. Intermetallic phases and nitride precipitates The microstructure shall be examined and shall be free from detrimental intermetallic phases and precipitations at 400 to 500 X magnification. Any presence of intermetallic phases and/or precipitates shall be reported. In case intermetallic phases and/or precipitations are detected the acceptance of product shall be based upon the corrosion and Charpy V-notch test results. Ferrite content The ferrite content shall be determined by point counting according to ASTM E 562 or by image analysis according to ASTM E 1245. The relative accuracy shall be less than 20 %. The ferrite content shall be within 35 - 55 %. 9. 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 and 35 J single. Reduction factors for sub-size specimens shall be: 7,5 mm - 5/6 and 5 mm - 2/3. 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 test shall expose the external and internal surfaces and a cross section surface in full wall thickness. Cut edges shall be prepared according to ASTM G 48. The complete specimen shall be pickled before being weighed and tested. Pickling may be performed for 5 minutes at 60 °C in a solution of 20 % HNO₃ + 5 % HF. The acceptance criteria are: No pitting at 20 X magnification The weight loss shall be less than 4,0 g/m² 11. EXTENT OF Microstructure, hardness, tensile, impact and corrosion testing shall be carried out for each lot. TESTING

MATERIAL DATA SHEET **MDS D58** Rev. 4 TYPE OF MATERIAL: Ferritic/Austenitic Stainless Steel, Type 25Cr duplex GRADE ACCEPT. CLASS SUPPL. REQ. PRODUCT STANDARD Tubes **ASTM A 789 UNS S32550** UNS S32750 UNS S32760 UNS S39274 Page 2 of 2 Samples for production testing shall realistically reflect the properties in the actual components. 12. TEST SAMPLING 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 The material manufacturer shall have a quality system certified in accordance with ISO 9001 and the system shall have undergone a specific assessment for the relevant materials. The material certificate shall be in accordance with EN 10204 Type 3.1, and shall include the following information: NORSOK M-650 Manufacturing Summary identification or QTR No. used; _ Steel manufacturer of starting material; Steel melting practice and refining method; Heat treatment condition (Solution annealing temperature, holding time and guench medium shall be stated.)

MATERIAL DATA SHEET MDS D59 Rev. 1

PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.	
Studs, bolts, nuts	ASTM A 1082	UNS S32550 UNS S32750 UNS S32760	-	-	
				Page 1 of 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. The referred standards do not include the specified material grade therefore all testing requirements are specified by this MDS. The product specific requirements of the referred				
	standards shall appl				
2. QUALIFICATION		he manufacturing proce dance with NORSOK S	ess used for manufacturing of p tandard M-650.	roduct to this MDS shal	
3. STEEL MAKING	The steel melt shall	be refined with AOD or	equivalent.		
4. CHEMICAL COMPOSITION	PREN = (% Cr + 3,3	3 % Mo + 16 % N) ≥ 40,	0.		
5. MANUFACTURING PROCESS	The manufacturing of products according to this MDS shall be carried out according to the M-650 qualified manufacturing procedure. The studs and bolts shall be made from solution annealed bars manufactured to ASTM A 276/479 and strain hardened to obtain the specified minimum tensile test properties. The strain hardening shall be performed in accordance with a calibrated straining procedure to ensure the correct level of hardening. Headed bolts shall be manufactured by machining from cold strain bar. No forging or heat treatment of the cold strained bar is permitted.				
6. HEAT TREATMENT	Nuts shall be from solution annealed and water quenched bar or forgings. The bars shall be solution annealed followed by water quenching and cold strain hardened.				
7. EXTENT OF	A test lot shall be limited to each melt of material, same heat treatment batch, size of pre-material				
TESTING	and same type of product and size. Charpy V-notch impact, microstructure, corrosion and tensile testing shall be carried out for each lot.				
8. TENSILE TESTING OF STUDS AND BOLTS	Tensile testing of studs shall be carried out from strain hardened bar or from finished product. Tensile testing of headed bolts shall be from finished product, reference is made to ASTM F 606 The minimum tensile test properties shall comply with the following requirements: $R_{p0.2} \ge 725$ MPa; $R_m \ge 860$ MPa; $A \ge 16$ %; $RA \ge 30$ %.				
9. MICROGRAPHIC EXAMINATION	General: The examination shalocation as tensile to electrolyte or anothe Intermetallic phases The microstructure s precipitations at 400 precipitates shall be In case intermetallic	all be taken in transvers est specimen. The spec er etchant qualified by the and nitride precipitates shall be examined and so to 500 X magnification reported.	e direction to the main working imen shall be polished and etch ne M-650 qualification program shall be free from detrimental in . Any presence of intermetallic ations are detected the accepta	ned in 20 % NaOH	
	The ferrite content shall be determined by point counting according to ASTM E 562 or by image analysis according to ASTM E 1245. The relative accuracy shall be less than 20 % measured in each specified region. The ferrite content shall be reported for both near surface and mid-thickness regions and shall be within 35 - 55 %.				

MDS D59

Rev. 1

TYPE OF MATERIAL: Ferritic / Austenitic Stainless Steel, Type 25Cr duplex					
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.	
Studs, bolts, nuts	ASTM A 1082	UNS S32550 UNS S32750 UNS S32760	-	-	
				Page 2 of 2	
10. IMPACT TESTING	Charpy V-notch testing according to ASTM A 370 at - 46 °C is required for bolt size M12 (½") and above. For nuts the testing shall be made from the bar prematerial. The minimum absorbed energy shall be 45 J average / 35 J single.				
11. CORROSION TEST	Corrosion test shall be carried out on bar in finished strained condition or finished product according to ASTM G 48 Method A. Test temperature shall be 50 °C and the exposure time 24 hours. The test specimen shall expose a cross section from surface to mid-thickness. Cut edges shall be prepared according to ASTM G 48. The complete specimen shall be pickled before weighing and testing. Pickling may be performed for 5 minutes at 60 °C in a solution of 20 % HNO ₃ + 5 % HF. The acceptance criteria are: - No pitting 20 X magnification. - The weight loss shall be less than 4,0 g/m ² .				
12. PROOF LOAD TESTING OF NUTS	At least one nut per test lot shall be proof load tested. The load shall comply with A 194 Grade 7. For nuts with size M36 ($1\frac{1}{2}$ inch) or above proof load testing may be replaced with cross section hardness testing to ASTM A 370. The hardness shall meet the requirement specified in section 12 above.				
13. DIMENSIONAL TOLERANCE	Product dimensions sl Category 2.	hall be checked or contro	lled to an extent as specified	d by ASME B18.18	
14. SURFACE FINISH	All products shall be 100 % visually examined in all areas of threads, shanks, and heads. Discontinuities shall comply with requirements specified in ASTM F 788 for bolts/studs and ASTM F 812 for nuts.				
15. REPAIR OF DEFECTS	Weld repair is not acc	eptable.			
16. MARKING	The component shall in addition to material grade and manufactures logo be hard marked with a traceability code to ensure full traceability to melt and heat treatment lot.				
17. CERTIFICATION	 The material manufacturer shall have a quality system certified in accordance with ISO 9001 and the system shall have undergone a specific assessment for the relevant materials. The material certificate shall be accordance with EN 10204 Type 3.1, and shall include the following information: NORSOK M-650 Manufacturing Summary identification or QTR No. used Steel producer of starting material; Steel melting practice and refining method. Heat treatment condition (Solution annealing temperature and holding time shall be stated.) 				

MATERIAL DATA SHEET **MDS D60** Rev. 1 TYPE OF MATERIAL: Ferritic / Austenitic Stainless Steel, Type 25Cr duplex STANDARD GRADE ACCEPT. CLASS SUPPL. REQ. PRODUCT **UNS S32550** Studs, bolts, nuts ASTM A 1082 S5 **UNS S32750 UNS S32750** Page 1 of 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. The referred standards do not include the specified material grade therefore all testing requirements are specified by this MDS. The product specific requirements of the referred standards shall apply. Manufacturers and the manufacturing process used for manufacturing of product to this MDS shall 2. QUALIFICATION be qualified in accordance with NORSOK Standard M-650. 3. STEEL MAKING The steel melt shall be refined with AOD or equivalent. 4. CHEMICAL PREN = (% Cr + 3.3 % Mo + 16 % N) \ge 40.0 COMPOSITION 5. MANUFACTURING The manufacturing of products according to this MDS shall be carried out according to the M-650 PROCESS qualified manufacturing procedure. The studs, bolts and nuts shall be made from solution annealed heat treated bars manufactured to ASTM A 276/479. Threads on studs and bolts shall be made by cold rolling. For machined threads the thread dimensions shall comply with UNR profile. Threads in nuts shall be machined. 6. PROOF LOAD At least one nut per test lot shall be proof load tested. The load shall comply with A 194 Grade TESTING OF NUTS 7M. For nuts with size M36 (1¹/₂ inch) or above proof load testing may be replaced with cross section hardness testing to ASTM A 370 (SR S6). The hardness shall meet the requirement specified in section 8 below. The test specimen shall be taken from same location as the tensile test specimen. The specimen 7. MICROGRAPHIC **EXAMINATION** shall be polished and etched in 20% NaOH electrolyte or another qualified etchant. Intermetallic phases and nitride precipitates: The microstructure shall be examined and shall be found free from detrimental intermetallic phases and nitride precipitations at 400 -500 X magnification. Any presence of intermetallic phases and/or precipitates shall be reported. In case intermetallic phases and/or precipitations are detected the acceptance of product shall be based upon the corrosion and Charpy V-notch test results. Ferrite content: The ferrite content shall be determined in the near surfaces and mid-thickness region of the component by point counting according to ASTM E 562 or by image analysis according to ASTM E 1245. The examination shall be made in transverse direction to the main working direction. The magnification shall be minimum 400 X. The relative accuracy shall be minimum 20 % measured in each specific region. The ferrite content shall be reported for both near surface and mid-thickness regions and shall be within 40-60 %. 8. IMPACT TESTING Charpy V-notch testing according to ASTM A 370 at - 50 °C is required for bolt size M12 (1/2") and above. For nuts the testing shall be made from the bar prematerial. The minimum absorbed energy shall be 45 J average / 35 J single.

MATERIAL DATA SHEET **MDS D60** Rev. 1 TYPE OF MATERIAL: Ferritic / Austenitic Stainless Steel, Type 25Cr duplex STANDARD GRADE ACCEPT. CLASS SUPPL. REQ. PRODUCT ASTM A 1082 **UNS S32550** Studs, bolts, nuts S5 **UNS S32750 UNS S32750** Page 2 of 2 9. CORROSION TEST Corrosion test shall be carried out on bar according to ASTM G 48 Method A. Test temperature shall be 50 °C and the exposure time 24 hours. The test specimen shall expose a cross section from surface to mid-thickness. Cut edges shall be prepared according to ASTM G 48. The complete specimen shall be pickled before weighing and testing. Pickling may be performed for 5 minutes at 60 °C in a solution of 20 % HNO₃ + 5 % HF. The acceptance criteria are: - No pitting 20 X magnification. The weight loss shall be less than 4.0 g/m^2 . A test lot shall be limited to each cast of material, same heat treatment batch, size of pre-material 10. EXTENT OF and same type of product and size. TESTING Charpy V-notch impact, microstructure, corrosion and tensile testing shall be carried out for each lot. 11. DIMENSIONAL Product dimensions shall be checked or controlled to an extent as specified by ASME B18.18 TOLERANCE Category 2. 12. SURFACE FINISH All products shall be 100 % visually examined in all areas of threads, shanks, and heads. Discontinuities shall comply with requirements specified in ASTM F 788 for bolts/studs and ASTM F 812 for nuts. 13. REPAIR OF Weld repair is not acceptable. DEFECTS The component shall in addition to material grade and manufactures logo be hard marked with a 14. MARKING traceability code to ensure full traceability to melt and heat treatment lot. 15. CERTIFICATION The material manufacturer shall have a quality system certified in accordance with ISO 9001 and the system shall have undergone a specific assessment for the relevant materials. The material certificate shall be accordance with EN 10204 Type 3.1, and shall include the following information: - NORSOK M-650 Manufacturing Summary identification or QTR No. used Steel producer; - Steel melting practice and refining method. Heat treatment condition (Solution annealing temperature and holding time shall be stated.)

MDS K01 MATERIAL DATA SHEET Rev. 3 TYPE OF MATERIAL: Copper/Nickel 90/10 PRODUCT GRADE ACCEPT. CLASS SUPPL. REQ. STANDARD Sml pipes & tubes **ASTM B 466 UNS C70600** _ _ Welded pipes **ASTM B 467 UNS C70600** _ Rod & bar **UNS C70600 ASTM B 151** _ Plates & sheets **UNS C70600 ASTM B 171** Fittings **UNS C70600** Flanges **UNS C76000** _ Page 1 of 1 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. The following EEMUA standards for: "90/10 Copper/Nickel Piping for Offshore Applications" 2. DESIGN AND DIMENSIONAL shall be used: STANDARDS 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. Cold forming or hot forming may be used according to written procedures 4. MANUFACTURING Forming: PROCESS established in cooperation with the material manufacturers. Welding: An electric fusion welding process shall be used. 5. HEAT TREATMENT/ Hot formed components: Parts hot formed in the temperature range of 760 - 800 °C do not DELIVERY need annealing after forming. CONDITION Cold formed components: Annealed. Welded components: Annealed, but acceptable as welded from annealed materials. 6. CHEMICAL For subsequent welding the chemical composition shall be modified as stated: COMPOSITION $Zn \le 0.50$ %, $Pb \le 0.02$ % and $C \le 0.05$ %. Tensile test specimens shall be taken from each lot. A lot is defined as all products of the same 7. EXTENT OF TESTING 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 over length on the components may be used. Sketches shall be established showing type, size and location of test samples and extraction of test specimens. Welding procedures shall be established and qualified in accordance with ASME IX. 9. WELDING 10. NON Welded Pipes to B 467: DESTRUCTIVE Sch 10S: Welded pipes shall be spot radiographed to the extent of not less than 12 in TESTING (300 mm) per 50 ft (15 m) of weld. Other sizes: All welds shall be 100 % radiographed. The radiographic testing shall be in accordance with the requirements of the ASME VIII, Div. 1, Paragraph UW-51 and UW-52 for 100 % and spot check tested respectively. 11. HYDROSTATIC Sml. pipes & tubes to B 466 and Welded pipes to B 467: TESTS Each length of finished pipe shall be subjected to the hydrostatic test in accordance with ASTM A 530. 12. CERTIFICATION The material manufacturer shall have a quality system certified in accordance with ISO 9001 and the system shall have undergone a specific assessment for the relevant materials. The material certificate shall be in accordance with EN 10204 Type 3.1.

MATERIAL	DATA S	HEET		MDS K02	Rev. 3	
TYPE OF MATER	RIAL: ALUMIN	IUM - BF	RONZE SAND	CASTINGS		
PRODUCT	STANDARD	GR	ADE	ACCEPT. CLASS	SUPPL. REQ.	
Castings	ASTM B 148	UNS	S C95800	-	-	
		<u>.</u>			Page 1 of 1	
1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.					
2. CHEMICAL COMPOSITION	Pb ≤ 0.02 %.					
3. HEAT TREATMENT	Heat treatment shall be carried out at the discretion of the manufacturer, e.g. approximate 700 °C for 6 hours.					
4. EXTENT OF TESTING	One tensile test s	hall be carri	ed out for each lot	as defined by the in B 148		
5. TEST SAMPLING	Samples for mec	nanical testir	ng shall realisticall	y reflect the properties in th	e actual components.	
DESTRUCTIVE TESTING	Liquid Penet ASME VIII D machined su Radiographic tes - Method of ra Appendix 7. - Extent of rad Extent of rad Extent of R Pressure C Extent of RT - Valve casting valves and o at abrupt cha When randou feeder and ri outside acce two fails all it	e surfaces (i rant (PT). Su iv. 1 Append rfaces shall <i>ting (RT):</i> diographic ex iographic ex <i>tographic ex</i> <i>tographic ex</i> <i>t</i>	urface examination lix 7. The testing s be pickled prior to and acceptance crit amination (RT) for pressure class and ≤ 150 $\geq 10^{\circ}$ Not applicable xamined in the area areas as defined b tions and at the jun on (10%) is specifi n any purchase or ria is detected, two ented shall be tester	eria shall be in accordance r valve castings shall be accordance d nominal size: 300 $\geq 10^{\circ}$ Not applicable eas as defined by ASME B ² y designer. In addition cast inctions of risers, gates or fe ed, minimum one casting c der with the foundry shall be pomore castings shall be test ed.	n accordance with al machining. Non- with ASME VIII Div. 1 cording to table.	
	 Other type of castings: Each casting shall be examined unless agreed otherwise. Testing shall be at abrupt changes in sections and at the junctions of risers, gates or feeders to the castings and other critical areas as defined by designer. Sketches of the areas to be tested shall be established and agreed. 					
7. WELD REPAIR	All major repairs shall be documented with a sketch showing location and size of excavations.					
	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. 					
	 A macro test shall be carried out. Repairs by peening and impregnation are prohibited. 					
	 Repairs by peening and impregnation are prohibited. Change of filler metal brand names requires requalification. 					
8. CERTIFICATION	 Change of filler metal brand names requires requires					
	The material certificate shall be issued in accordance with EN 10204 Type 3.1, and shall include the following information:					
	-		(annealing temper			

MATERIAL DATA SHEET			MDS N01	Rev. 5		
TYPE OF MATERIAL: Nickel alloy Type 625						
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.		
Wrought fittings	ASTM B 366	UNS N06625 Grade 1	-	S3		
Pipes	ASTM B 705	UNS N06625 Grade 1	Class 2	-		
Forgings	ASTM B 564	UNS N06625	-	S5.3		
Plates	ASTM B 443	UNS N06625 Grade 1	-	-		
Bars	ASTM B 446	UNS N06625 Grade 1	-	-		
Pipes and tubes	ASTM B 444	UNS N06625 Grade 1	-	-		
HIP products	ASTM B 834	UNS N06625 Grade 1	-	-		
				Page 1 of 1		
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	Annealed.					
3. MACHINING OF VALVES FROM FORGING	 Valves with nominal size NPS 4 and smaller may be machined from solid forgings in compliance with the terminology of ASTM A 788 on the following conditions: Purchasers' acceptance shall be obtained in each case. Supplementary requirement S5.3 shall apply to all finished products, ref. Section 5 below. 					
4. MANUFACTURING	Welded pipes to B 705: Pipes welded with the addition of filler metal is acceptable. The WPS shall be qualified in accordance with ASME IX or ISO 15614-1. The qualification shall be carried out on the same material grade (UNS number) as used in production.					
5. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual component.					
6. NON DESTRUCTIVE TESTING	<i>Fittings to B 366:</i> Supplementary requirement S3, liquid penetrant testing, shall apply to the weld end area at 10 % of seamless (from the same lot as defined for mechanical testing) and 100 % of welded fittings above NPS 2. For welded fittings the testing shall cover the weld only. <i>Welded pipes to B705:</i> All welds shall be 100 % radiographically examined to give a joint factor of 1,0. <i>Forgings to B 564:</i> 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).					
7. SURFACE FINISH	White pickled. Shall be carried out after any blasting and shall include finished machined surfaces.					
8. REPAIR OF DEFECTS	Weld repair of base material is not acceptable.					
9. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.					
10. CERTIFICATION	The material manufacturer shall have a quality system certified in accordance with ISO 9001 and the system shall have undergone a specific assessment for the relevant materials. The material certificate shall be issued in accordance with EN 10204 Type 3.1, and include the					
	following information:					
	- Heat treatment condition. (Solution annealing and annealing temperature shall be stated.)					

MDS N02 Rev. 5 MATERIAL DATA SHEET TYPE OF MATERIAL: Cast Nickel alloy GRADE ACCEPT. CLASS PRODUCT STANDARD SUPPL. REQ. ASTM A 494 Grade CW6MC Castings (UNS N26625) Grade CX2MW (UNS N26022) Page 1 of 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. Manufacturers and the manufacturing process used for manufacturing of products to this MDS 2. QUALIFICATION shall comply with the requirement of NORSOK Standard M-650. 3. MANUFACTURE The manufacturing of products according to this MDS shall be carried out according to the M-650 qualified manufacturing procedure. Components shall be placed in such a way as to ensure free circulation of heating and cooling media around each component during the heat treatment process including guenching 4. METAL MAKING The melt shall be refined with AOD or equivalent process. Remelting of AOD or equivalent processed metal in an electric furnace is acceptable. Use of internal scrap is not acceptable. 5. HARDNESS The hardness shall be maximum 35 HRC. 6. CORROSION Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C TESTING 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. The complete specimen shall be pickled before being weighed and tested. Pickling may be performed for 5 minutes at 60 °C in a solution of 20 % HNO₃ + 5 % HF. The acceptance criteria are: - No pitting at 20 X magnification. - The weight loss shall be less than 4,0 g/m². 7. EXTENT OF Tensile test and corrosion test shall be made for each melt and heat treatment load. A test lot TESTING shall not exceed 5000 kg. 8. TEST SAMPLING Samples for mechanical testing shall realistically reflect the properties in the actual components. For castings with weight 250 kg or more the 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. Thickness of the test block shall be equal to the thickest part of the casting represented. For flanged components the largest flange thickness is the ruling section. Dimensions of test blocks and location of test specimens within the test blocks are shown in figures 1 and 2 for integral and gated test blocks respectively. The test specimens shall be taken within the cross hatched area and in a distance of T/4 from the ends. During any PWHT the test block shall be tack welded onto the casting. T or min. 50mm T/4 T/4 T/4 T/4 >=1/2 T/2 X >=T+XT/2 Fig.1 - Integral test block Fig. 2 - Gated test block

MATERIAL	D	ATA S	HEE	Γ		Ν	MDS	N02	Re	ev. 5	
TYPE OF MATER	IAL	: Cast Nic	ckel allo	У							
PRODUCT	ST.	ANDARD	G	RADE		AC	CCEPT.	CLASS	SUPF	PL. RE	Q.
Castings	AST	TM A 494	(L G	rade CW6N INS N2662 rade CX2M INS N2602	5) W						
									Pa	age 2 of 3	}
9. NON DESTRUCTIVE TESTING	Lic -	Page 2 of 3 NDT operators shall be qualified in accordance with ISO 9712 or equivalent. Liquid penetrant testing: - All accessible surfaces (including internal surfaces) of all castings shall be examined with Liquid Penetrant (PT). Surface examination of steel castings shall be in accordance with ASME VIII Div. 1 Appendix 7. The testing shall be carried out after final machining. Non-machined surfaces shall be pickled prior to the testing. Radiographic testing (RT): - Method of radiography and acceptance criteria shall be in accordance with ASME VIII Div. Appendix 7. - Extent of radiographic examination (RT) for valve castings shall be according to table. Independent of the extent specified in table below one pilot cast of each pattern shall be 100 % volumetrically RT. Extent of RT based on pressure class and valve size: Pressure Class: ≤ 150 300 600 900 1500 ≥ 2500 Extent of RT based on pressure class and valve size: Pressure Class: ≤ 150 300 600 900 1500 ≥ 2500 Extent of RT based on pressure class and valve size: Pressure Class: ≤ 150 300 600 900 1500 ≥ 2500 Extent of RT based on pressure class and valve size: $ressure class$ $\leq 10^{n}$ $\geq 10^{n}$ $\geq 2^{n}$ $\geq 2^{n}$ $\geq 2^{n}$							th Div. 1 e class to ach ed. ng		
10. SURFACE FINISH			Shall be ca	arried out afte	er any bla	sting	g and shal	l include fin	ished ma	chined	
11. REPAIR OF DEFECTS	All Re Th	 surfaces. All major repairs shall be documented according to ASTM A 703 SR S20. Repair welding shall be carried out in accordance with ASTM A 488. The repair welding procedure shall be qualified in accordance with ASTM A 488 or ISO 11970 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. 						070			
12. MARKING	Th	e componen	t shall be r	marked to en	sure full t	race	ability to r	nelt and hea	at treatme	ent lot.	

MATERIAL DATA SHEET			MDS N02	Rev. 5			
TYPE OF MATERIAL: Cast Nickel alloy							
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.			
Castings	ASTM A 494	Grade CW6MC (UNS N26625) Grade CX2MW (UNS N26022)					
				Page 3 of 3			
13. CERTIFICATION	 The material manufacturer shall have a quality system certified in accordance with ISO 9001 and the system shall have undergone a specific assessment for the relevant materials. The material certificate shall be issued in accordance with EN 10204 Type 3.1, and shall include the following information: NORSOK M-650 Manufacturing Summary identification or QTR No. used; Melting and refining process to be stated; Heat treatment condition (Solution annealing temperature and holding times shall be stated.) 						

MDS N03 Rev. 2

TYPE OF MATERIAL: Ni 625							
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.			
Studs, bolts, screws	ASTM F 468	Ni 625 (UNS N06625)					
Nuts	ASTM F 467	Ni 625					
				Page 1 of 1			
1. SCOPE			ferred standard and addition nding requirements in the re				
2. HEAT TREATMENT	The bolts, cap screws	and nuts shall be delivered	d in the annealed condition	at 870 °C minimum.			
	Heat treatment shall b	be carried out after the final	hot forming operation.				
3. TENSILE TESTING	R _{p0.2} ≥ 415 MPa; R _m ≥	: 825 MPa; A ≥ 30 %; HRC	≤ 35.				
	For sizes above 37,5	mm (1½ inch) in diameter t	he strength properties shal	l be agreed.			
4. EXTENT OF	One set of tensile test	and hardness test shall be	e carried out for each lot de	fined as:			
TESTING	 Bars: Each heat of furnace. 	of material, size and heat tr	eatment load/each 8 hours	for continuous			
		ts heat treated after formin s for continuous furnace	g: Heat of material, size an	d heat treatment			
5. MARKING	Each bolt and nut sha treatment lot.	ll be marked on the end/he	ad to ensure full traceability	y to melt and heat			
6. CERTIFICATION			ystem certified in accordand ssment for the relevant ma				
	The material certificate following information:	es shall be in accordance v	vith EN 10204 Type 3.1, an	d shall include the			
	- Heat treatment co	onditions (Annealing tempe	rature and time shall be sta	ited).			
	- Original material	certificate of the bar materia	al shall be included in the d	ocumentation.			

MATERIAL	DATA SHE	MDS N04	Rev. 1				
TYPE OF MATERIAL: Grade 660							
PRODUCT	STANDARD	STANDARD GRADE ACCEPT. CLASS SUPPL. R					
Studs, bolts, screws and Nuts	ASTM A [°] 453	Grade 660 (UNS N66286)	Class D				
				Page 1 of 1			
1. SCOPE			referred standard and addition onding requirements in the received and the				
2. MANUFACTURE	Heat treatment shall be carried out after the final hot forming operation. Threading of studs, bolts and screws shall be done by machining or rolling. Thread rolling shall be done after precipitation heat treatment. In case of machining the thread dimensions shall comply with UNR profile.						
3. TENSILE TESTING	R _{p0.2} ≥ 725 MPa; R _m ≥	895 MPa; A ≥ 15 %.					
4. HARDNESS	Hardness shall be in the	he range 24 – 35 HRC or	248 – 321 HB.				
5. IMPACT TESTING		g shall be carried out at - l single, the lateral expan	101 °C. The minimum absorl sion shall be 0,38 mm.	bed energy shall be			
6. STRESS RUPTURE TEST	Not applicable.						
7. MARKING	Each bolt and nut shal treatment lot.	II be marked on the end/h	nead to ensure full traceabilit	y to cast and heat			
8. CERTIFICATION		The material manufacturer shall have a quality system certified in accordance with ISO 9001 and the system shall have undergone a specific assessment for the relevant materials.					
	The material certificate following information:	he material certificates shall be in accordance with EN 10204 Type 3.1, and shall include the					
			erature and time shall be sta	,			
	- Original material of	certificate of the bar mate	rial shall be included in the d	locumentation.			

MDS N05 MATERIAL DATA SHEET Rev. 1 TYPE OF MATERIAL: Alloy 718 GRADE PRODUCT STANDARD ACCEPT. CLASS SUPPL. REQ. UNS N07718 **ASTM A 1014** S2. S4. S5 Studs, bolts, screws and Nuts Page 1 of 1 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 standards. 2. MANUFACTURE Heat treatment shall be carried out after the final hot forming operation. Headed bolts shall be forged (S4). Threading of studs, bolts and screws shall be done by machining or rolling. Thread rolling shall be done after precipitation heat treatment (S5). In case of machining the thread dimensions shall comply with UNR profile. 3. HEAT TREATMENT The products shall be solution annealed and age hardened to the following temperatures: Solution annealing: 1021- 1052 °C Age hardening: 774 - 802 °C 4. TENSILE TESTING R_{p0.2} = 725 - 1000 MPa; R_m = 895 - 1250 MPa; A ≥ 30 %. 5. HARDNESS Hardness shall be in the range 22 - 40 HRC or 248 - 363 HB. 6. IMPACT TESTING Charpy V-notch testing shall be carried out at - 101 °C. The minimum absorbed energy shall be 27 J average and 20 J single, the lateral expansion shall be 0,38 mm. Microstructural examination shall be carried out in accordance with the requirements specified in 7. MICROSTRUCTURAL API 6A 718. **EXAMINATION** 8. STRESS RUPTURE Not applicable. TEST 9. PROOF LOAD Proof load testing shall be carried out in accordance with ASTM A 194. The loading shall be in accordance with Table 4 or 11 Grade 7. TESTING 10. SURFACE FINISH Parts shall be delivered cleaned with nitric acid (S2). 11. MARKING Each bolt and nut shall be marked on the end/head to ensure full traceability to cast and heat treatment lot. 12. CERTIFICATION The material manufacturer shall have a quality system certified in accordance with ISO 9001 and the system shall have undergone a specific assessment for the relevant materials. The material certificates shall be in accordance with EN 10204 Type 3.1, and shall include the following information: Heat treatment conditions (Annealing temperature and time shall be stated). Original material certificate of the bar material shall be included in the documentation.

MATERIAL	DATA SHEET	MDS P11	Rev. 3			
TYPE OF MATERI	AL: Hydrogenated N	litrile (HNBR)				
PRODUCT	O-ring	TEMPERATURE RANGE	-20 °C to 150 °C ^{1), 2), 3)}			
			Page 1 of 1			
1. SCOPE	This MDS specifies the techr	ical requirements for the HNBR O-ring	material.			
2. PURCHASE INFORMATION	The purchase order shall cor and/or referenced drawing.	tain the following information: Product	type, size, grade designatior			
3. CHEMICAL COMPOSITION	36 – 40 % acrylonitrile conter	nt (ACN)				
4. QUALIFICATION TEST REQUIREMENTS	minimum requirements. The production route, manufactur	ressure reduction resistant (ED resistar qualification shall be repeated if there a ing procedures, specified composition of ned from qualification testing (each man	re changes in the product			
	Construction 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					
		eakage test at room temperature and se ther, no cracks shall be longer than 80 e leakage test.				
	Mechanical properties:	-				
	- Hardness A	STM D 2240 90 ± 5 Shore A				
	- Tensile strength A	STM D 412/1414 min. 20 MPa				
	-	STM D 412/1414 min. 100 %				
	-	STM D 395 max. 25 % (after 2-	4 hours at 150 °C)			
		e strength and elongation at break at 15				
	Physical properties:					
	- Specific gravity ASTM D	$1,2 - 1,3 \text{ g/cm}^3$				
5. DIMENSIONS	According to ISO 3601-1 and					
6. PRODUCTION TEST REQUIREMENTS		be performed according to the requirem irement for hardness as stated above a				
7. MARKING & PACKAGING		aled airtight bags. Markings on the bag shall ensure traceability through the pro anufacturing details.				
8. CERTIFICATION	The material manufacturer sh and the system shall have ur	nall have a quality system certified in ac adergone a specific assessment for the	cordance with ISO 9001 relevant materials.			
	Inspection certificate shall be	to the requirements in ISO 10423, qua	lity level PSL 3.			
NOTES	1) Short time exposure down t	o - 46 °C is acceptable.				
	(mechanical, temperature, s		Ū			
	3) Mechanical properties are r	educed by increasing temperature and may	be degraded by service.			

MATERIAL			MDS P12	Rev. 3
TYPE OF MATER	IAL: Fluorocarbon terp	oolymer (F	KM)	
PRODUCT	O-ring	TEMPER	ATURE RANGE	- 10 °C to 150 °C ^{1) 2)}
				Page 1 of 1
1. SCOPE	This MDS specifies the technica	I requirements f	for the FKM O-ring mate	erial.
2. PURCHASE INFORMATION	The purchase order shall contai and/or referenced drawing.	n the following in	nformation: Product typ	e, size, grade designation
3. CHEMICAL COMPOSITION	Vinylidene fluoride (VF2), hexafi necessary fillers, stabilisers, cro		(HFP), and tetrafluoroet	thylene (TFE) with
4. QUALIFICATION TEST REQUIREMENTS	The material shall be rapid press minimum requirements. The quaroute, manufacturing procedures exceeds the limits defined from qualified). <i>ED-test:</i> O-ring cross section diameter 5, medium 3 % CO ₂ in Methane, te followed by 5 cycles of: - 200 bar (24h) - Depressurisation: 20-40 bar - 1 hour rest time - Re-pressurisation - Leakage test No leakage shall occur in a leak 5 decompression cycles. Further based on dissection, after the lea	alification shall b s, specified com qualification test 33 mm, 20 % co est temperature r/min. age test at room r, no cracks sha	e repeated if there are position or properties o ting (each manufacture ompression, text fixture 100 °C, 72 hours initial	changes in the production f the product which r and seal type shall be , 70 – 85 % groove fill, test soak at full pressure,
	Mechanical properties:			
	- Hardness AST	M D 2240	90 ± 5 Shore A	
	- Tensile strength AST	M D 412/1414	min. 11 MPa	
	- Elongation at break AST	M D 412/1414	min. 90 %	
	- Compression set AST	M D 395	max. 40 % (after 24 h	ours at 150 °C)
	- Documentation of tensile stre	ngth and elonga	ation at break at 150 °C.	
	Physical properties:			
	- Specific gravity AST	M D 792	1,6 – 1,9 g/cm ³	
5. DIMENSIONS	According to ISO 3601-1 and -3			
6. PRODUCTION TEST REQUIREMENTS	The production testing shall be level PSL 3, and satisfy requirer as stated in ISO 10423.			
7. MARKING & PACKAGING	Seals shall be supplied in seale number, and such markings sha manufacturing details.			
8. CERTIFICATION	The material manufacturer shall the system shall have undergon Inspection certificate shall be to	e a specific ass	essment for the relevar	t materials.
NOTES				- · - · · · • •
NOTES	 Short time exposure down to - Materials properties in actual a (mechanical, temperature, serv may be degraded by service. 	pplication to be do	ocumented, at combined d	

MATERIAL I		Г М	IDS P13	3 Rev. 3				
TYPE OF MATERI	TYPE OF MATERIAL: Low temperature Fluorocarbon Terpolymer (FKM GLT)							
PRODUCT	O-ring	TEMPERATUR	E RANGE	-30 °C to + 150 °C ^{1), 2), 3), 4)}				
				Page 1 of 2				
1. SCOPE	This MDS specifies the te	chnical requirements f	or the FKM GL	T O-ring material.				
2. PURCHASE INFORMATION	The purchase order shall and/or referenced drawin		nformation: Pro	duct type, size, grade designation				
3. CHEMICAL COMPOSITION	Vinylidenefluoride (VF2) a cross-link agents.	and tetrafluoroethylene	(TFE) with nec	cessary fillers, stabilisers and				
4. QUALIFICATION TEST REQUIREMENTS	T 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 production exceeds the limits defined from qualification testing (each manufacturer and seal type shall be qualified).							
	Qualification test requirer fixture, 70 – 85 % groove 72 hours initial soak at ful - 200 bar (24h)	<i>ED-test</i> 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							
		Further, no cracks sha		nd service pressure following the n 80 % of the sample thickness,				
	Mechanical properties	U U						
	- Hardness	ASTM D 2240	90 ±5 Shore A	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 % (af	fter 24 hours at 150 °C)				
	- Documentation of ter	sile strength and elong	gation at break	at 150 °C.				
	Physical properties							
	- Specific gravity	ASTM D 792	1,6 – 1,9 g/cm	1 ³				
5. DIMENSIONS	According to ISO 3601-1	and -3.	-					
6. PRODUCTION TEST REQUIREMENTS		d satisfy requirement f		uirements in ISO 10423, section stated above and for the other				
7. MARKING & PACKAGING	O-rings shall be supplied batch number, and marki manufacturing details.			ne bags shall clearly indicate aterials, formulation and				

MATERIAL	. DA	ATA SHEE	Г	MDS P13	8 Rev. 3		
TYPE OF MATE	TYPE OF MATERIAL: Low temperature Fluorocarbon Terpolymer (FKM GLT)						
PRODUCT	0-	ring	TEMPER	ATURE RANGE	-30 °C to + 150 °C ^{1), 2), 3), 4)}		
	-				Page 2 of 2		
8. CERTIFICATION					in accordance with ISO 9001 r the relevant materials.		
		e material certificate sh clude the following in		at the products meet	this specification and shall		
	-	manufacturer pa	art number,				
	-	specification nur	nber,				
	-	compound numb	ber,				
	-	batch number,					
	-	cure/mould date	and				
	-	shelf-life expirati	ion date.				
NOTES	1)	Only short time exposu	re below - 30 °C	s acceptable.			
	2)	Only to be used as a se material performs better			and in special cases where the seal		
	3)	Materials properties in a (mechanical, temperatu		to be documented, at co	mbined dimensioning loads		
	4)	Mechanical properties a	are reduced by in	creasing temperature and	I may be degraded by service.		

MATERIA	DATA SHEET	M	DS P14	Rev. 3			
TYPE OF MATE	RIAL: Nitrile (NBR)						
PRODUCT	O-ring	TEMPERATUR	E RANGE	-20 °C to 150 °C ^{1), 2), 3)}			
				Page 1 of 1			
1. SCOPE	This MDS specifies the technica	I requirements for the N	NBR O-ring mat	terial.			
2. PURCHASE INFORMATION	The purchase order shall contai and/or referenced drawing.	n the following informat	ion: Product typ	be, size, grade designation			
3. CHEMICAL COMPOSITION	36 – 40% acrylonitrile content (A	ACN)					
4. QUALIFICATION TEST REQUIREMENTS	The material shall be tested for qualification shall be repeated if procedures, specified compositi from qualification testing (each r	there are changes in the on or properties of the	ne production ro product which e	oute, manufacturing exceeds the limits defined			
	Qualification test requirements: fixtures, 70 – 85 % groove fill, te temperature 70 °C, 72 hours soa 50 bars. No leakage shall occur	<i>Oil resistance test</i> Qualification test requirements: O-ring cross section diameter 5,33 mm, 20 % compression, test fixtures, 70 – 85 % groove fill, test medium 10 % toluene/ 90 % iso-octane/ ASTM oil No. 3, test temperature 70 $^{\circ}$ 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 % (at	fter 24 hours at 150 °C)			
	- Documentation of tensile	strength and elongation	at break at 10	0 °C.			
	Physical properties						
	- Specific gravity	ASTM D 792	1,2 – 1,3 g/cm	1 ³			
5. DIMENSIONS	According to ISO 3601-1 and -3						
6. PRODUCTION TEST REQUIREMENTS	The production testing shall be plevel PSL 3, and satisfy requirer as stated in ISO 10423.						
7. MARKING & PACKAGING	number, and such markings sha	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.					
8. CERTIFICATION	The material manufacturer shall the system shall have undergon						
	Inspection certificate shall be to	· · · · · · · · · · · · · · · · · · ·					
NOTES	1) Only short time exposure below		•				
	 Not to be used for gas systems special cases with benign envir 		al material based	on specific assessment and in			
	3) Mechanical properties are redu	iced by increasing temperation	ature.				

MATERIAL I	DATA SHEET	М	DS P21	Rev. 3			
TYPE OF MATERI	AL: PEEK (Poly-ether-et	her-ketone)					
PRODUCT	Back-up rings and seat inserts	TEMPERAT	URE RANGE	-100°C to 200°C			
				Page 1 of 1			
1. SCOPE	This MDS specifies the technical rec	quirements for the P	PEEK material.				
2. PURCHASE INFORMATION	The purchase order shall contain the and/or referenced drawing.	e following informati	on: Product type, siz	ze, grade designatior			
3. CHEMICAL COMPOSITION	Poly-ether-ether-ketone polymer wit	h necessary stabilis	ers and processing	aids.			
4. QUALIFICATION TEST REQUIREMENTS	The material shall satisfy the followin repeated if there are changes in the composition or properties of the pro- testing:	production route, m	nanufacturing proced	dures, specified			
	Mechanical properties:	Test standard	Virgin	Glass filled			
	- Tensile strength	ASTM D638	95 MPa	> 150 MPa			
	- Tensile modulus	ASTM D 638	> 3000 MPa	> 3500 MPa			
	- 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 D638	> 55 %	> 2 %			
	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 %			
	Properties at elevated temp.:						
	The following properties shall be						
	documented at 150 °C and 200 °C:						
	- Tensile strength	ASTM D 638	Manufacturer	Manufacturer			
	- Ultimate elongation	ASTM D 638	requirements	requirements			
5. DIMENSIONS	According to manufacturer's written	specification.					
6. PRODUCTION TEST REQUIREMENTS	The production testing shall be performed level PSL3, and satisfy requirement as stated in ISO 10423.						
7. MARKING & PACKAGING	damage prior to installation. Marking	Components shall be supplied in suitable packaging as to protect the items from physical amage prior to installation. Markings on the packaging shall clearly indicate material batch umber, and such markings shall ensure traceability to raw materials, formulation and					
8. CERTIFICATION	The material manufacturer shall hav and the system shall have undergor						
	Inspection certificate shall be to the	•					

MATERIAL	DATA SHEET			MDS P	22	Rev.	3
TYPE OF MATER	RIAL: PTFE (Poly-tetra-f	luoro-ethy	ylen	e)			
PRODUCT	Lip-seals, back-up rings and inserts.	l seat	TEN	MPERATURE	ERANGE	-150 to 2	200 °C
						Page 1 o	f 1
1. SCOPE	This MDS specifies the technic	al requireme	ents f	or the PTFE mate	erial.		
2. PURCHASE INFORMATION	The purchase order shall conta and/or referenced drawing.	in the follow	ring ir	nformation: Produ	uct type, size, g	grade desig	gnation
3. CHEMICAL COMPOSITION	Carbon and fluorine, polymeric aids. Also with graphite, glass (metallic spring (UNS R30003)	or carbon fib					
4. QUALIFICATION TEST REQUIREMENTS	The material shall satisfy the for if there are changes in the proc properties of the product which	luction route	, mai	nufacturing proce	dures, specifie	ed compos	
	 Mechanical properties Tensile strength Hardness Compressive strength, 1% Compressive modulus HDT @ 1,81 MPa Impact strength (notched) Ultimate elongation <i>Physical properties</i> Specific gravity Melting point Water absorption (24 hrs) <i>Properties at elevated T</i> The following properties shall be documented at 150 °C and 200 °C: Tensile strength Ultimate elongation 	Test standa ASTM D 6 ASTM D 6 ASTM D 6 ASTM D 6 ASTM D 6 ASTM D 2 ASTM D 7 ASTM D 7 ASTM D 34 ASTM D 5	38 85 95 95 48 56 38 92 118 70 38	<i>Virgin</i> > 25 MPa 50-60 Shore D > 4 MPa > 400 MPa 54 °C > 145 J/m > 220 % 2,0-2,2 g/cm ³ 325 °C 0,01 % Manufacturer requirements	25 % Glass > 15 MPa 50-60 Shore > 6 MPa > 600 MPa 110 °C > 130 J/m > 180 % 2,0-2,3 g/cm 325 °C 0,02 % Manufacture requiremen	$\begin{array}{c c} > 18\\ 0 & 60-70\\ > 6\\ 3 & > 60\\ 98\\ > 14\\ > 7\\ 13 & 1,9-2\\ 32\\ 0,0\\ \end{array}$	Graphite 5 MPa 5 hore D 0 MPa 5 °C 40 J/m 75 % 1 g/cm3 25 °C 01 %
5. DIMENSIONS	According to manufacturer's w			•	requirement		rements
6. PRODUCTION TEST REQUIREMENTS	The production testing shall be	According to manufacturer's written specification. The production testing shall be performed according to the requirements in ISO 10423, quality level PSL 3, and satisfy requirement for hardness as stated above and for the other parameters as stated in ISO 10423.					
7. MARKING & PACKAGING	Components shall be supplied prior to installation. Markings o such markings shall ensure tra	n the packag	ging s	shall clearly indica	ate material ba	atch numbe	er, and
8. CERTIFICATION	The material manufacturer sha the system shall have undergo Inspection certificate shall be to	ne a specific	asse	essment for the re	elevant materi	als.)01 and

MATERIAL	DATA SHEE	Т	MDS P41	Rev. 1				
TYPE OF MATERIA	L: PE 100 - Polyethylene	(PE) Piping						
PRODUCT	Pipes, Fittings, Flanges, and welded products							
STANDARD	EN 12201: Plastic piping systems for water supply – Polyethylene, Parts 1-3, 5							
TEMPERATURE RANGE	Water service: -40 to 40 Other types of services.		aximum 80 °C short term ns.	ì.				
				Page 1 of 2				
1. SCOPE			referred standard and addir ponding requirements in the					
2. MANUFACTURING	extrusion. Fittings shall be	made by moulding of	lymer compounds. Pipes sh or by welding/ fusion metho					
	Recycled material shall no							
	For potable water service Authorities requirements (terial used shall comply with	n National Health				
3. MATERIAL	Material designation:	PE 100						
PROPERTIES	Required material properti							
	Minimum required strength							
	Min. yield strength	6.3 N/mm ²						
	Design Coefficient:	1,6						
	E- module 800 – 900 MPa (short time 100 sec)							
		-	ig time 50 - 100 years)					
	Design lifetime	Min. 50 years						
	Deformation	Max. 9 % (shor						
		Max. 15 % afte	,					
			accordance with ISO 4433.					
	The material proposed to have documented properties as defined in EN 12201-1 tables 1 and 2. Further, the material shall satisfy the applicable requirements in EN 12201-2 tables 1, 2 and 3.							
4. TESTING	Each batch of raw material shall be tested and comply with in EN 12201-1 table 1. Nominated values shall be established, as required, by compound producer. A statistical number of manufactured pipes and fittings shall be tested and documented to satisfy the requirements in EN 12201-1 table 2, EN 12201- 2 tables 1, 2, and 3, and in EN 12201-3 table 4 and 6.							
	The extent of the different tests shall be presented to Purchaser for approval.							
	Test total extent shall be included in manufacturer's quality plan.							
	Additional tests required for							
	<i>Test 1: Determination of longitudinal reversion</i> Test to be performed in accordance with EN 743, Method A.							
	Frequency: Start and end							
	The test shall be to the following the follo	-						
	Fluid temperature:	110 °C						
	Submerged time :	30 minutes						
	Test piece length:	30 cm						
	Acceptance criteria:		n length, and no visual impe isters.	erfections, incl. defects,				

MATERIAL	. DATA SHEET	MDS P41	Rev. 1				
TYPE OF MATERIA	L: PE 100 - Polyethylene (PE) Piping						
PRODUCT	Pipes, Fittings, Flanges, and welded	products					
STANDARD	EN 12201: Plastic piping systems for Polyethylene, Parts 1-3, 5	EN 12201: Plastic piping systems for water supply – Polyethylene, Parts 1-3, 5					
TEMPERATURE	Water service: -40 to 40 °C continuou	is, maximum 80 °C short term					
RANGE	Other types of services: Special evaluation	uations.					
			Page 2 of 2				
4. TESTING	Test 2 Residual stresses:		·				
(continued)	Due to normally used processing/cooling certain "frozen in"/ residual stresses in the compression stresses on the outside.	e pipe wall, tensile stresses on the	e inside and balancing				
	Frequency: The tests shall be done at sta						
	The following method shall be used to de A piece of pipe with a length, for instance out axially from this pipe piece to leave ar reduced by hoop shrinkage of the pipe.	equal to the pipe diameter, is cut	off. A thin rod is sawed				
	The residual stresses shall be calculated by the following equation:						
	$\sigma = a/(\pi D_m - a) \times (s/D_m)E$						
	where:						
	a = reduction of pipe periphery						
	D_m = mean diameter of the pipe (D-s))					
	D = external diameter of the pipe						
	s = wall thickness E = creep modulus of the pipe material (for interval of time occurring between cutting and measuring, approx. 900 MPa for HDPE with a 3 min. interval) (Based on book by Lars-Eric Janson: Plastics pipes for water supply and sewage disposal, section 3,3)						
	The residual stresses indicated by this me	ethod shall be below 2,5 MPa for	all PE material.				
5. ELECTRIC CONDUCTIVITY	Not required.	· · · · · ·					
6. PRODUCTION METHOD	Fittings shall be made by moulding, or by mirror welding for larger dimension. The welding of mitre/segment fittings shall satisfy requirements in DS/INF 70 (parts 1-7), and additional requirements in EN 12201. Welded fittings shall be calculated, tested and documented according to EN 12201–2, and EN 12201-5 (test assembly) requirements.						
	All welding shall be made by qualified oper qualified and accepted welding procedure include test methods (1 & 2) for residual s Welding equipment shall be certified and	e specifications (WPS). The WPS stress level below 2,5 MPa, as sp calibrated to DS/INF 70. Whenev	qualification shall ecified under Section 4.				
7. VISUAL INSPECTION	fittings shall have the weld bead ground to 100% visual inspection shall be carried ou All cut surfaces shall be homogenous.		ooth and scratch free.				
8. MARKING	All cut surfaces shall be homogenous. All pipe and fitting to be marked by coloured lines, to identify the pressure rating of the pipes. Yellow for PN 4, red shall be used for PN 6, blue for PN 10, and green for PN 12½.						
9. CERTIFICATION	The material manufacturer shall have a q the system shall have undergone a specif The material certificate shall be issued in	fic assessment for the relevant matrix	aterials.				

MATERIAL	DATA SHE	ET	MDS R11	Rev. 5	
TYPE OF MATER	RIAL: Austenitic sta	inless steel, Type	6Mo		
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.	
Seamless pipes	ASTM A312	UNS S31254 UNS N08367 UNS N08926	-	-	
				Page 1 of 1	
1. SCOPE			ferred standard and addition nding requirements in the r		
2. QUALIFICATION		manufacturing process us ce with NORSOK Standa	sed for manufacturing of pro ard M-650.	oduct to this MDS shall	
3. MANUFACTURING PROCESS	The manufacturing of pr qualified manufacturing		MDS shall be carried out a	ccording to the M-650	
4. STEEL MAKING	The steel melt shall be r	efined by AOD or equiva	lent.		
5. HEAT TREATMENT	Pipes shall be placed in	ion annealed followed by such a way as to ensure g the heat treatment proc	free circulation of heating	and cooling media	
6. TENSILE TESTING	$R_{p0,2} \ge 310 \text{ MPa}; R_M \ge 6$	55 MPa; A ≥ 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 test shall expose the external and internal surfaces and a cross section surface in full wall thickness. Cut edges shall be prepared according to ASTM G 48. The complete specimen shall be pickled before being weighed and tested. Pickling may be performed for 5 minutes at 60 °C in a solution of 20 % HNO ₃ + 5 % HF.				
	The acceptance criteria		,		
	- No pitting at 20 X m	-			
	- The weight loss sha	II be less than 4,0 g/m ² .			
8. EXTENT OF TESTING	For all specified destruc	tive tests one test shall b	e carried out for each lot.		
9. TEST SAMPLING	Samples for production	testing shall realistically	reflect the properties in the	actual components.	
10. SURFACE FINISH	White pickled or bright a	annealed.			
11. REPAIR OF DEFECTS	Weld repair is not accep	otable.			
12. MARKING	The component shall be	e marked to ensure full tra	aceability to melt and heat t	treatment lot.	
13. CERTIFICATION			ystem certified in accordan ssment for the relevant ma		
	The material certificate shall be issued in accordance with EN 10204 Type 3.1, and shall include the following information:				
	- NORSOK M-650 Mar	nufacturing Summary ide	ntification or QTR No. used	l;	
	- Steel manufacturer of	-			
		tion. (Solution annealing	temperature, holding time a for pipes produced hot finis		

MDS R12 MATERIAL DATA SHEET Rev. 5 TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo ACCEPT. CLASS PRODUCT STANDARD GRADE SUPPL. REQ. ASTM A 358 UNS S31254 Class 1, 3 and 5. S3 Welded Pipes **UNS N08367 UNS N08926** Page 1 of 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. Manufacturers and the manufacturing process used for manufacturing of product to this MDS 2. QUALIFICATION shall be qualified in accordance with NORSOK Standard M-650. 3. STEEL MAKING Steel melt shall be refined with AOD or equivalent refining. 4. MANUFACTURING The manufacturing of products according to this MDS shall be carried out according to the M-650 qualified manufacturing procedure. PROCESS 5. HEAT TREATMENT The pipes shall be solution annealed followed by water quenching. Pipes shall be placed in such a way as to ensure free circulation of heating and cooling media around each pipe during the heat treatment process including guenching. Post weld solution annealing is not required for pipes with nominal wall thickness up to 7.11 mm manufactured out of solution annealed plate material and shall be marked as stated in A 358. 6. TENSILE TESTING $R_{p0,2} \ge 310 \text{ MPa}; R_M \ge 655 \text{ MPa}; A \ge 35 \%.$ 7. CORROSION Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C TESTING and the exposure time 24 hours. The test shall expose the external and internal surfaces and a cross section surface including weld zone in full wall thickness. Cut edges shall be prepared according to ASTM G 48. The complete specimen shall be pickled before being weighed and tested. Pickling may be performed for 5 minutes at 60 °C in a solution of 20 % HNO₃ + 5 % HF. The acceptance criteria are: No pitting at 20 X magnification. The weight loss shall be less than $4,0 \text{ g/m}^2$. 8. EXTENT OF Tensile and corrosion testing shall be carried out for each lot defined as follows: TESTING 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 is heat treated the same day. 9. TEST SAMPLING Samples for production testing shall realistically reflect the properties in the actual components. 10. WELDING The WPS shall be gualified in accordance with ASME IX or ISO 15614-1 and this MDS: A matching consumable with enhanced Mo or Cr content compared to the base material shall be used. The S content shall not exceed 0,015 %. The PQR/WPQR 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 regualification. 11. NON Eddy current testing according to ASTM A 450 is acceptable as replacement for radiography for DESTRUCTIVE wall thickness less than 4.0 mm. TESTING 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. NDE operators shall be gualified in accordance with ISO 9712 or equivalent. 12. SURFACE FINISH White pickled.

MATERIAL	DATA SHE	ET	MDS R12	Rev. 5			
TYPE OF MATER	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			
				Page 2 of 2			
13. REPAIR OF DEFECTS		material is not acceptable production welding shall	e. For repair of welds the same apply.	e requirements to use			
14. MARKING	The component shall	be marked to ensure ful	I traceability to melt and heat	treatment lot.			
15. CERTIFICATION	 The material manufacturer shall have a quality system certified in accordance with ISO 9001 and the system shall have undergone a specific assessment for the relevant materials. The material certificate shall be issued in accordance with EN 10204 Type 3.1, and shall include the following information: NORSOK M-650 Manufacturing Summary identification or QTR No. used; Steel manufacturer of starting material; Steel melting and refining practice; Heat treatment condition. (Solution annealing temperature, holding time and quench medium shall be stated.) 						

MATERIAL	DATA SHEE	Т	MDS R13	Rev. 5
TYPE OF MATER	IAL: Austenitic Stai	inless Steel, Type 6	бМо	
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Wrought fittings	ASTM A 403	WP S31254	WP-S, WP-WX and	
HIP products	ASTM A 988	UNS N08367	WP-W	
		UNS N08926		
				Page 1 of 2
1. SCOPE			eferred standard and addition nding requirements in the r	
2. QUALIFICATION		manufacturing process us ordance with NORSOK S	sed for manufacturing of pro Standard M-650.	oduct to this MDS
3. STEEL MAKING	Steel melt shall be refin	ed with AOD or equivaler	nt.	
4. MANUFACTURING PROCESS	650 qualified manufactu	uring procedure.	MDS shall be carried out a cceptable alternative manuf	-
5. HEAT TREATMENT		ution annealed followed b		acturing process.
5. HEAT TREATMENT	Fittings shall be placed	in such a way as to ensu	re free circulation of heating cess including quenching.	g and cooling media
			d forging or bar-stock need ance with MDS R14 or R17	
6. TENSILE TESTING	$R_{p0,2} \ge 300 \text{ MPa}; R_M \ge 6$	655 MPa; A ≥ 35 %.		
7. CORROSION TESTING	Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 and the exposure time 24 hours. The test shall expose the external and internal surfaces an cross section including weld zone (if relevant) in full wall thickness. Cut edges shall be prepared according to ASTM G 48. The complete specimen shall be pickled before being weighed an tested. Pickling may be performed for 5 minutes at 60 °C in a solution of 20 % HNO ₃ + 5 %			
	The acceptance criteria			
	- No pitting at 20 X m	all be less than 4,0 g/m ² .		
8. EXTENT OF			for each heat, heat treatme	ant load with a wall
TESTING		m and welded with the sa		
9. TEST SAMPLING			reflect the properties in the g or from a prolongation the	
		blished showing location f ent identification number.	or extraction of test specim	ens. The sketch
10. WELDING	MDS:		rdance with ASME IX or IS	
	shall be used. The	S content shall not excee		the base material
		hall be corrosion tested a	•	
			e material grade (UNS num e) of welding consumables	
11. NON DESTRUCTIVE TESTING	and 100 % of welded fit only. The weld of each penetrant testing. The t	tings above NPS 2. For v examined fitting shall be esting shall be carried ou	ss fittings (from the test lot a velded fittings the testing sh ground flush in a length of t after calibration and pickli	nall cover the weld 100 mm prior to
	-	shall be to ASME VIII, D		
12. SURFACE FINISH	NDT operators shall be White pickled.	qualified in accordance v	vith ISO 9712 or equivalent	•

MATERIAL I	DATA SHEE	Т	MDS R13	Rev. 5		
TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo						
PRODUCT	STANDARD	NDARD GRADE ACCEPT. CLASS				
Wrought fittings	ASTM A 403	WP S31254	WP-S, WP-WX and			
HIP products	ASTM A 988	UNS N08367	WP-W			
		UNS N08926				
				Page 2 of 2		
13. REPAIR OF DEFECTS		terial is not acceptable. F ly as for production testir	or repair of welds the same	e requirement to use		
14. MARKING	The component shall be	e marked to ensure full tra	aceability to melt and heat t	treatment lot.		
15. CERTIFICATION			ystem certified in accordan assessment for the relevan			
	The material certificate the following information		ance with EN 10204 Type 3	3.1, and shall include		
	- NORSOK M-650 Manufacturing Summary identification or QTR No. used;					
	- Steel manufacturer of the starting material;					
	- Steel melting and refining practice;					
	- Heat treatment condition. (Solution annealing temperature, holding time and quench medium shall be stated.)					
	- Copy of test sampling	g sketch				

MATERIAL	DATA SHE	ET	MDS R14	Rev. 5
TYPE OF MATER	AL: Austenitic Sta	ainless Steel, Typ	be 6Mo	
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ
Forgings	ASTM A 182	F44 UNS N08367 UNS N08926	-	S56
				Page 1 of 2
1. SCOPE	which shall be added	or supersede the corre for forgings with maxir	ne referred standard and additions sponding requirements in the r num thickness of 200 mm. For ase.	eferred standard.
2. QUALIFICATION	• •	e manufacturing proces	ss used for manufacturing of pr	oduct to this MDS
3. STEEL MAKING	The steel melt shall be	e refined with AOD or e	equivalent.	
4. MANUFACTURING PROCESS	650 qualified manufac	turing procedure.	this MDS shall be carried out a in acceptable alternative to forg	C C
5. HEAT TREATMENT	The components shall be solution annealed followed by water quenching. Components shall be placed in such a way as to ensure free circulation of heating and cooling media around each component during the heat treatment process including quenching.			
	sacrificial product. TB = = = FLANGE BODY FLANGE BODY Pos FLANGE BODY FLANGE BODY Pos FLANGE BODY Pos FLANGE BODY FLANGE BODY Pos FLANGE BODY FLANGE B	$T_{B}/2$ a.2 a.2 a.2 a.1 T_{B}/2 or min.50mm imm.50mm im	d, the test specimen shall be of For products forged by the op rolling method, the test specim obtained from a sacrificial forg integral prolongation. For flang the prolongation shall minimum hub thickness (T_H) as shown i Integrated test blocks shall be components manufactured by <u>Test location flanges</u> : The bas mid-thickness of hub (T_H) in a minimum 50 mm from weld er position 1. If test specimens cannot be ex- position 1 test specimens sha flange body position 2. When prolongations are used shall be taken in a distance T_H <u>s</u> : For forgings having maximum at mid thickness and its mid le equal distance from the second ess, T > 50 mm, the test specim id-length of test specimens at lease a showing type, and size of test e sketch shall be given a docum	en die or by the ring nen shall be ging or from an ges the thickness o m be equal to the n fig. 1. used for HIP. sic test location is distance $T_B/2$ or nd, see fig. 1, xtracted from Il be extracted from test specimens a/2 or minimum m section thickness ngth shall be at surfaces. mens shall be taker east T or 100 mm, t samples and

MATERIAL	DATA SHEE	Т	MDS R14	Rev. 5		
TYPE OF MATER	IAL: Austenitic Stai	nless Steel, Type 6	бМо			
PRODUCT	STANDARD	STANDARD GRADE ACCEPT. CLASS SUPPL.				
Forgings	ASTM A 182	F44 UNS N08367 UNS N08926	-	S56		
				Page 2 of 2		
7. EXTENT OF TESTING	7. EXTENT OF One set of tensile test and corrosion test shall be carried out for each heat and heat treatment					
8. TENSILE TESTING	$R_{p0.2} \ge 300 \text{ MPa}; R_M \ge 6$	655 MPa; A ≥ 35 %.				
9. 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. The complete specimen shall be pickled before being weighed and tested. Pickling may be performed for 5 minutes at 60 °C in a solution of 20 % HNO ₃ + 5 % HF. The acceptance criteria are: - No pitting at 20 X magnification.					
10. NON DESTRUCTIVE TESTING	forgings (from the lot as carried out after final ma 1, Appendix 8.	nent ASTM A 961 S56, p defined for mechanical t achining and pickling. The	enetrant testing, shall appl esting) above NPS 2. The e acceptance criteria shall I with ISO 9712 or equivalent	testing shall be be to ASME VIII, Div.		
11. SURFACE FINISH	White pickled including	machined surfaces.				
12. REPAIR OF DEFECTS	Weld repair is not accept	otable.				
13. MARKING	The component shall be	e marked to ensure full tra	aceability to melt and heat t	treatment lot.		
14. CERTIFICATION			ystem certified in accordan assessment for the relevan			
	The material certificate the following information		ance with EN 10204 Type 3	3.1, and shall include		
		• •	ntification or QTR No. used	l;		
	- Steel manufacturer of	-				
			, holding time and quench r	nedium shall be		
	stated) - Copy of test sampling	g sketch				

MATERIAL	DATA SHE	ET	MDS R15	Rev. 5		
TYPE OF MATER	IAL: Austenitic St	ainless Steel, Ty	be 6Mo			
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.		
Plates	ASTM A 240	UNS S31254 UNS N08367 UNS N08926	-	-		
		·	·	Page 1 of 1		
1. SCOPE			he referred standard and additions and additions and the responding requirements in the r			
2. QUALIFICATION		ne manufacturing proce accordance with NORS	ss used for manufacturing of pr OK Standard M-650.	oduct to this MDS		
3. MANUFACTURING PROCESS	The manufacturing o 650 qualified manufa	f products according to cturing procedure.	this MDS shall be carried out a	ccording to the M-		
4. STEEL MAKING	The steel melt shall b	be refined with AOD or	equivalent.			
5. HEAT TREATMENT	Plates shall be place	The plates shall be solution annealed followed by water quenching. Plates shall be placed in such a way as to ensure free circulation of heating and cooling media around each plate during the heat treatment process including quenching.				
6. TENSILE TESTING	$R_{p0.2} \geq 310 \text{ MPa; } R_M$	≥ 655 MPa; A ≥ 35 %.				
TESTING	cross section surface G 48. The complete s be performed for 5 m The acceptance crite - No pitting at 20 X	in full wall thickness. C specimen shall be pickl inutes at 60 °C in a sol ria are:	all expose the external and inte Cut edges shall be prepared acc ed before being weighed and te ution of 20 % HNO ₃ + 5 % HF. m ² .	cording to ASTM		
8. EXTENT OF TESTING	and heat treatment lo	oad. For heat treatment	Il be carried out for each heat, r in continuous furnace a heat tro- ly in the same furnace, of the s	eatment load is		
9. TEST SAMPLING	Samples for producti Tensile test specime thickness for thickness E 8.	on testing shall realistic ns shall be sampled in ss (t) \leq 40 mm and in lo	ally reflect the properties in the transverse direction and shall be cation t/4 for thicknesses (t) > 4 ried out at both ends of the coil	actual components. e located in mid- l0 mm, ref. ASTM		
10. SURFACE FINISH	White pickled.	<u>sel oltesis shali de car</u>	neo our ar doin enos or me coir			
11. REPAIR OF DEFECTS	Weld repair is not ac	ceptable.				
12. MARKING	The component shall	be marked to ensure f	ull traceability to melt and heat	treatment lot.		
13. CERTIFICATION	and the system shall The material certifica following information: - NORSOK M-650 - Steel manufacture - Steel melting and	have undergone a spe te shall be in accordan Manufacturing Summar er of the starting materia refining practice;	ity system certified in accordan cific assessment for the relevan ce with EN 10204 Type 3.1, and y identification or QTR No. used al; aling temperature, holding time	it materials. d shall include the d;		

MATERIAL	DATA SHEE	Т	MDS R16	Rev. 5	
TYPE OF MATER	IAL: Austenitic Sta	inless Steel, Type	6Mo		
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.	
Castings	ASTM A 351	CK-3MCuN CN-3MN	-	S6, S20	
1. SCOPE			eferred standard and addition		
2. QUALIFICATION	Manufacturers and the	· · · ·	sed for manufacturing of pr		
3. MANUFACTURE	The manufacturing of p 650 qualified manufactu		MDS shall be carried out a	ccording to the M-	
4. STEEL MAKING			valent process. Remelting c internal scrap is not accept		
5. HEAT TREATMENT		laced in such a way as to	ensure free circulation of h reatment process including		
6. CHEMICAL COMPOSITION	P ≤ 0,030 %				
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 specimen shall be at the same location as those for mechanical testing. Cut edges shall be prepared according to ASTM G 48. The complete specimen shall be pickled before being weighed and tested. Pickling may be performed for 5 minutes at 60 °C in a solution of 20 % HNO ₃ + 5 % HF. 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			each melt and heat treatme	ent load including	
9. TEST SAMPLING	Tensile test and corrosion test shall be made for each melt and heat treatment load including any PWHT. A test lot shall not exceed 5000 kg. Samples for mechanical testing shall realistically reflect the properties in the actual components. For castings with weight 250 kg or more the 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. Thickness of the test block shall be equal to the thickest part of the casting represented. For flanged components the largest flange thickness is the ruling section. Dimensions of test blocks and location of test specimens within the test blocks are shown in figures 1 and 2 for integral and gated test blocks respectively. The test specimens shall be taken within the cross hatched area and in a distance of T/4 from the ends. During any PWHT the test block shall be tack welded onto the casting. $\frac{T}{T4} = \frac{T}{T4} = \frac{T}{T2} = \frac{T}{T2}$				
	Fig.1 - Integral test block	Fig. 2 - Gated te	est block		

MATERIAL	DATA S	HEET	Γ	N	IDS F	R16	Rev	/. 5
TYPE OF MATER	RIAL: Austeni	itic Stair	less Steel,	Туре 6Мо)			
PRODUCT	STANDAR	D	GRADE	AC	CEPT.	CLASS	SUPPI	. REQ.
Castings	ASTM A 351		CK-3MCuN CN-3MN	-			S6, S20	
	·						Page 2 o	f 3
10. NON DESTRUCTIVE TESTING	 Liquid penetrar All accessi Liquid Pen ASME VIII machined Radiographic to Method of Div. 1 App Extent of r 	 Liquid Penetrant (PT). Surface examination of steel castings shall be in accordance with ASME VIII, Div. 1 Appendix 7. The testing shall be carried out after final machining. Non-machined surfaces shall be pickled prior to the testing. <i>Radiographic testing (RT):</i> Method of radiography and acceptance criteria shall be in accordance with ASME VIII, Div. 1 Appendix 7. 						
	below.	RT based c	on pressure cla	ss and valve s	size:			
	Pressure (, ≤ 150	300	600	900	1500	≥ 2500
	Extent of	10 %	≥ 10"	≥ 10"	≥ 2"	≥ 2"	≥ 2"	≥ 2"
	RT	100 %	Not applicable	Not applicable	≥ 20"	≥ 16"	≥ 6"	≥ 6"
	 Valve castings shall be examined in the areas as defined by ASME B16.34 for special class valves and other critical areas as defined by valve designer. In addition castings shall be examined at abrupt changes in sections and at the junctions of risers, gates or feeders to the castings. When random examination (10 %) is specified, minimum one casting of each pattern including feeder and riser system in any purchase order with the foundry shall be examined. If defect outside acceptance criteria is detected, two more castings shall be tested, and if any of these two fails all items represented shall be tested. Other type of castings: Each casting shall be examined unless agreed otherwise. Testing shall be at abrupt changes in sections and at the junctions of risers, gates or feeders to the castings and other critical areas as defined by designer. Sketches of the areas to be tested shall be established and agreed. 							
11. SURFACE FINISH	White pickled. surfaces.	Shall be ca	arried out after	any blasting a	nd shall ind	clude finish	ed machin	ed
12. REPAIR OF DEFECTS	All major repairs shall be documented according to ASTM A 703 SR S20. Post weld heat treatment (PWHT) is required after all weld repairs. For minor weld repairs, as defined by ASTM A 995, the PWHT may be excluded provided the welding procedure qualification shows that all specified properties, as specified in this MDS, can be fulfilled. Repair welding shall be carried out with Ni-based consumable with enhanced Mo or Cr content compared to the base material. The S content shall not exceed 0,015 %. Welding consumables with matching chemical composition are acceptable provided solution annealing heat treatment after welding. The repair welding procedure shall be qualified in accordance with ASTM A 488 and this MDS. The repair welding procedure qualification shall include the following: - A cast plate shall be used for the test welding.							
	- A macro and		-				,	
	 Change specific make of filler metal (brand name) requires requalification. All casting with major repairs shall be given a solution heat treatment after welding. 							

MATERIAL DATA SHEET			MDS R16	Rev. 5		
TYPE OF MATERI	Austenitic Sta	inless Steel, Type	6Mo			
PRODUCT	STANDARD	SUPPL. REQ.				
Castings	ASTM A 351	CK-3MCuN CN-3MN	-	S6, S20		
	Page 3 of 3					
13. MARKING	The component shall be	e marked to ensure full tra	aceability to melt and heat t	reatment load.		
14. CERTIFICATION			ystem certified in accordan assessment for the relevan			
	The material certificatio following information:	n shall be in accordance	with EN 10204 Type 3.1, a	nd shall include the		
	- NORSOK M-650 Mar	nufacturing Summary ide	ntification or QTR No. used	;		
	- Steel manufacturer ir	n case remelted ingots ar	e used, ref. Section 4. abov	/e;		
	- Steel melting and refining practice;					
	- Heat treatment condition. (Solution annealing temperature, holding time and quench medium shall be stated.)					

MATERIAL DATA SHEET MDS R17 Rev. 5 TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo PRODUCT STANDARD GRADE ACCEPT. CLASS SUPPL. REQ.

PRODUCI	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.	
Bars	ASTM A 479	UNS S31254	-	-	
		UNS N08367			
		UNS N08926			
	I			Page 1 of 2	
1. SCOPE	This MDS specifies the	selected options in the refe	erred standard and addition	al requirements	
	which shall be added or	supersede the correspond	ding requirements in the ref	erred standard.	
			ness of 200 mm. For large d on the result of qualificati		
2. QUALIFICATION		nanufacturing process use ce with NORSOK Standar	ed for manufacturing of proo d M-650.	duct to this MDS shall	
3. STEEL MAKING	The steel melt shall be r	refined with AOD or equiva	llent.		
4. MANUFACTURING PROCESS	qualified manufacturing	procedure.	IDS shall be carried out acc	-	
		ts as valves, fittings and h		.y.	
		ned from bar under the foll			
	-	otance shall be obtained in	-		
	-	be tested and certified acc			
	 When bar with outside diameter 100 mm or greater is used, tensile specimens shall be taken in both longitudinal and transverse direction. Acceptance criteria shall be the same in both directions. 				
	acceptance criteri		S56 shall apply to all finish 1, Appendix 8. NDT operat		
5. HEAT TREATMENT	Solution annealing follow	wed by water quenching.			
		such a way as to ensure fro the heat treatment process	ee circulation of heating an s including quenching.	d cooling media	
6. TENSILE TESTING	$R_{p0.2} \geq 300 \text{ MPa}; R_M \geq 6$	55 MPa; A ≥ 35 %; RA ≥ 5	50 %.		
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. The complete specimen shall be pickled before being weighed and tested. Pickling may be performed for 5 minutes at 60 °C in a solution of 20 % HNO ₃ + 5 % HF.				
	The acceptance criteria				
	- No pitting at 20 X m	-			
	 The weight loss sha 	II be less than 4,0 g/m ² .			
8. EXTENT OF TESTING	One tensile test and cor	rosion test shall be carried	l out for each heat and hea	t treatment load.	
9. TEST SAMPLING	Samples for production	testing shall realistically re	flect the properties in the a	ctual components.	
	Test location shall be:				
	 For bars having section thickness, T ≤ 50 mm, the test specimens shall be taken in longitudinal direction at mid thickness and its mid length shall be at least 50 mm from any second surface. 				
		T from the nearest surface	, the test specimen shall be and at least T or 100 mm,		

MATERIAL	DATA SH	EET	MDS R17	Rev. 5		
TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo						
PRODUCT	STANDARD	ACCEPT. CLASS	SUPPL. REQ.			
Bars	ASTM A 479	UNS S31254 UNS N08367 UNS N08926	-	-		
	Page 2 of 2					
10. SURFACE FINISH	Finished product shall be 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	The material manufacturer shall have a quality system certified in accordance with ISO 9001 and the system shall have undergone a specific assessment for the relevant materials.					
	The material certificate shall be in accordance with EN 10204 Type 3.1, and shall include the following:					
	 NORSOK M-650 Manufacturing Summary identification or QTR No. used; 					
	- Steel manufacturer of the starting material;					
	- Steel melting and refining practice;					
	- Heat treatment condition. (Solution annealing temperature, holding time and quench medium shall be stated.)					

MATERIAL DATA SHEET **MDS R18** Rev. 5 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 Page 1 of 1 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. Manufacturers and the manufacturing process used for manufacturing of product to this MDS shall 2. QUALIFICATION be qualified in accordance with NORSOK Standard M-650. 3. MANUFACTURING The manufacturing of products according to this MDS shall be carried out according to the M-650 PROCESS qualified manufacturing procedure. 4. STEEL MAKING The steel melt shall be refined by AOD or equivalent. 5. HEAT TREATMENT The tubes shall be solution annealed followed by accelerated cooling. Tubes shall be placed in such a way as to ensure free circulation of air and quenching medium around each pipe during the heat treatment process including cooling. 6. CORROSION Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C TESTING and the exposure time 24 hours. The test shall expose the external and internal surfaces and a cross section surface including weld zone in full wall thickness. Cut edges shall be prepared according to ASTM G 48. The complete specimen shall be pickled before being weighed and tested. Pickling may be performed for 5 minutes at 60 °C in a solution of 20 % HNO_3 + 5 % HF. The acceptance criteria are: No pitting at 20 X magnification. The weight loss shall be less than $4,0 \text{ g/m}^2$. 7. EXTENT OF All destructive tests shall be carried out for each lot. TESTING 8. TEST SAMPLING Samples for production testing shall realistically reflect the properties in the actual components. 9. REPAIR OF Weld repair is not acceptable. DEFECTS 10. MARKING The component shall be marked to ensure full traceability to melt and heat treatment lot. 11. CERTIFICATION The material manufacturer shall have a quality system certified in accordance with ISO 9001 and the system shall have undergone a specific assessment for the relevant materials. The material certificate shall be issued in accordance with EN 10204 Type 3.1, and shall include the following: - NORSOK M-650 Manufacturing Summary identification or QTR No. used; - Steel manufacturer of the starting material; - Steel melting and refining practice; - Heat treatment condition (Solution annealing temperature, holding time and quench medium shall be stated.)

MATERIAL DATA SHEET **MDS R21** Rev. 2 TYPE OF MATERIAL: Austenitic stainless steel, Type 565 GRADE ACCEPT. CLASS SUPPL. REQ. PRODUCT STANDARD **ASTM A 312** UNS S34565 Seamless pipes Page 1 of 1 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 and the manufacturing process used for manufacturing of product to this MDS shall be qualified in accordance with NORSOK Standard M-650. 3. MANUFACTURING The manufacturing of products according to this MDS shall be carried out according to the M-650 qualified manufacturing procedure. PROCESS 4. STEEL MAKING The steel melt shall be refined by AOD or equivalent. 5. HEAT TREATMENT The pipes shall be solution annealed followed by water guenching. Pipes shall be placed in such a way as to ensure free circulation of heating and cooling media around each pipe during the heat treatment process including quenching 6. TENSILE TESTING $R_{p0,2} \ge 415 \text{ MPa}; R_M \ge 795 \text{ MPa}; A \ge 35 \%$ 7. CORROSION Corrosion test according to ASTM G²48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. The test shall expose the external and internal surfaces and a TESTING cross section surface in full wall thickness. Cut edges shall be prepared according to ASTM G 48. The complete specimen shall be pickled before being weighed and tested. Pickling may be performed for 5 minutes at 60 °C in a solution of 20 % HNO₃ + 5 % HF. The acceptance criteria are: No pitting at 20 X magnification. - The weight loss shall be less than 4,0 g/m². 8. EXTENT OF Corrosion test shall be carried out to the same extent as stated for mechanical tests in the referred standard. TESTING 9. TEST SAMPLING Samples for production testing shall realistically reflect the properties in the actual components. 10. SURFACE FINISH White pickled. 11. REPAIR OF Weld repair is not acceptable. DEFECTS The component shall be marked to ensure full traceability to melt and heat treatment lot. 12. MARKING 13. CERTIFICATION The material manufacturer shall have a quality system certified in accordance with ISO 9001 and the system shall have undergone a specific assessment for the relevant materials. The material certificate shall be issued in accordance with EN 10204 Type 3.1 and shall include the following information: NORSOK M-650 Manufacturing Summary identification or QTR No. used; - Steel manufacturer of the starting material; - Steel melting and refining practice; - Heat treatment condition. (Solution annealing temperature, holding time and quench medium shall be stated. Holding time is not applicable for pipes produced hot finished/ direct quenched.)

MDS R22

Rev. 2

TYPE OF MATERIAL: Austenitic Stainless Steel Type 565					
PRODUCT	STANDARD GRADE ACCEPT. CLASS SUPPL. REG				
Welded Pipes	ASTM A 358	UNS S34565	Class 1 and 3	S3	
				Page 1 of 2	
1. SCOPE			eferred standard and addition nding requirements in the r		
2. QUALIFICATION	Manufacturers and the shall be qualified in acc	manufacturing process us ordance with NORSOK S	sed for manufacturing of pr Standard M-650.	oduct to this MDS	
3. STEEL MAKING	Steel melt shall be refin	ed with AOD or equivaler	nt refining.		
4. MANUFACTURING PROCESS	The manufacturing of p 650 qualified manufactu		MDS shall be carried out a	ccording to the M-	
5. HEAT TREATMENT	Pipes shall be placed in around each pipe during Post weld solution anne	n such a way as to ensure g the heat treatment proc ealing is not required of pi	150 °C followed by water of e free circulation of heating ess including quenching. ipes with nominal wall thick erial as stated in chapter 6	and cooling media ness up to 7,11 mm	
6. TENSILE TESTING	$R_{p0,2} \ge 415 \text{ MPa}; R_M \ge 7$	795 MPa; A ≥ 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 test shall expose the external and internal surfaces and a cross section surface including weld zone in full wall thickness. Cut edges shall be prepared according to ASTM G 48. The complete specimen shall be pickled before being weighed and tested. Pickling may be performed for 5 minutes at 60 °C in a solution of 20 % HNO₃ + 5 % HF. The acceptance criteria are: No pitting at 20 X magnification. The weight loss shall be less than 4,0 g/m². 				
8. EXTENT OF TESTING	 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 heat treated the same day. 				
9. TEST SAMPLING	Samples for production	testing shall realistically	reflect the properties in the	actual components.	
10. WELDING	 The WPQR shall be qualified in accordance with ASME IX or ISO 15614-1 and this MDS: All welding shall be done with ERNiCrMo-7 type consumables with C ≤ 0,03 % and S ≤ 0,015 %. The WPQR 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. 				
11. NON DESTRUCTIVE TESTING	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.				
12. SURFACE FINISH	White pickled.				
13. REPAIR OF DEFECTS	Weld repair of base material is not acceptable. For repair of welds the same requirements to WPQR as for production welding shall apply.				
14. MARKING			aceability to melt and heat	treatment lot.	

MATERIAL DATA SHEET			MDS R22	Rev. 2	
TYPE OF MATER	IAL: Austenitic Stai	nless Steel Type 5	65		
PRODUCT	STANDARD	ACCEPT. CLASS	SUPPL. REQ.		
Welded Pipes	ASTM A 358	UNS S34565	Class 1 and 3	S3	
				Page 2 of 2	
15. CERTIFICATION	 The material manufacturer shall have a quality system certified in accordance with ISO 9001 and the system shall have undergone a specific assessment for the relevant materials. The material certificate shall be issued in accordance with EN 10204 Type 3.1 and shall include the following information: NORSOK M-650 Manufacturing Summary identification or QTR No. used; Steel manufacturer of the starting material; Steel melting and refining practice; Heat treatment condition (solution annealing temperature, holding time and quench medium shall be stated.) 				

MATERIAL	DATA SHEE	Т	MDS R23	Rev. 2	
TYPE OF MATERIAL: Austenitic Stainless Steel Type 565					
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.	
Wrought fittings	ASTM A 403	WP S34565	WP-S, WP-WX		
HIP products	ASTM A 988				
				Page 1 of 2	
1. SCOPE			eferred standard and addition nding requirements in the re-		
2. QUALIFICATION	Manufacturers and the m shall be qualified in acco		sed for manufacturing of pro Standard M-650.	oduct to this MDS	
3. STEEL MAKING	Steel melt shall be refine	d with AOD or equivale	nt.		
4. MANUFACTURING PROCESS	650 qualified manufactur	ing procedure.	MDS shall be carried out a		
			cceptable alternative manuf		
5. HEAT TREATMENT	e e		1150 °C followed by quence re free circulation of heating	•	
	around each fitting during	g the heat treatment pro	cess including quenching.		
			d forging or bar-stock need tified in accordance with M		
6. TENSILE TESTING	$R_{p0,2} \ge 415 \text{ MPa}; R_M \ge 79$	95 MPa; A ≥ 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 test shall expose the external and internal surfaces and a cross section including weld zone (if relevant) in full wall thickness. Cut edges shall be prepared according to ASTM G 48. The complete specimen shall be pickled before being weighed and tested. Pickling may be performed for 5 minutes at 60 °C in a solution of 20 % HNO ₃ + 5 % HF. 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	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.				
9. TEST SAMPLING		reflect the properties in the	-		
			g or from a prolongation the		
			or extraction of test specim	ens. The sketch	
shall be given a document identification number. 10. WELDING The welding procedure shall be qualified in accordance with ASME IX or ISO 1 MDS:				O 15614-1 and this	
	 All welding shall be done with ERNiCrMo-7 type consumables with C ≤ 0,03 % and S ≤ 0,015 %. 				
		corrosion tested as spe			
			same material grade as use		
	- Change of specific make (brand name) of welding consumables requires requilification.				
11. 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 testing shall be carried out after calibration and pickling. The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 8.				
NDT operators shall be qualified in accordance with ISO 9712 or equivalent.					
12. SURFACE FINISH	White pickled.				
13. REPAIR OF DEFECTS	Weld repair of base material is not acceptable. For repair of welds the same requirement to WPQR shall apply as for production testing.				
14. MARKING	The component shall be	marked to ensure full tra	aceability to melt and heat t	reatment lot.	

MATERIAL DATA SHEET			MDS R23	Rev. 2		
TYPE OF MATERI	TYPE OF MATERIAL: Austenitic Stainless Steel Type 565					
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.		
Wrought fittings	ASTM A 403	WP S34565	WP-S, WP-WX			
HIP products	ASTM A 988					
	Page 2 of 2					
15. CERTIFICATION	The material manufacturer shall have a quality system certified in accordance with ISO 9001 and the system shall have undergone a specific assessment for the relevant materials.					
	The material certificate shall be issued in accordance with EN 10204 Type 3.1 and shall include the following information:					
	- NORSOK M-650 Manufacturing Summary identification or QTR No. used;					
	- Steel manufacturer of the starting material;					
	- Steel melting and refining practice;					
	- Heat treatment condition. (Solution annealing temperature, holding time and quench medium shall be stated.)					
	- Copy of test sampling sketch					

MDS R24 Rev. 2

PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.	
Forgings	ASTM A 182	UNS S34565	-	S56	
	•	•		Page 1 of 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. 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 and the shall be qualified in acc		s used for manufacturing of pro K Standard M-650.	duct to this MDS	
3. STEEL MAKING	The steel melt shall be	refined with AOD or e	quivalent.		
4. MANUFACTURING PROCESS	qualified manufacturing	g procedure.	his MDS shall be carried out ac	-	
5. HEAT TREATMENT	Components shall be p	The components shall be solution annealed followed by water quenching. Components shall be placed in such a way as to ensure free circulation of heating and cooling			
6. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual components. Samples for production testing shall realistically reflect the properties in the actual components. For products forged by the closed die method, the test specimen shall be obtained from a sacrificial product. $\frac{T_B}{F_{II}} = \frac{T_{II}}{T_{II}} = \frac{T_{II}}{T_{I$				
7. EXTENT OF TESTING	NOTE: For closed die forged components and flanges exceeding 80 kg it is recognized that alternative test 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 \leq 50 kg, and 5000 kg for forgings with as forged weight > 50 kg.				

MATERIAL	DATA SHEI	MDS R24	Rev. 2			
TYPE OF MATERIAL: Austenitic Stainless Steel, Type 565						
PRODUCT	STANDARD GRADE ACCEPT. CLASS SUPPL. REG					
Forgings	ASTM A 182	S56				
				Page 2 of 2		
8. TENSILE TESTING	$R_{p0,2} \ge 415 \text{ MPa}; R_M \ge$	795 MPa; A ≥ 35 %				
9. 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. The complete specimen shall be pickled before being weighed and tested. Pickling may be performed for 5 minutes at 60 °C in a solution of 20 % HNO ₃ + 5 % HF.					
	The acceptance criteria					
	 No pitting at 20 X magnification. The weight loss shall be less than 4,0 g/m². 					
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.					
11. SURFACE FINISH	White pickled including		/ FF			
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	The material manufacturer shall have a quality system certified in accordance with ISO 9001 and the system shall have undergone a specific assessment for the relevant materials. The material certificate shall be in accordance with EN 10204 Type 3.1, and shall include the following information:					
	 NORSOK M-650 Manufacturing Summary identification or QTR No. used; 					
	- Steel manufacturer of the starting material;					
	- Steel melting and re	fining practice;				
	 Heat treatment condition. (Solution annealing temperature, holding time and quench medium shall be stated.) 					
	- Copy of test sampling sketch					

MDS R25 Rev. 2

TYPE OF MATERIAL: Austenitic Stainless Steel, Type 565					
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.	
Plates	ASTM A 240	UNS S34565		-	
				Page 1 of 1	
1. SCOPE			eferred standard and additi nding requirements in the r		
2. QUALIFICATION	Manufacturers and the r shall be qualified in acco	manufacturing process u ordance with NORSOK S	sed for manufacturing of pr Standard M-650.	oduct to this MDS	
3. MANUFACTURING PROCESS	The manufacturing of pr 650 qualified manufactu		MDS shall be carried out a	ccording to the M-	
4. STEEL MAKING	The steel melt shall be r	refined with AOD or equi	valent.		
5. HEAT TREATMENT	Plates shall be placed in		y water quenching. e free circulation of heating cess including quenching	and cooling media	
6. CORROSION TESTING	Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 ° and the exposure time 24 hours. The test shall expose the external and internal surfaces and cross section surface in full wall thickness. Cut edges shall be prepared according to ASTM G 48. The complete specimen shall be pickled before being weighed and tested. Pickling ma be performed for 5 minutes at 60 °C in a solution of 20 % HNO ₃ + 5 % HF. The acceptance criteria are:				
	 No pitting at 20 X m The weight loss sha 				
7. EXTENT OF TESTING	Tensile, hardness and corrosion testing shall be carried out for each heat, nominal thickness and heat treatment load. For heat treatment in continuous furnace a heat treatment load is defined as all plates heat treated continuously in the same furnace, of the same heat and				
8. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual components. Tensile test specimens shall be sampled in transverse direction and shall be located in mid- thickness for thickness (t) \leq 40mm and in location t/4 for thicknesses (t) > 40mm, ref. ASTM E 8. For coils a complete set of tests shall be carried out at both ends of the coil.				
9. SURFACE FINISH	White pickled.	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	The material manufacturer shall have a quality system certified in accordance with ISO 9001 and the system shall have undergone a specific assessment for the relevant materials. The material certificate shall be issued in accordance with EN 10204 Type 3.1 and shall include				
	the following information:				
		• •	entification or QTR No. use	ed;	
		of the starting material;			
	 Steel melting and refining practice; Heat treatment condition. (Solution annealing temperature, holding time and quench medium shall be stated.) 				

MATERIAL	DATA SHE	ET	MDS R27	Rev. 2	
TYPE OF MATER	RIAL: Austenitic St	tainless Steel, Ty	pe 565		
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.	
Bars	ASTM A 479	UNS S34565	-	-	
				Page 1 of 2	
1. SCOPE	which shall be added This MDS is intended	l or supersede the corr d for bars with maximu	the referred standard and additi esponding requirements in the m thickness of 200 mm. For larg d based on the result of qualific	referred standard. ger thickness special	
2. QUALIFICATION	Manufacturers and th	ne manufacturing proce accordance with NORS	ess used for manufacturing of pr OK Standard M-650.	roduct to this MDS	
3. STEEL MAKING	The steel melt shall b	be refined with AOD or	equivalent.		
4. MANUFACTURING PROCESS	The manufacturing of products according to this MDS shall be carried out according to the M- 650 qualified manufacturing procedure. The Hot Isostatic Pressed (HIP) process is an acceptable alternative to forging. <i>Machining of components as valves, fittings and hollow sections from bar:</i> Products may be machined from bar under the following conditions: - Purchasers' acceptance shall be obtained in each case.				
	 When bar with taken in both lo in both directio 100 % penetra acceptance cri 	outside diameter 100 r ongitudinal and transve ns. nt testing to ASTM A 9	ied according to this MDS. mm or greater is used, tensile s rse direction. Acceptance criter 61 SR S56 shall apply to all fini II, Div. 1, Appendix 8. NDT ope c or equivalent.	ia shall be the same shed products. The	
5. HEAT TREATMENT	Bars shall be placed		hing. sure free circulation of heating a process including quenching.	and cooling media	
6. TENSILE TESTING	$R_{p0,2} \ge 415 \text{ MPa}; R_M$	≥ 795 MPa; A ≥ 35 %.			
7. CORROSION TESTING	and the exposure tim those for mechanical complete specimen s	ne 24 hours. The corros l testing. Cut edges sha shall be pickled before lites at 60 °C in a solutio ria are:	thod A is required. Test temperation test specimens shall be at tall be prepared according to AS being weighed and tested. Pick on of 20 % HNO ₃ + 5 % HF.	he same location as TM G 48. The	
		shall be less than 4,0 g	/m².		
8. EXTENT OF TESTING			carried out for each heat and he	eat treatment load.	
9. TEST SAMPLING	 Samples for production testing shall realistically reflect the properties in the actual components. Test location 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. 				
10. SURFACE FINISH	Finished product sha	III be white pickled. Ma	chined surfaces do not require	bickling.	
11. REPAIR OF DEFECTS	Weld repair is not ac	· · · · · · · · · · · · · · · · · · ·			

MATERIAL	DATA SHEE	T	MDS R27	Rev. 2	
TYPE OF MATER	IAL: Austenitic Stai	inless Steel, Type &	565		
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.	
Bars	ASTM A 479	UNS S34565	-	-	
12. MARKING	The component shall be	e marked to ensure full tra	aceability to melt and heat t	treatment lot.	
13. CERTIFICATION	 The material manufacturer shall have a quality system certified in accordance with ISO 9001 and the system shall have undergone a specific assessment for the relevant materials. The material certificate shall be issued in accordance with EN 10204 Type 3.1 and shall include the following information: NORSOK M-650 Manufacturing Summary identification or QTR No. used; Steel manufacturer of starting material; Steel melting and refining practice; Heat treatment condition. (Solution annealing temperature, holding time and quench medium shall be stated.) 				

MATERIAL DATA SHEET **MDS S01** Rev. 5 TYPE OF MATERIAL: Austenitic Stainless Steel, Type 316 GRADE PRODUCT ACCEPT. CLASS SUPPL. REQ. STANDARD ASTM A 403 W/S/WX Wrought fittings WP316 Welded pipes **ASTM A 358** Class 1, 3, 4 or 5 316 Seaml. & welded pipe **ASTM A 312 TP316** Forgings **ASTM A 182** F316 Plates ASTM A 240 316 Tubes **ASTM A 269** 316 Bars **ASTM A 479** 316 Page 1 of 1 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 During heat treatment components shall be placed in such a way as to Fittings and forgings: PROCESS ensure free circulation around each component during the heat treatment process including possible quenching operation. 3. CHEMICAL All products: C ≤ 0,035 % COMPOSITION Welded pipes and plates to A 240: S \leq 0,015 % Grade 316L is acceptable with: $R_{p0.2} \ge 205 \text{ MPa}$; $R_M \ge 515 \text{ MPa}$; A > 35 %. 4. TENSILE TESTING 5. TEST SAMPLING Samples for production testing shall realistically reflect the properties in the actual component. Tensile test specimens shall be sampled in transverse direction and shall be located in Plates: mid-thickness for thickness (t) \leq 40 mm and in location t/4 for thicknesses (t) > 40 mm, ref. ASTM E 8. Bars A 479: Test location shall be: For bars having section thickness, $T \le 50$ mm, the test specimens shall be taken in longitudinal direction at mid thickness and its mid length shall be at least 50 mm from any second surface. For bars having section thickness, T > 50 mm, the test specimen shall be taken in longitudinal direction at least 1/4 T from the nearest surface and at least T or 100 mm, whichever is less, from any second surface. 6. NON DESTRUCTIVE Welded tubes to A 269: Non-destructive electric testing is required. TESTING All products: NDT operators shall be qualified in accordance with ISO 9712 or equivalent. 7. SURFACE FINISH White pickled or bright annealed. Machined surfaces do not require pickling. All products: 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	The material manufacturer shall have a quality system certified in accordance with ISO 9001 and the system shall have undergone a specific assessment for the relevant materials. The material certificate shall be issued in accordance with EN 10204 Type 3.1, and shall include
	the heat treatment condition.

MATERIAL DATA SHEET

MDS S02 Rev. 5

TYPE OF MATERIAL: Austenitic Stainless Steel Castings									
PRODUCT	STANDAR	D	GRADE	A	CCEPT	CLASS	SUF	PPL. RE	Q.
Castings	ASTM A 351		CF8M CF3M	-			S6 S6	4 -5 4	
4 00005		: f ine the end					Page		4-
1. SCOPE	This MDS spec which shall be								
2. EXTENT OF TESTING	Tensile testing	is required	for each hea	at and heat	treatment lo	oad including	g any P\	WHT.	
3. TEST SAMPLING	Samples for me For castings wi casting. The te During any PW	th weight 2 st blocks s	250 kg and a hall be heat t	bove the test treated toge	st blocks sh ther with th	all be integr e castings tl	ally cast	with the	ents.
4. NON DESTRUCTIVE TESTING	 NDT operators shall be qualified in accordance with ISO 9712 or equivalent. Liquid penetrant testing: All accessible surfaces (including internal surfaces) of all castings shall be examined wit Liquid Penetrant (PT). Surface examination of steel castings shall be in accordance wit ASME VIII Div. 1 Appendix 7. The testing shall be carried out after final machining. Normachined surfaces shall be pickled prior to the testing. Radiographic testing (RT): Method of radiography and acceptance criteria shall be in accordance with ASME VIII E Appendix 7. Extent of radiographic examination (RT) for valve castings shall be according to table b Extent of RT based on pressure class and nominal size: 					lance with ning. Non- ME VIII Div	v. 1		
	Pressure Extent	10 %	≤ <i>150</i> ≥ 10"	300 ≥ 10"	600 ≥ 2"	900 ≥ 2"	1500 ≥ 2"	≥2300 ≥2"	_ !
	of RT	10 %	Not applic able	≥ 10 Not applic able	≥ 20"	≥ 2 ≥ 16"	≥ 2 ≥ 6"	≥ 2 ≥ 6"	-
	 Valve castings shall be examined in the areas as defined by ASME B16.34 for special class valves and other critical areas as defined by valve designer. In addition castings shall be examined at abrupt changes in sections and at the junctions of risers, gates or feeders to the castings. When random examination (10 %) is specified, minimum one casting of each path including feeder and riser system in any purchase order with the foundry shall be examined defect outside acceptance criteria is detected, two more castings shall be tested, and if any these two fails all items represented shall be tested. Other type of castings: Each casting shall be examined unless agreed otherwise. Testing shall be at abrupt changes in sections and at the junctions of risers, gates or feeders to the castings and other critical areas as defined by designer. Sketches of the areas to be tested shall be established and agreed. 					o the attern ed. If ny of ne			
5. REPAIR OF	All major repairs shall be documented according to ASTM A 703 SR S20.								
DEFECTS	The repair weld MDS.	The repair welding procedure shall be qualified in accordance with A 488 or ISO 11970 and this							
6. SURFACE FINISH	White pickled.	Machined	surfaces do r	not require p	bickling.				
7. CERTIFICATION	The material m and the system The material ce the heat treatm	shall have ertificate sh	e undergone nall be issued	a specific a	ssessment	for the relev	ant mat	erials.	

MATERIAL DATA SHEET			MDS S03	Rev. 1	
TYPE OF MATER	IAL: Austenitic St	ainless Steel, Type	316		
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.	
Studs, bolts, screws Nuts	ASTM A 320 ASTM A 194	B8M 8M	1 or 2		
		·	·	Page 1 of 1	
1. SCOPE	DPE The MDS specifies the selected options in the referred standards and additional requirements which shall be added or supersede the corresponding requirements in the referred standards. NOTE: The class and size of fastener and the service design conditions for use of fasteners in type 316 shall be defined by the designer.				
2. CERTIFICATION	The material manufacturer shall have a quality system certified in accordance with ISO 9001 and the system shall have undergone a specific assessment for the relevant materials.				
	- The material certifi	cates shall be in accordar	nce with EN 10204 Type 3.	1.	

_

MDS T01 **MATERIAL DATA SHEET** Rev. 5 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 _

1 10100	/ 10 Hill B 200	-		
Bars	ASTM B 348	2	-	-
Tubes	ASTM B 338	2	-	-
				Page 1 of 1
1. SCOPE			referred standard and addit onding requirements in the	
2. CHEMICAL COMPOSITION	Alternatively: Chemical co	mposition according t	o GOST VT 1-0 is accepta	ble.
3. HEAT TREATMENT	Wrought fittings to B 363,	Forgings to B 381, Pl	ates to B 265 and Bars to E	3 348:
	- Annealed condition if as formed condition.	not the tensile proper	ties in the referred standard	d can be achieved in
4. EXTENT OF TESTING		Tensile test shall be c ype and size.	arried out for each heat, he	eat treatment load,
	á	all products of the sar	n shall be taken from each le ne heat and heat treatment t block thickness of 10 mm	load with a maximum
5. TEST SAMPLING		Samples for production n the actual components of the sectual components of the sectual components of the sectual sect	on testing shall realistically i ent.	eflect the properties
6. WELDING	<i>Welded pipes to B 862:</i> ISO 15614-5.	Nelding procedures s	hall be qualified in accorda	nce with ASME IX or
7. REPAIR	Repair welding of forgings	is not permitted.		
8. CERTIFICATION			system certified in accordant c assessment for the releva	
	The material certificate shall be issued in accordance with EN 10204 Type 3.1 and shall include the following information:			
	- Manufacturer of the st	arting material		

Г

MATERIAL	DATA SHE	ET	MDS T02	Rev. 5			
TYPE OF MATER	PIAL: Titanium Gra	de 2					
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.			
Castings	ASTM B 367	C2	-	S2			
				Page 1 of 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.					
2. QUALIFICATION	Manufacturers of proc M-650.	luct to this MDS shall	be qualified in accordance with	NORSOK Standard			
3. MANUFACTURING PROCESS	The manufacturing of 650 qualified manufaction		o this MDS shall be carried out a	ccording to the M-			
4. HOT ISOSTATIC PRESSING	-	e to size limitations ca	Pressing (HIP). Annot be HIP, shall be heat treat repairs carried out after HIP.	ed and radiographed.			
5. α-CASE	 For castings manufactured to this MDS α-case in the casting surface shall be completely removed at the foundry from following locations: All surfaces, which shall be machined. All weld bevels including an area of 20 mm on each side of the bevel. All highly stressed areas including areas prone to fatigue. Otherwise the acceptance of α -case shall be agreed between the foundry and the customer at order placement. Procedure for removal of α-case shall be established. NOTE: Alpha-case (TiO) is a very hard and brittle surface layer, which is formed as a result of reaction between the molten titanium and some type of mould binders, e.g. periclase. The thickness of the alpha-case is dependent on the cooling rate during solidification. The heavier the casting wall, the thicker the alpha-case layer. The alpha case makes machining difficult, may cause cracking during welding and shallow micro cracks may appear during liquid penetrant examination. 						
6. EXTENT OF TESTING	Tensile testing is requ	ired for each heat and	d HIP batch or heat treatment loa	ad.			
7. TEST SAMPLING	 Samples for mechanical testing shall realistically reflect the properties in the actual components for production testing shall be cut from the gating system of the casting. For car with weight 150 kg and above the test blocks shall be integrally cast with the casting. Size of the test block shall be 140 mm in length and 80 mm in height with thickness (T): T = 22 mm for t ≤ 30 mm. T = 50 mm for 30 < t ≤ 60 mm T = 75 mm for t > 60 mm <i>NOTE: t</i> = section (shell) thickness of castings. For flanged components the largest flange thickness. Test samples shall accompany the castings through HIP and any heat treatment, chemic cleaning process or any other operation that may alter metallurgical or mechanical properties. 						

MATERIAL	DATA SH	IEET		MDS T02	Rev. 5		
TYPE OF MATE	RIAL: Titanium	Grade 2	2				
PRODUCT	STANDAR)	GRADE	ACCEPT. CLASS	SUPPL. REQ.		
Castings	ASTM B 367		C2	-	S2		
					Page 2 of 2		
8. NON DESTRUCTIVE TESTING	 Liquid penetrant te - All accessible Liquid Penetr ASME VIII, D Radiographic testa Method of radi Appendix 7. Extent of radi Extent of R Pressure C Extent of RT Valve casting valves and ot examined at a castings. Whe pattern includ examined. If of and if any of te shall be at ab castings and of shall be estable 	 Extent of radiographic examination (RT) for valve castings shall be according to table below. Extent of RT based on pressure class and nominal size: Pressure Class: ≤ 150 300 Extent of 10 % ≥ 10" ≥ 10" RT 100 % Not applicable Not applicable Valve castings shall be examined in the areas as defined by ASME B16.34 for special class valves and other critical areas as defined by valve designer. In addition castings shall be examined at abrupt changes in sections and at the junctions of risers, gates or feeders to the castings. When random examination (10 %) is specified, minimum one casting of each pattern including feeder and riser system in any purchase order with the foundry shall be examined. If defect outside acceptance criteria is detected, two more castings shall be tested and if any of these two fails all items represented shall be tested. Other type of castings: Each casting shall be examined unless agreed otherwise. Testing shall be at abrupt changes in sections and at the junctions of risers, gates or feeders to the castings and other critical areas as defined by designer. Sketches of the areas to be tested 					
9. MARKING 10. CERTIFICATION	The material man	ufacturer sl	nall have a quality s		e with ISO 9001 and		
	 I The material manufacturer shall have a quality system certified in accordance with ISO 9001 is the system shall have undergone a specific assessment for the relevant materials. The material certificate shall be issued in accordance with EN 10204 Type 3.1 and shall inclust the following information: NORSOK M-650 Manufacturing Summary identification or QTR No. used; Name of HIP manufacturer. HIP parameters (e.g. temperature, time at temperature and pressure). If HIP is replaced by radiography. If heat treated, ref. Section 4, the heat treatment conditions shall be stated. 						

MATERIAL	DATA SHEET	г	MDS X01	Rev. 3			
TYPE OF MATER	IAL: Low alloyed ste	el Type AISI [°] 4130)				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.			
Seamless pipes	ASTM A 519	AISI 4130		S2			
Wrought fittings	ASTM A 234	AISI 4130		- Page 1 of 1			
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 tempering temperature shares and pipes		quenched and tempered c	ondition. The			
3. MANUFACTURING PROCESS	Only seamless fittings are	e acceptable.					
4. CHEMICAL COMPOSITION	The steel shall be product melting (VIM). The steel s S \leq 0,015 %; P \leq 0,025 %	hall be fully killed.	ic oxygen, electric-furnace,	, or vacuum-inductior			
5. TENSILE TESTING							
6. IMPACT TESTING	Charpy V-notch impact te t ≥ 6 mm. Full sized Char specimen shall be taken i shall be perpendicular to	py V-notch specimens and the transverse to the transverse to the the surface. The test te ize specimens shall be	ut according to ASTM A 37 shall be used wherever pos major material flow directic mperature shall be - 30 °C. 42 J average and 30 J sing - 5/6 and 5 mm - 2/3.	ssible. The test on, and the notch . The minimum			
7. HARDNESS TESTING			50 Hv10, 237 HB or 22 HR	C.			
8. EXTENT OF TESTING	of the same type, nomina	I size and wall thicknes	d out for each lot. A lot is d s, produced from the same ous furnace the maximum l	heat and heat			
9. TEST SAMPLING	treatment load. For pipes heat treated in continuous furnace the maximum lot size shall be Samples for production testing shall realistically reflect the properties in the actual component. Pipes: Supplementary requirement S2 shall apply. Wrought fittings: Sketches shall be established showing location for extractions of test						
10. NON DESTRUCTIVE TESTING	Specimens. The sketch shall be given a document identification number. Pipes: All pipes shall be 100 % ultrasonically tested with a notch calibration on N5 in accordance with ISO 3183. Acceptance criteria for surface examination by ultrasonic method shall be: - Defects, with depths exceeding 5 % of the nominal wall thickness or 1,5 mm, whichever is the lesser, are not acceptable. - Cracks or linear defects are not acceptable regardless of dimensions.						
11. REPAIR OF DEFECTS	· · · · ·	<i>Fittings:</i> 100 % magnetic particle testing in accordance with ASME VIII, Div. 1, Appendix 6. Weld repair is not acceptable.					
12. MARKING	The component shall be r	narked to ensure full tra	aceability to melt and heat	treatment lot.			

MATERIAL DATA SHEET			MDS X01	Rev. 3			
TYPE OF MATERI	TYPE OF MATERIAL: Low alloyed steel Type AISI [°] 4130						
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.			
Seamless pipes	ASTM A 519	AISI 4130		S2			
Wrought fittings	ASTM A 234	AISI 4130		- Page 2 of 2			
13. CERTIFICATION			ystem certified in accordance assessment for the relevance assessment for the relevance assessment for the relevance as the r				
	The material certificate sh the following information:	nall be issued in accord	ance with EN 10204 Type 3	3.1, and shall include			
	- Steel manufacturer of	f starting material;					
	- Heat treatment condition (For QT condition, austenitisation and tempering temperature and quenching medium shall be stated.)						
	- Copy of test sampling	g sketch.					

MATERIAL	DATA SHEET		MDS X02	Rev. 4		
TYPE OF MATER	IAL: High Strength Lo	w Alloyed Steel	Type AISI 4140			
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.		
Forgings	ASTM A 788	AISI 4140	-	S18		
				Page 1 of 2		
1. SCOPE	This MDS specifies the sele which shall be added or sup NOTE: Not suitable for sour se	persede the correspo				
2. MANUFACTURING	The forgings shall be finished	ed hot-worked.				
3. HEAT TREATMENT	The forgings shall be auste	nitised, liquid quench	ned and tempered.			
	Components shall be place component during the heat		o ensure free circulation aro cluding quenching.	und each		
4. CHEMICAL COMPOSITION	According to ASTM A 29, A	ISI 4140				
5. EXTENT OF TESTING	One set of tensile and impa and heat treatment load.	act test shall be carrie	ed out for each melt, section	thickness +/- 25 %		
6. TEST SAMPLING		Samples for production testing shall realistically reflect the properties in the actual components. For products forged by the closed die method, the test specimen shall be obtained from a sacrificial product.				
	$\frac{T_B}{=}$	rol ob int the	r products forged by the op- ling method, the test specin tained from a sacrificial forg egral prolongation. For flang e prolongation shall minimur b thickness (T _H) as shown i	nen shall be ing or from an ges the thickness of n be equal to the		
	Pos. 2		egrated test blocks shall be mponents manufactured by			
	FLANGE BODY Pos. 1	min. 50mm mi mi	<u>est location flanges:</u> The bas d-thickness of hub (T _H) in a nimum 50 mm from weld er sition 1.	distance T _B /2 or		
	FLANGE	YTT/// 1 1 ^H no	est specimens cannot be ex sition 1 test specimens shal nge body position 2.			
	Fig. 1 - Location of test specimens for flanges K When prolongations are used test specimens shall be taken in a distance $T_B/2$ or minimum 50 mm from the second heat treated surface.					
	<u>Test location other forgings and HIP products</u> : For forgings having maximum section thickness, $T \le 50$ mm, the test specimen shall be taken at mid thickness and its mid length shall be at least 50 mm from any second surface or at equal distance from the second surfaces.					
	For forgings having maximum section thickness, $T > 50$ mm, the test specimens shall be taken at least $\frac{1}{4}$ T from the nearest surface and mid-length of test specimens at least T or 100 mm, whichever is less, from any second surface.					
	For all forgings sketches sh location for extraction of tes number.		owing type, and size of test etch shall be given a docum			
	NOTE: For closed die forged c may be used. Such alternative sacrificial forgings and the prop	test sampling shall be				
7. TENSILE TESTING	Minimum yield strength:	$R_{eh} \ge 515 \text{ MPa}$				
	Minimum tensile strength:	$R_M \geq 690 \ MPa$				
	Minimum elongation:	$A \ge 15$ %				

MATERIAL	DATA SHEET	MDS X02	Rev. 4		
TYPE OF MATERI	AL: High Strength Lov	w Alloyed Steel	Type AISI 4140		
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.	
Forgings	ASTM A 788	AISI 4140	-	S18	
				Page 2 of 2	
8. IMPACT TESTING	Charpy V-notch testing is rependicular to the surface 42 J average and 30 J single	e. The minimum abso le.	rbed energy for full size spo	ecimens shall be	
	For flanges test specimens position 1.	shall be taken in axia	I direction to the bore of the	e flange, see fig. 1,	
9. HARDNESS TESTING	Except when only one forgin per batch or continuous run 35 HRC.				
10. NON DESTRUCTIVE TESTING	Supplementary Requirementary R			all forgings.	
11. REPAIR OF DEFECTS	Weld repair is not acceptab	le.			
12. MARKING	The component shall be ma	arked to ensure full tra	aceability to melt and heat t	reatment lot.	
13. CERTIFICATION	The material manufacturer shall have a quality system certified in accordance with ISO 9001 and the system shall have undergone a specific assessment for the relevant materials. The material certificate shall be issued in accordance with EN 10204 Type 3.1, and shall				
	include the following information:				
	- Steel manufacturer of sta	•			
	quenching medium shall	be stated.)	ustenitisation and tempering	g temperature and	
	- Copy of test sampling ske	etch			

TYPE OF MATERI PRODUCT Castings 1. SCOPE 2. IMPACT TESTING	which shall be added or a Charpy V-notch testing is	Grade 2 Grade 2 selected options in the supersede the corresp	ACCEPT. CLASS Class B and C referred standard and addi	SUPPL. REQ. S20 Page 1 of 2
Castings 1. SCOPE	ASTM A 487 This MDS specifies the s which shall be added or s Charpy V-notch testing is	Grade 2 selected options in the supersede the corresp	Class B and C referred standard and addi	S20
1. SCOPE	This MDS specifies the s which shall be added or Charpy V-notch testing is	elected options in the supersede the corresp	referred standard and addi	
	which shall be added or a Charpy V-notch testing is	supersede the corresp		Page 1 of 2
	which shall be added or a Charpy V-notch testing is	supersede the corresp		
2. IMPACT TESTING		s required according to	bolialing requirements in the	
	specimens) and 30 J sing	ace. The minimum abs	o ASTM A 370 at - 30 °C. T sorbed energy shall be 42ໍງ	
3. HARDNESS TESTING			ninimum of two castings sha tings are within the hardnes	
4. EXTENT OF TESTING	One set of tensile and im shall not exceed 5000 kg		or each melt and heat treat	ment load. A test lot
5. TEST SAMPLING	For castings with weight castings and shall not be Thickness of the test bloc flanged components the Dimensions of test block figures 1 and 2 for integr within the cross hatched During any PWHT the te	250 kg or more the tea e removed from the cas ck shall be equal to the largest flange thicknes s and location of test s al and gated test block area and in a distance st block shall be tack w	specimens within the test bl ks respectively. The test sp e of T/4 from the ends. welded onto the casting. T or min. 50mm	ast or gated onto the lality heat treatment. g represented. For ocks are shown in ecimens shall be taken

MATERIAL	DATA SHEET					Μ	DS X	03	Rev.	. 4
TYPE OF MATERI	AL	: High Sti	rength L	ow Alloy S	Steel					
PRODUCT	S	TANDAR	D	GRAI	DE	AC	CEPT.	CLASS	SUPP	L. REQ.
Castings	AS	5TM A 487		Grade	2	Clas	ss B and (C	S20	
									Page 2 o	f 2
6. NON DESTRUCTIVE TESTING	Ma -	NDT operators shall be qualified in accordance with ISO 9712 or equivalent. Magnetic particle testing: - - All accessible surfaces (including internal surfaces) of all castings shall be examined with Magnetic Particle (MT). Surface examination of steel castings shall be in accordance with ASME VIII, Div. 1, Appendix 7. The testing shall be carried out after final machining. Non machined surfaces shall be pickled prior to the testing. <i>Radiographic testing (RT):</i> - - Method of radiography and acceptance criteria shall be in accordance with ASME VIII, Div. 1, Appendix 7. - Extent of radiographic examination (RT) for valve castings shall be according to table. Extent of radiographic examination (RT) for valve castings shall be according to table. Extent of RT based on pressure class and valve size: Pressure Class: ≤ 150 300 600 900 1500 ≥ 2500 Extent of 10 % ≥ 10" ≥ 10" ≥ 2" ≥ 2" ≥ 2" - Valve castings shall be examined in the areas as defined by ASME B16.34 for special clavalves and other critical areas as defined by designer. In addition castings shall be examined at abrupt changes in sections and at the junctions of risers, gates or feeders to the castings. When random examination (10 %) is specified, minimum one casting of eac pattern including feeder and riser system in any purchase order with the foundry shall be examined. If defect outside acceptance criteria is detected, two more					dance with ning. Non- ME VIII, ≥ 2500 $\ge 2^{"}$ $\ge 6^{"}$ special class be feeders to ing of each y shall be			
7. REPAIR OF DEFECTS 8. MARKING 9. CERTIFICATION	All inc - The The	 shall be at abrupt changes in sections and at the junctions of risers, gates or feeders to the castings and other critical areas as defined by designer. Sketches of the areas to be tested shall be established and agreed. All major repairs shall be documented according to ASTM A 703 SR S20. 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; The component shall be marked to ensure full traceability to melt and heat treatment lot. 								
	The	e material co following in Heat treati	ertificate sh formation: ment condi	e undergone iall be issued tion (For QT nall be stated	d in accor condition	dance	e with EN 1	0204 Туре	e 3.1, and	shall include

MATERIAL	DATA SHEE	T	MDS X04	Rev. 3		
TYPE OF MATER	IAL: High Strength	Low Alloyed Stee	I Type AISI 4130			
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.		
Forgings	API 6A	60K (AISI 4130)	PSL 3	- Page 1 of 2		
1. SCOPE			referred standard and addition on ding requirements in the r			
2. MANUFACTURING	The flanges shall be for accepted.	ged to shape. Flanges	machined out of bar and or p	late are not		
3. HEAT TREATMENT	The flanges shall be au Components shall be pl during the heat treatme	laced in such a way as	to ensure free circulation aro	und each componen		
4. CHEMICAL COMPOSITION			uirements of AISI 4130, but I 6A. The chemical composit			
5. EXTENT OF TESTING			ied out for each melt, section est lot shall not exceed 2000			
6. TEST SAMPLING		-	y reflect the properties in the the test specimen shall be of	-		
		rc o ir ,/2 tł	or products forged by the op olling method, the test specin btained from a sacrificial forg tegral prolongation. For flang te prolongation shall minimu ub thickness (T_H) as shown i	nen shall be jing or from an ges the thickness of m be equal to the		
	-Pos. 2		ntegrated test blocks shall be omponents manufactured by			
	FLANGE BODY Pos. 1 T _B /2 or min. 50mm 1 T _B /2 or min. 50mm 1 T _B /2 or mid-thickness of hut minimum 50 mm from position 1. If test specimens ca position 1 test speci			distance T _B /2 or id, see fig. 1,		
	Fig. 1 - Location of test specin 50 mm from the second	nens for flanges S	ange body position 2. /hen prolongations are used hall be taken in a distance T _E			
	<u>Test location other forgings and HIP products:</u> For forgings having maximum section thickness, $T \le 50$ mm, the test specimen shall be taken at mid thickness and its mid length shall be at least 50° mm from any second surface or at equal distance from the second surfaces.					
	For forgings having maximum section thickness, $T > 50$ mm, the test specimens shall be taken at least ¹ / ₄ T from the nearest surface and mid-length of test specimens at least T or 100 mm, whichever is less, from any second surface.					
	location for extraction or number.	f test specimens. The s	howing type, and size of test ketch shall be given a docum es exceeding 80 kg it is recognize	nent identification		
7. IMPACT TESTING	Charpy V-notch testing specimens shall be 42	at - 46 °C is required. T J average and 30 J sing	he minimum absorbed energile.	gy for full size		
	For flanges test specim position 1.	ens shall be taken in ax	ial direction to the bore of the	e flange, see fig. 1,		
8. HARDNESS TESTING			inimum of two forgings shall ings are within the hardness			

MATERIAL	DATA SHE	ET	MDS X04	Rev. 3		
TYPE OF MATER	RIAL: High Strength	Low Alloyed Stee	el Type AISI 4130			
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.		
Forgings	API 6A	60K (AISI 4130)	PSL 3	-		
				Page 2 of 2		
9. 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.				
10. NON DESTRUCTIVE TESTING	 NDT shall be carried out after final heat treatment: 100 % MT according to ASME VIII, Div.1, Appendix 6, shall be carried out. 100 % UT according to ASTM A 388, shall be carried out. The acceptance criteria shall be according to the recording level of ASTM A 388. 					
11. REPAIR OF DEFECTS	Weld repair is not acc	Weld repair is not acceptable.				
12. MARKING	The component shall	be marked to ensure full	traceability to melt and heat	treatment lot.		
13. CERTIFICATION	The material manufacturer shall have a quality system certified in accordance with ISO 9001 and the system shall have undergone a specific assessment for the relevant materials.					
	The material certificate shall be issued in accordance with EN 10204 Type 3.1, and shall include the following information:					
	- Steel manufactu	irer of starting material;				
	- Heat treatment condition (For QT condition, austenitisation and tempering temperature and quenching medium shall be stated.)					
	- Copy of test sar	npling sketch				

MATERIAL	DATA SHEE	Г	MDS X05	Rev. 3		
TYPE OF MATER	IAL: High Strength L	ow Alloyed St	eel Type F22			
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.		
Forgings	ASTM A 182	F22	3	S4		
		•		Page 1 of 2		
1. SCOPE			he referred standard and add sponding requirements in the			
2. HEAT TREATMENT	Normalized and tempered	d.				
	Components shall be plac during the heat treatment		as to ensure free circulation a quenching.	round each componen		
3. EXTENT OF TESTING	One set of tensile and im test lot shall not exceed 2		arried out for each heat and h	eat treatment load. A		
4. TEST SAMPLING		-	ally reflect the properties in th d, the test specimen shall be	obtained from a		
	TB = = = min.T _B /2	2	For products forged by the c rolling method, the test spec obtained from a sacrificial for integral prolongation. For fla the prolongation shall minim hub thickness (T _H) as shown	imen shall be rging or from an inges the thickness of um be equal to the		
	Pos. 2		Integrated test blocks shall be used for components manufactured by HIP.			
	FLANGE BODY Pos. 1	T _B /2 or min. 50mm	position 1 test specimens shall be extracted from			
	Fig. 1 - Location of test specimer		flange body position 2. When prolongations are used test specimens			
	50 mm from the second h		shall be taken in a distance	I _B /2 or minimum		
	<u>Test location other forgings and HIP products:</u> For forgings having maximum section thickness, $T \le 50$ mm, the test specimen shall be taken at mid thickness and its mid length shall be at least 50 mm from any second surface or at equal distance from the second surfaces.					
	For forgings having maximum section thickness, $T > 50$ mm, the test specimens shall be taken at least $\frac{1}{4}$ T from the nearest surface and mid-length of test specimens at least T or 100 mm, whichever is less, from any second surface.					
	For all forgings sketches shall be established showing type, and size of test samples and location for extraction of test specimens. The sketch shall be given a document identification number.					
	NOTE: For closed die forged components and flanges exceeding 80 kg it is recognized that may be used. Such alternative test sampling shall be qualified and shall comprise comparat sacrificial forgings and the proposed alternative test sample.					
5. IMPACT TESTING	specimens shall be 27 J a shall be: 7,5 mm - 5/6 and	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 sub-size specimens shall be: 7,5 mm - 5/6 and 5 mm - 2/3.				
	For flanges test specimer position 1.	ns shall be taken in	axial direction to the bore of	the flange, see fig. 1,		
6. DIMENSIONAL TOLERANCES	Flanges to MSS SP-44 sh hub at the welding end.	hall have a maximu	m wall thickness under tolera	nce of 0,3 mm for the		
7. NON DESTRUCTIVE	Supplementary Requirem	nent, S4, Magnetic	Particle testing, shall apply to	all forgings.		
TESTING	The acceptance criteria s	hall be to ASME VI	II, Div. 1, Appendix 6.			

MATERIAL I	DATA SHEET	MDS X05	Rev. 3			
TYPE OF MATERI	AL: High Strength L	ow Alloyed Stee	I Type F22			
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.		
Forgings	ASTM A 182	F22	3	S4		
		Page 2 of 2				
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	The material manufacturer shall have a quality system certified in accordance with ISO 9001 and the system shall have undergone a specific assessment for the relevant materials.					
	The material certificate shall be issued in accordance with EN 10204 Type 3.1, and shall include the following information:					
	- Steel manufacturer of starting material;					
	- Heat treatment condition (For QT condition, austenitisation and tempering temperature and quenching medium shall be stated.)					
	- Copy of test sampling	sketch				

MATERIAL	DATA SHEE	T	MDS X06	Rev. 3	
TYPE OF MATER	RIAL: High Strength	Low Alloy Steel fo	r application down to	₀ -46 [°] °C	
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.	
Castings	ASTM A 487	Grade 2	Class B and C		
				Page 1 of 2	
1. SCOPE			eferred standard and addition of the requirements in the r		
2. CHEMICAL COMPOSITION	$C \le 0,14$ %; $Si \le 0,50$ %	%; Mn ≤ 1,60 %; Cr ≤ 0,20	0 %; Ni = 0,90-1,10 % ; Mo	= 0,15-0,25 [%]	
3. IMPACT TESTING			ASTM A 370 at - 46 °C. The orbed energy shall be 42 J a		
4. HARDNESS TESTING			nimum of two castings shall ngs are within the hardness		
5. 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.			
6. TEST SAMPLING					
	Fig.1 - Integral test block	Fig. 2 -	Gated test block		

MATERIAL	DA	TA S	HEE.		N		6	Rev	v. 3
TYPE OF MATERI	AL:	High Str	rength L	ow Alloy S	teel for a	application	down to	₀-46 [°] °C	
PRODUCT	S7	ANDAR	D	GRADE		ACCEPT.	CLASS	SUPP	L. REQ.
Castings	AS	TM A 487		Grade 2		Class B and	С		
								Page	2 of 2
7. NON DESTRUCTIVE TESTING	Mag -	NDT operators shall be qualified in accordance with EN ⁶ 473 or equivalent. Magnetic particle testing: All accessible surfaces (including internal surfaces) of all castings shall be examined with Magnetic Particle (MT). Surface examination of steel castings shall be in accordance with ASME VIII, Div. 1, Appendix 7. The testing shall be carried out after final machining. Non-machined surfaces shall be pickled prior to the testing. Radiographic testing (RT): Method of radiography and acceptance criteria shall be in accordance with ASME VIII, Div. 1, Appendix 7. Extent of radiographic examination (RT) for valve castings shall be according to table. Independent of the extent specified in table below one pilot cast of each pattern shall be 100 % volumetrically RT. Extent of RT based on pressure class and valve size: Pressure Class: ≤ 150 300 600 900 1500 ≥ 2500 Extent of RT based on pressure class and valve size: Pressure Class: ≤ 150 300 600 900 1500 ≥ 2500 Extent of RT based on pressure class and valve size: 2" ≥ 2" 2" ≥ 6" 2" Valve castings shall be examined in the areas as defined by ASME B16.34 and critical areas as defined by designer for special class valves. When random examination (10 %) is specified, minimum one casting of each pattern including feeder and riser system in any purchase order with the foundry shall be examined. If defect outs				ance with ing. Non- \equiv VIII, table. shall be ≥ 2500 $\ge 2^{\circ}$ $\ge 6^{\circ}$ critical n (10 %) is n in any criteria is so Testing ders to the			
8. REPAIR OF DEFECTS 9. MARKING 10. CERTIFICATION	All v incl - - The and	 All major repairs shall be documented according to ASTM A 703 SR S20. 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 both weld metal and fusion line. The component shall be marked to ensure full traceability to melt and heat treatment lot. The material manufacturer shall have a quality system certified in accordance with ISO 9001 and the system shall have undergone a specific assessment for the relevant materials. 							
	the	following in Heat treatn	formation: nent condi	hall be issued i tion (For QT co hall be stated.)	ondition, au				

MATERIAL	DATA SHEET	Г	MDS X07	Rev. 2
TYPE OF MATER	PIAL: Low alloyed stee	el		
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Studs and bolts	ASTM A 320	L7, L7M		
Nuts	ASTM A 194	4, 7 or 7M		S3, S4, S5
				Page 1 of 1
1. SCOPE		upersede the correspor	eferred standard and addition nding requirements in the r 1.	
2. IMPACT TESTING	Nuts to A 194: Supplement	ntary requirement S3 lo	w temperature requiremen	ts shall apply.
3. PROOF LOAD TESTING	Nuts to A 194: Supplementary requirement S4 Proof load testing shall apply.			
4. DIMENSIONS	Studs: The stud length shall be according to ASME B16.5 or NORSOK L-005. Prior to hot dip galvanizing threading shall be in accordance with ASME B1.1, class 2A fit for diameters 1 inch and smaller (UNC series) and 8 pitch thread series for 1 1/8 inch and larger. Nuts: Nut threads shall be oversized to fit studs/bolts dependent of specified coating. Nuts shall be ASME heavy HEX-series, double chamfered. Dimensions shall conform to ASME B18.2.2.			
5. SURFACE PROTECTION	All studs, bolts, nuts and washers shall be hot dipped galvanized according to ASTM A 153 or ISO 10684. The zinc coating on threads shall not be subjected to cutting, rolling or finishing tool operation. Nuts may be tapped after galvanizing.			
6. CERTIFICATION	Nuts may be tapped after galvanizing. The material manufacturer shall have a quality system certified in accordance with ISO 9001 and the system shall have undergone a specific assessment for the relevant materials. Supplementary requirement S5 shall apply for nuts to A 194. The material certificate shall be issued in accordance with EN 10204 Type 3.1, and shall include: - Steel manufacturer of starting material; - Heat treatment condition.			

MATERIAL	DATA SHEET	MDS X08	Rev. 2		
TYPE OF MATERIAL: Low alloyed steel					
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.	
Studs and bolts	ASTM A 193	B7, B7M			
Nuts	ASTM A 194	2H, 2HM			
				Page 1 of 1	
1. SCOPE		upersede the correspor	ferred standard and addition nding requirements in the r		
2. DIMENSIONS	Studs Stud bolt length shall be according to ASME B16.5 or NORSOK L-005. Prior to hot dip galvanizing threading shall be in accordance with ASME B1.1, class 2A fit for diameters 1 inch and smaller (UNC series) and 8 pitch thread series for 1 1/8 inch and larger. Nuts Nut threads shall be oversized to fit studs/bolts dependent of specified coating. Nuts shall be ASME heavy HEX-series, double chamfered. Dimensions shall conform to ASME B18.2.2.				
3. SURFACE PROTECTION	All studs, bolts, nuts and washers shall be hot dipped galvanized according to ASTM A 153 or ISO 10684. The zinc coating on threads shall not be subjected to cutting, rolling or finishing tool operation. Nuts may be tapped after galvanizing.				
4. CERTIFICATION	The material manufacturer shall have a quality system certified in accordance with ISO 9001 and the system shall have undergone a specific assessment for the relevant materials. The material certificate shall be issued in accordance with EN 10204 Type 2.2 as minimum, and shall include: - Steel manufacturer of starting material; - Heat treatment condition.				

Annex B (normative) Element data sheets (EDSs)

EDS NBE1

Rev. 5 Page 1 of 4

Title: Cold bending

1. SCOPE

This document specifies requirements that shall apply when pipes and tubes are cold bent for use within a pressure containing piping system.

NOTE Instrument and hydraulic tubing is not within scope of this document.

2. GENERAL

All base material shall comply with the specified Material Data Sheet of NORSOK M-630.

All bending shall be performed in accordance with a written and qualified procedure.

The equipment and processes shall be qualified and maintained to ensure that the material properties fulfil the requirements for piping fabrication.

3. COLD BENDING

3.1 Limitations and special requirements

The structural strength shall be in compliance with ASME B31.3 paragraph 304.7.2. Flexibility and stress intensification factor shall be documented with maximum allowed thinning of the outside wall for the actual bending radius.

The limitations and/or additional testing for the different material types related to cold bending are given in table 1.

When solution anneal heat treatment is required, the heat treatment manufacturer shall be qualified according to NORSOK M-650.

3.2 Bending of welded pipe

The longitudinal weld of welded pipes should be located in a sector ± 40 ° from the neutral plan.

3,3 Welding

No welding shall be performed in the plastically deformed zone nor closer than 2 times WT, minimum 30 mm, to this zone.

3.4 Bending procedure

All cold forming shall be performed in accordance with a written procedure detailing:

- Material
- Diameter
- Wall thickness
- Type of forming equipment
- Relevant forming parameters
- Post forming heat treatment if applicable
- Visual inspection and NDT of bends and flares, including acceptance criteria
- Dimensional control, including acceptance criteria

Title: Cold bending

ELEMENT DATA SHEET

EDS NBE1

Page 2 of 4

Rev. 5

Table 1 — Limitations and special requirements for cold bent pipes					
Material	Service	Limitations and/or additional requirements			
CMn-steel for LT service	Utility service and non-sour hydro-carbon service	The maximum hardness requirements shall be 35 Hv10 or 35 HRC.			
MDS C01, C11, C22		When the hardness exceeds this limit a post bend heat treatment according to ASME B31.3 shall be applied.			
	H ₂ S containing service defined sour in accordance with ISO 15156-2.	Not acceptable to use without post bend heat treatment.			
Type 316, MDS S01	Utility service and non-sour hydro-carbon service	The maximum hardness shall be 328 HB or 35 HRC.			
	H ₂ S containing service within the limitations of ISO 15156-3.	The maximum hardness requirements shall be 22 HRC and SSC testing to ISO 15156 is required.			
Type 22Cr and 25Cr duplex,	Utility service and non-sour hydro-carbon service	The maximum hardness shall be 328 HB or 35 HRC.			
MDS D41, D42, D48, D51, D52 and D58	H ₂ S-containing service within the limitations of ISO 15156-3.	The maximum hardness shall be 328 HB or 35 HRC and SSC testing to ISO 15156 is required.			
SS Type 6Mo MDS R11, R12	Utility service and non-sour hydro-carbon service	The maximum hardness shall be 328 HB or 35 HRC.			
and R18	H ₂ S containing service within the limitations of ISO 15156-3.	The maximum hardness shall be 328 HB or 35 HRC and SSC testing to ISO 15156 is required.			
Titanium Grade 2	Utility service				
MDS T01	H ₂ S containing service within the limitations of ISO [°] 15156-3.	Not accepted.			

Table 1 — Limitations and special requirements for cold bent pipes

3.5 Qualification of bending procedure

The qualification bend shall be 90°. Specimens for destructive testing shall be sampled from the extrados area. For bends made from welded pipes both the weld and base material shall be tested.

The material properties of the qualification bend shall be verified by testing after bending. All tests specified in the applicable MDS for the pipe and table 1 shall be performed, except cross weld tensile testing. Carbon steel intended used for service containing H_2S shall be in heat treated condition and without any post cold forming. Stainless steel may be used in solution annealed and post cold formed condition provided hardness are within the requirement of ISO 15156 and SSC tested to ISO 15156.

Acceptance criteria shall be according to the applicable MDS with the following exceptions:

- Minimum elongation shall be <u>></u> 14 %.
- Impact toughness shall comply with NORSOK M-601.
- The hardness of any cold-formed steel shall not exceed the limits specified in Table 1, 328 HB/35[°]HRC.
- For items exposed to H₂S-containing service, SSC testing shall comply with ISO 15156.

If any of these requirements are not met, heat treatment is required with temperatures and duration as given in ASME B31.3.

EDS NBE1

Page 3 of 4

Rev. 5

Title: Cold bending

The qualification bend shall be subjected to 100 % visual inspection and 100 % MT/PT as applicable. For bends made from welded pipes the weld area shall be subjected to 100 % RT after bending. NDT methods and acceptance criteria shall be as per the pipe MDS.

The dimensional tolerances of the qualification bend shall be controlled (before and after bending) as per section 7 of this document.

The qualification dossier shall contain:

- Record of bending method and parameters
- Record of bending radius and angle
- Test reports
- NDE reports
- Material certificate for pipe material

The bending procedure essential variables and changes requiring requalification are defined in Table 2.

Variable	Essential change
Material	Change of MDS or type of material
Type of pipe	Welded pipe qualifies seamless, but not vice versa
Bend radius	One radius qualifies all larger radii but not vice versa
Diameter (D)	+ 0 % /- 50 %
Wall thickness (t) ≤ 20 mm	+ 10 % / -25 %
Wall thickness (t) > 20 mm	+ 0 % / - 25 %
Heat treatment	Any change in PBHT
Type of equipment	Any change

Table 2 — Essential variables and essential change for bend procedure qualification.

4. NON DESTRUCTIVE TESTING

The extent of NDT for cold formed products shall be 100 % visual inspection and 10 % surface testing by the MT or PT methods for carbon steel and stainless steel grades, respectively.

For MT and PT the acceptance criteria shall be in accordance with ASME VIII, Div. 1, Appendix 6 and 8 respectively.

If defect indications are revealed the NDT extent shall be increased to 100 % until the reasons for the defect indications are concluded and necessary corrections in the forming process are made.

5. **PRODUCTION TESTING**

Production testing shall be performed to demonstrate that the requirements listed under Section 3.5 above are fulfilled. The testing frequency shall be agreed with each Project and/or Company.

EDS NBE1

Rev. 5 Page 4 of 4

Title: Cold bending

6. POST BEND HEAT TREATMENT TESTING

If a stress relieving heat treatment is carried out in accordance with the specified temperatures of ASME B31.3 no additional testing is required except for surface hardness measurements.

If the cold formed bends have to be given a full new heat treatment, e.g. normalising, quench and temper or solution anneal, the material properties shall be documented by testing in accordance with the applicable MDS, ref. table 1. The heat treatment procedure shall be qualified to M-650 when specified by the MDS. The lot definition, extent of testing, test location, acceptance criteria, etc. shall be in accordance with the relevant MDS for wrought fittings.

7. DIMENSIONAL CONTROL

The out-of-roundness, waves at bends, wall thickness and other dimensional requirements of the bend shall be checked before and after bending.

The pipe wall thickness requirements shall comply with ASME B31.3.

The out-of-roundness and waves at bends tolerances shall comply with EN 13480-4.

The angle and straightness tolerances shall comply with NORSOK Standard L-004.

8. TEST REPORT

A test report that documents the specified test shall be established.

EDS NBE2

Title: Hot induction bending

1. SCOPE

This document specifies the technical delivery conditions for bends made by the induction bending process for use within a pressure containing piping system.

2. GENERAL

Bend manufacturer shall have an implemented quality assurance system according to ISO 9001.

Mother pipes shall comply with NORSOK M-630 and the applicable Material Data Sheet (MDS) or as agreed. Mother pipes clad with a CRA internal layer shall comply with an agreed specification.

For manufacture of bends in stainless steel type 22Cr duplex, 25Cr duplex, 6Mo or 565 where solution heat treatment is carried out the heat treatment procedure shall be qualified in accordance with NORSOK Standard M-650.

The induction bending process of pipe shall be performed according to requirements given by ISO 15590-1 and this EDS.

Hot forming by induction heating, bending and quenching down to room temperature by water spray does not require a new quality heat treatment provided the process is successfully qualified and tested as required by this EDS.

If full heat treatment, involving an austenitization and tempering or solution annealing process, is applied after the induction bending operation, the bend shall be destructively tested in compliance with the mother pipe specification. If the mother pipe is delivered in as welded condition the extent of destructive testing of the weld shall include the same tests as specified for the weld procedure qualification by the mother pipe specification.

At no time, prior to or during bending, shall the pipe contact low melting temperature materials such as zinc, copper, brass or aluminium.

3. ESSENTIAL VARIABLES

For all steels and Nickel based alloys the essential variables of the MPS qualification shall be in accordance with ISO 15990-1 except that the modifications specified in Table 1 shall apply, additionally, any change of the clad welding procedure shall be an essential variable.

Essential variable	Maximum permissible variations		
Bend radius, R	For all radii: Qualifies all larger radii, but no less		
Forming velocity	\pm 2,5 mm/min or \pm 10 %, whichever is the greatest		

Table 1 — Essential va	riables
------------------------	---------

4. MPS QUALIFICATION BEND TESTING

Each bend group, as defined by the essential variables referenced above shall be qualified in accordance with ISO 15590-1 and this section before commencement of production bending.

All testing of the qualification bends shall be to Table 2. The tests shall be located as specified in Table 3 and Figure 1.

NOTE: Where the entire length of the mother pipe, including tangents, is subject to the same continuous induction heating, cooling and speed parameters as the bent portion during the induction bending process then, unless specified otherwise by the purchaser, these induction bends are not considered to have transitions for testing purposes.

All testing shall be carried out in accordance with test methods specified for the mother pipe specification and the test acceptance criteria shall be to the same standard.

EDS NBE2

Rev. 2 Page 2 of 4

Title: Hot induction bending

Transverse tensile test and bend test of weld shall be carried out in accordance with ISO 15614-1 or ASME IX and the acceptance criteria shall be accordingly.

Transverse tensile testing is only applicable for pipes with OD 168mm or greater.

For tensile test transverse weld only the tensile strength, R_M , shall be required.

Dimensional control and tolerances shall be in accordance with ISO 15590-1 for all type of materials.

Type of tests	Carbon steel	Duplex SS	Austenitic SS and Nickel alloys	CS Clad ⁹	Test conditions and acceptance criteria
Tensile	Т	Т	Т	Т	According to the
Tensile transverse weld	Т	Т	Т	Т	mother pipe specification
Charpy V-notch (CVN)	Tb	Tb	Ν	Т	NORSOK M-630 and
Through thickness hardness (Including HAZ if applicable)	Т	Ν	Ν	T ^{ce}	applicable MDS.
Microstructure	Ν	Т	Т	T^d	
Corrosion	Ν	Т	Т	Ν	
Bend test	Т	Ν	N	Тa	ISO 15614-1/ASME IX
Surface NDT ^f	T and P	T and P	T and P	T and P ^g	
Bend body (UT) laminations	Ν	N	Ν	Р	
Residual magnetism ends	Р	Ν	Ν	Р	< 2 mT (20 Gauss)

^a Definition of N, O, T and P shall be as follows:

N – Not required.

O – Performance of the test or inspection on a production induction bend may be required by agreement.

P – Required for each production bend.

T – Required for each test bend.

^b For bends with wall thickness greater than 20 mm, additional Charpy V-notch testing shall be performed during MPS qualification testing. In addition to the test pieces sampled 2 mm below the outer surface, the same number of specimens shall be sampled 2 mm below inner surface position in the following locations:

— transition zones base metal (if applicable)

- bend extrados base metal
- bend intrados base metal
- bend weld metal (if applicable)

^C The clad layer and interface to carbon or low-alloyed steel shall be tested in accordance with ASME IX.

- ^d The cladding thickness shall be verified by destructive testing at the extrados location. The cladding thickness shall be minimum 3 mm after bending.
- ^e For clad pipe bends the MPS qualification shall repeat the mechanical testing from the clad WPQR, i.e. side bend and hardness tests, ref. ISO 10423 PSL 3.
- ^f For all bends, independent of material type, the bend body shall be visual and surface inspected according to ISO 15590-1.
- ^g The cladding of carbon or low-alloyed steel shall be 100 % inspected with LP and bond line integrity with UT per API 6A/ISO 10423 PSL 3.

EDS NBE2

Rev. 2 Page 3 of 4

Title: Hot induction bending

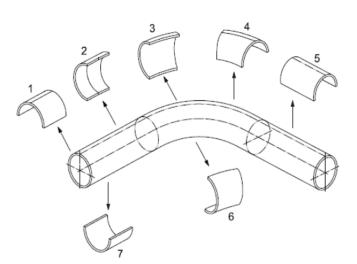
Table 3 – Location of test specimens and type of destructive testing of qualification test bend dependent of type of material, see Table 2

Location, ref. Figure 1	Type of test		
Tangent base metal (7)	Tensile		
Testing after bending is not necessary if test results are available	Charpy V-notch		
for mother pipe and the tangent is not heat-treated during	Microstructure		
induction bending or subsequent heat treatment.	Corrosion test		
	Through-thickness hardness		
Tangent weld (1)	Tensile transverse, ISO 15614-1/ASME IX		
Testing after bending is not necessary if test results are available	Microstructure		
for mother pipe and the tangent is not heat-treated during	Charpy V-notch		
induction bending or subsequent heat treatment.	Corrosion test		
	Through-thickness hardness		
	Guided bend, ISO 15614-1/ASME IX		
Transition zones base metal extrados, start and stop (2)	Tensile		
Testing in stop transition zone is not required provided quenching	Charpy V-notch		
of heated zone is carried out continuously. (No release of pipe	Microstructure		
clamp needed.)	Corrosion test		
	Through-thickness hardness		
Transition zones weld (start and stop) (5)	Microstructure		
Testing in stop transition zone is not required provided quenching	Charpy V-notch		
of heated zone is carried out continuously. (No release of pipe clamp needed.)	Corrosion test		
Bend extrados base metal (3)	Through-thickness hardness		
Bend intrados base metal (6)	Tensile		
	Charpy V-notch		
	Microstructure		
	Corrosion test		
	Through-thickness hardness		
Bend weld (4)	Tensile transverse, ISO 15614-1/ASME IX		
	Microstructure		
	Charpy V-notch		
	Corrosion test		
	Through-thickness hardness		
	Guided bend, ISO 15614-1/ASME IX		

ELEMENT DATA SHEET EDS NBE2 Rev. 2

Title: Hot induction bending

Page 4 of 4



Key:

- 1 Tangent weld
- 2 Transition zone base metal (both stop and start transitions)
- 3 Bend extrados base metal
- 4 Bend weld
- 5 Transition zone weld (both stop and start transitions)
- 6 Bend intrados base metal
- 7 Tangent base metal

Figure 1 – Location for extraction of test samples

5. DELIVERY CONDITION

The surface condition of bends in carbon and low alloyed steel shall be as agreed.

All bends in stainless steel, nickel base alloys and the internal clad layer of clad carbon steel/low alloyed steel shall be delivered in white pickled and passivated condition.

6. BEND DOCUMENTATION

A material certificate shall be issued in accordance with EN 10204 Type 3.1 including all inspection test reports.

The documentation dossier shall include the following test reports:

- Material certificate;
- MPS qualification test report;
- NDT test report;
- Starting pipe material certificate;
- Dimensional test report.

EDS NBO2 Rev. 3

Page 1 of 2

Title: Body/Bonnet bolting for valves

1. SCOPE

This document specifies acceptable bolting materials for body/bonnet bolting for valves in different body/bonnet materials.

2. ACCEPTABLE BOLTING MATERIALS

The table below lists acceptable materials for body/bonnet bolting. Where a MDS is referred to, the requirements on the MDS shall apply. The valve manufacturer shall verify the suitability of material selection with respect to thermal expansion and allowable stress.

Bolting that can be exposed directly to a sour environment, or buried, insulated, equipped with flange protectors or otherwise denied direct atmospheric exposure, shall be in M-grade material.

"Through-bolted" fastener is used in through holes that are not threaded, while "integrated" bolting is used in threaded holes.

Fastener material grade	MDS	Note	Valve body & bonnet material				-			
			cs	LTCS	SS316	22Cr duplex	25Cr duplex	6Mo HC	6Mo SW	Ті
A 320 Gr L7/A 194 Gr 7	X07	1	I/TB	I/TB	I/TB	I/TB	I/TB	I/TB	Ι	
A 320 Gr L7M/A 194 Gr 7M	X07	1	I/TB	I/TB	I/TB	I/TB	I/TB	I/TB	I	
A 320 Gr B8M/A 194 Gr 8M	S03	3			I/TB					
A 320/A 194 UNS S32750/ S32760	D59/ D60					I/TB	I/TB		I/TB	I/TB
A 468/F 467 Gr Ni625	N03				I/TB			I/TB	I/TB	I/TB
A 468/F 467 Gr Ti5		2								I/TB
A 453 Gr 660 Class D	N04	3, 4			I	1	1	1	1	
A 1014 UNS N07718	N05				I/TB	I/TB	I/TB	I/TB	I/TB	I/TB
NOTES			6	6	5, 6	6	6	6	6	6

NOTES

1. All items shall be hot dip galvanized in accordance with ASTM A 153 (or equivalent coatings in accordance with BS 729 or NS 1970).

2. Each bolt and nut shall be marked on the end/head to ensure full traceability to melt and heat treatment lot.

3. Load bearing part of the bolt shall not be exposed to the marine environment.

4. Special considerations with respect to thermal expansion are required when used in ferritic and duplex stainless steels. Stress rupture test is not required.

5. For integral bolting other type 316 bolting material from ASME B31.3 table A-2 is also considered acceptable.

6.	Valve manufacturer to check the bolt material suitability with	espect to thermal expansion and allowable stress.

Legends		Legends	
CS	carbon steel	I	accepted for integrated fasteners
LTCS	low temperature carbon steel	ТВ	accepted for "Trough-bolted" fasteners
6Mo HC	type 6Mo for hydrocarbon service	VDS	valve data sheet
6Mo SW	type 6Mo for seawater service		
Ti	titanium grade 2		

Rev. 3

EDS NBO2

Title: Body/Bonnet bolting for valves

Page 2 of 2

3. GENERAL REQUIREMENTS TO VALVE BOLTING

3.1 Dimensions and shape

- Bolts: Threading shall be in accordance with ASME B1.1, class 2A fit for diameters 1 inch and smaller (UNC series) and 8 pitch thread series for 1 1/8 inch and larger.
- Nuts: Threading shall be in accordance with ASME B1.1, UNC series for diameters 1 inch and smaller with a class 2B fit, and 8 UN series for diameter 1 1/8 inch and larger with a class 2B fit. Nuts shall be ASME heavy HEX. series, double chamfered. Dimensions shall conform to ASME B18.2.2.

3.2 Hardness

Hardness shall be tested and the maximum hardness shall not exceed 35 HRC or 328 HB.

3,3 Surface protection

All low alloyed steel bolts, nuts and washers shall be hot dipped galvanized according to ASTM A 153 or ISO 10684.

The zinc coating on threads shall not be subjected to cutting, rolling or finishing tool operation. Nuts may be tapped after galvanizing.

3.4 Valve design rules for bolting

For valves that are required to comply with ASME B16.34, rules of par. 6.4, shall apply. Otherwise, allowable stress shall be evaluated according to ASME VIII, Div. 1 or 2.

3.5 Certification

The material manufacturer shall have a quality system certified in accordance with ISO 9001 and the system shall have undergone a specific assessment for the relevant materials.

The material certificate shall be issued in accordance with EN 10204 as follows:

- Studs Grade B7, B7M: Type 2.2
- Nuts Grade 2H, 2HM: Type 2.2
- Studs Grade L7, L7M: Type 3.1
- Nuts Grade 4, 7, 7M: Type 3.1
- All stainless steel and non ferrous grades and products: Type 3.1

EDS NHF1

Rev. 5 Page 1 of 2

Title: Hardfacing by overlay welding

1. SCOPE

This document specifies requirements to hardfacing by overlay welding to components for use within pressure containing equipment.

NOTE: Hard facing of small components in type 22Cr and 25Cr duplex should be avoided due to high risk for impairing the material resulting in brittleness and reduced corrosion properties

2. GENERAL

Welding procedures shall be qualified according to ASME IX and according to this EDS (NHF1).

3. WELDING CONSUMABLES

For general and hydrocarbon service the welding consumables shall be of type Alloy 6 (Stellite 6 or equivalent).

For seawater service welding consumables such as Triballoy 800, Ultimet or alloy with equivalent corrosion resistance should be used.

4. MANUFACTURE

The hard facing shall be made by overlay welding using PTAW (plasma transferred arc), GTAW (gas tungsten inert gas) or LBW/EBW (laser/electro beam welding).

5. HEAT TREATMENT

Heat treatment after hardfacing shall be carried out, as necessary, to meet specified properties. Components to be exposed to H₂S containing environment shall be heat treated as required in ISO 15156.

6. WELDING AND WELD QUALIFICATION

6.1 General

The hardfacing shall be carried out according to qualified procedures according to ASME IX modified as follows:

- Size and geometry of test plates shall be representative of the actual components which shall be welded in production. This is especially important for small components, which may suffer from overheating.
- The qualification shall be carried out on base material of same grade as used in production.
- The testing shall be carried out according to ASME IX and the requirements in this EDS.

A string technique is recommended used. If weaving is used, the width shall be within qualified range taking into consideration risk for overheating of the material and cracking.

The temperature of the components shall be checked during welding, e.g. with contact pyrometer at the start and end of each string. For type 22 and 25Cr duplex the component temperature shall not exceed 350 °C or 300 °C for type 22Cr and 25Cr duplex, respectively.

The thickness of final hardfacing shall be minimum 1,6 mm after final machining. The deposit thickness shall be measured.

EDS NHF1

Rev. 5

Title: Hardfacing by overlay welding

Page 2 of 2

6.2 Weld qualification testing

6.2.1 Hardness test

Hardness testing shall be carried out for the qualification test and shall include base material, heat affected zone (HAZ) and weld metal. Vickers hardness HV10 shall be used. The examination of HAZ shall be carried

out with maximum 0.5 mm distance between the indentations from fusion line, through HAZ into the unaffected base material. The hardness for HAZ and unaffected base material shall not exceed the maximum values specified in ISO 15156 (all parts) and for type 22 and 25Cr duplex the hardness shall not exceed 350 Hv10 or 35 HRC.

6.2.2 Metallographic examination

Metallographic examination shall be carried out on the gualification testing for the following materials: type 22Cr duplex, type 25Cr duplex, type 6Mo and Alloy 625. For type 22 and 25Cr duplex the ferrite content in the heat affected zone shall be determined in accordance with ASTM E 562 and shall be in the range of 30 % to 70 %.

6.2.3 Macrosection

The macrosection for the qualification shall show no cracking and complete fusion between base material and hardfacing.

6.2.4 Impact testing

The gualification testing shall include Charpy V-notch impact testing for materials that require impact testing by the applicable ASTM standard or MDS. The test conditions and acceptance criteria shall be as stated in the ASTM standard or MDS (the MDS requirements prevail). One set of impact testing shall be carried out with specimens located in the base material 2 mm below the fusion line between the hardfacing and base material. The notch shall be perpendicular to the hard faced surface.

7. NDT

All deposited surfaces shall, after final machining, be penetrant tested in accordance with ASME VIII, Div. 1, Appendix 8 and the acceptance criteria shall be in accordance with the same, except on sealing surfaces where no indication is acceptable. (Design drawing should define actual sealing surface area.)

EDS NHF2

Rev. 5

Title: Hardfacing by thermal spraying of Tungsten Carbide

1. SCOPE

This document specifies requirements to build-up hardfacing coating by thermal spraying of tungsten carbide on components for use within pressure containing equipment.

2. PROCESS

The process shall be of type high Velocity Oxygen Fuel (HVOF) or equivalent process. NOTE: Typical proprietary equipment considered acceptable for use is TAFA/Praxair JP 5000/8000, Metco Diamond Jet and Miller Top Gun.

2.1 Coating composition

The coating shall be of cermet type based on Tungsten Carbide (WC) and a metallic binder. The binder shall be based on Co and/or Ni which shall be alloyed with Cr or Cr and Mo. Pure Co or Ni binders are not accepted.

2.2 Coating thickness

The coating shall be in the range 0,10 - 0,20 mm after grinding and lapping.

2.3 **Pre-treatment**

The components shall be cleaned for removal of oil by a cleaning agent (acetone or similar) before grit blasting with aluminium oxide. The surface roughness before spraying shall be minimum μ Ra = 4.

The components shall be at a temperature minimum 10 °C above dew point and be immediately grit blasted in warm condition. Any dust or particles shall be removed before spraying.

2.4 Thermal spraying

The component shall be coated immediately after grit blasting, while the component still is at a temperature above the dew point.

All thermal spraying shall be carried out under optimal conditions and accordance with established and qualified procedures to ensure that the coating on all areas fulfil the specified requirements.

For valves all seating area shall be coated. For ball valves the complete spherical part of the ball shall be coated. For gate valves all surfaces sliding against the seats during valve opening and closing shall be coated.

2.5 Sealing

All coated surfaces shall be sealed. The type of sealer shall be specified in the procedure.

2.6 Finishing

All coated parts shall be ground and lapped to a mirror like finish and maximum roughness of $R_a = 0,15 \mu m$.

3. PROCEDURE QUALFICATION TESTING

The thermal spray procedure shall be supported with a qualification test and the following essential variables shall apply to each procedure:

EDS NHF2

Rev. 5

Title: Hardfacing by thermal spraying of Tungsten Carbide

- The type of equipment used;
- Nozzel length;
- Fuel and gas flow rate, ± 5 %;
- Spray distance, ± 5 %;
- Spray rate, ± 5 %;
- Grade of powder;
- Powder supplier.

The procedure shall be re-qualified if any of the above is changed outside given allowable range. The qualification test shall be made at test samples of sufficient size for extraction the required test specimens. Each procedure qualification shall be tested as specified in the following clauses.

3.1 Bonding test

The bonding strength shall be tested in accordance with ASTM C 633 or ISO 4624. Not less than 3 specimens of a type shall be tested.

Acceptance criteria: Minimum bond strength shall be 60 MPa.

3.2 Bending test

Three coupons, with size 20 x 100 x minimum 1,5 mm shall be tested. The coupons shall be bent 90 $^\circ$ over a mandrel with diameter 25 mm.

Acceptance criteria: No spalling is acceptable. However, cracking in the coating is acceptable.

3,3 Hardness test

A minimum of 3 indentations shall be made on a cross section for metallographic examination. Acceptance criteria: The average hardness shall be minimum 1000 HV0,3.

3.4 Porosity test

One piece shall be prepared for cross section metallographic examination. An area of minimum 1,0 mm² shall be examined.

Acceptance criteria: The porosity shall be less than 1 % by area.

3.5 Surface finish test

The surface roughness of the finished component shall be tested.

Acceptance criteria: The maximum roughness value shall be R_a 0,15.

4. **PRODUCTION TESTING**

Production testing shall be carried out on regular basis as minimum twice per week and on every new batch of powder or on changing grade of powder. The test shall be similar to a procedure qualification test, but on a plate less in size and the applicable testing shall consist of hardness and porosity test, ref. clause 3,3 and 3.4 above.

EDS NHF7

ELEMENT DATA SHEET

Title: Corrosion resistant overlay welding

1. SCOPE

This EDS specifies requirements to carbon and low alloyed steels that need to be overlay welded to obtain the required corrosion resistance.

2. WELDING

Overlay welding shall be made by process 51 (electro beam), 52 (laser beam), 72 (electro slag), 131 (MIG), 141 (TIG) welding processes.

The process 72 is not acceptable for overlay welding of sealing surfaces.

Two layers of weld metal shall be deposited for all processes, while only one layer is acceptable for the electro slag weld process.

The weld consumable for the weld overlay deposit shall comply with UNS N06625 (AWS ERNiCrMo 3) unless agreed otherwise.

Thickness of the overlay deposit for corrosion protection after final machining shall be minimum 3 mm or as required on applicable design drawing.

Deposit thickness shall be measured at minimum three locations for each component or as agreed. For components with complicated geometry the manufacturer shall establish a procedure for this purpose.

3. WELD PROCEDURE QUALIFICATION

Overlaying shall be carried out to qualified procedures according to ASME IX modified according to this EDS.

The weld qualification test shall be carried out on base material of same grade as used in production.

3.1 Chemical analysis

For chemical analyses the distance between analysed surfaces to weld interface shall be the minimum qualified and shall be reported.

The maximum iron content at the finished surface of the overlay shall not exceed 10 % (mass fraction).

3.2 Hardness test

Hardness testing shall be carried out on the qualification test along three traverses across base material, heat affected zone (HAZ) and weld metal deposition. Vickers hardness HV10 shall be used. Testing of HAZ shall be carried out with maximum 0,5 mm distance between the indentations from fusion line, through HAZ into unaffected base material. The hardness for HAZ and unaffected base material shall not exceed 350 Hv10.

When sour service conditions to ISO 15156 are specified the maximum hardness shall not exceed 250 Hv10 if the heat affected zone of the base material will be exposed to the sour environment. If the overlay deposite fully covers the base material the maximum hardness shall be less than 350 Hv10.

4. HEAT TREATMENT

Heat treatment after overlay welding shall be carried out, as necessary, to meet specified properties. Items designed for sour service shall be heat treated as required in the ISO 15156.

5. NON DESTRUCTIVE EXAMINATION (NDE)

All deposited surfaces shall, after final machining, be 100 % penetrant tested in accordance ASME VIII, Div. 1, Appendix 8.

The acceptance criteria shall be in accordance with ASME VIII, Div. 1, Appendix 8, except on sealing surfaces where no indication is acceptable. (Design drawings should define actual sealing surface area.)

Rev. 2

Page 1 of 1

EDS NHF8

Title: Solid tungsten carbide material

Page 1 of 2

1. SCOPE

This document specifies requirements to solid tungsten carbide for use within pressure containing equipment such as valves. Examples of components are production choke trim as cage, sleeve or plug.

NOTE: Other designations used instead of tungsten carbide materials are cermets, hard metals, TC, WC or cemented carbide. The tungsten carbide materials consist of tungsten carbide grains sintered together in a metallic matrix (binder), and combine a high hardness level with fair fracture toughness. Their properties are influenced by a number of factors:

- Type of binder (alloy content)
- Amount of binder
- Carbide grain size
- Fabrication method (sintering / sintering and subsequent HIP/ sinterHIP).

Tungsten carbide materials are especially suitable for severe erosive service, with high sand concentrations and high flow velocity, e.g. choke trim components.

2. MANUFACTURING AND TESTING

The manufacturing and testing shall fulfill the following requirements:

- a) The amount of binder in the cemented tungsten carbide (WC) shall be in the range of 5 7 %.
- b) The binder shall be of Co or Ni base. Co base materials shall be alloyed with Cr and Ni or Cr, Ni and Mo to be corrosion resistant in well stream service. Ni base materials shall be alloyed with Cr or Cr and Mo.
- c) The WC-grain size shall be of type F (fine grained) according to ISO 4499/ASTM B 390.
- d) The material shall be produced by sintering with a subsequent hot isostatic pressing (HIP) or produced by a combined sinter/HIP process.
- e) The minimum hardness shall be 1900 Hv30, measured by the Vickers method. (ISO 3878 and ISO 6507)
- f) The fracture toughness shall be minimum $K_{1c} = 9,5$ MPa/m measured by the Palmqvist (Vickers indentation crack length) method at high magnification (minimum 500 X).
- g) The transversal rupture strength shall be sufficient for the design and design pressure and for bidirectional flow
- h) NDT fluorescent dye penetrant testing shall be performed on each component to confirm that the material is free from surface cracks.
- i) The tungsten carbide grade shall be erosion tested according to ASTM G 76 and subject to evaluation by Purchaser.
- j) Depending on results of the above additional qualification and testing might be required.

Tungsten carbide materials not satisfying these requirements may be accepted for less severe applications after evaluation of erosion and corrosion potential, the hardness level of the material and the fracture toughness. The testing and acceptance criteria shall be agreed between the involved parties.

Pure Co binder tungsten carbide grades shall not to be used during multiphase duty (corrosive environment i.e. fluid containing water), due to the poor corrosion resistance of the Co binder.

The material requirements shall also apply for solid tungsten carbide materials to be used in raw seawater injection. However, the grade composition should be evaluated in each case due to the corrosivity of the oxygen rich seawater. System temperature shall also be taken into consideration.

EDS NHF8 Rev. 2

Title: Solid tungsten carbide material

Page 2 of 2

3. MANUFACTURING PROCEDURE

The manufacturer shall establish detailed manufacturing procedure to ensure that the above requirements are fulfilled. The manufacturing procedures shall include tolerances on all essential variables.

4. CERAMIC MATERIALS

Ceramic materials might also be used provided documentation of satisfactory properties in line with the criteria stated for solid tungsten carbide. The ceramic material shall be subject to acceptance by Purchaser.

Page 1 of 2

ELEMENT DATA SHEET NSR1 Rev. 1

Title: Metallic seal rings

1. SCOPE

This Element Data Sheet (EDS) specifies acceptable material selection for metallic seal ring for ASME/MSS SP 44 type flanges, compact flange to NORSOK L-005 and mechanical joint connections dependent of the selected flange/hub material.

2. MATERIALS SELECTION

The materials selection for seal rings used in ASME/API RTJ flange, compact flange and mechanical joint connections in oil and gas service are specified in Table 1.

Table 1 — Material selections for metallic seal rings for flange and mechanical joint connections in oil and gas service

Flange/hub material	Type of connections			
	Compact flange, L-005	Mechanical joint	ASME/API RTJ flange	
Carbon steel	AISI 4140 ¹	AISI 4140 ¹	Soft iron	
	Alloy 630	Alloy 630		
Туре 316	Alloy 630 ^{2, 3, 4}	Alloy 630 ^{2, 3, 4}		
Туре 6Мо	Type 25Cr ^{3, 4}	Type 25Cr ^{3, 4}	UNS S31600 ⁵	
Type 22Cr duplex	Alloy 630 ^{2, 3}	Type 22/25Cr		
Type 25Cr duplex	Type 25Cr ⁴	Type 25Cr⁴		
Alloy 625	Alloy 625 or 725	Alloy 625 or 725		
Notes:				

notes

1. Alternatively, low steels with another chemistry may be applied. Minimum tensile strength requirement is specified by NORSOK L-005.

2. Alternative material to Alloy 630 is type 22/25Cr duplex or nickel base alloy such as Alloy 718.

3. Seal rings in type 22/25Cr duplex and Alloy 630 are only applicable for design temperature equal to or above -46°°C and -101°°C, respectively.

4. Alternatively, high alloyed Nickel base alloys may be used, e.g. Alloy 625 and Alloy 725.

Seal ring for flanges/hubs in Type 22/25Cr duplex and 6Mo in service where traces of oxygen may be present, e.g. produced 5. water, jetting water, injection water etc. must be galvanic compatible with flange material. Type 6Mo should be used.

Selection of the ring material shall address the desired level of corrosion resistance, as well as any environmental limits imposed by ISO 15156 (all parts), if applicable.

The seal ring in the ASME/API RTJ and mechanical joints are exposed to both the internal and external environment and shall therefore have the same or better corrosion resistance than the flange/hub material to both these environments

The seal ring in a compact flange design may not be directly exposed to the internal or the external environment under normal operation, however, all seal rings shall have the same or better corrosion resistance than the flange/hub material to both these environments.

For connections to be installed subsea, the seal ring shall be corrosion resistant to ambient seawater and with PREN = % Cr + 3,3 % Mo + 16 % N \geq 40, e.g. type 25Cr duplex and Alloy 625 or 725.

1.011

NSR1

Title: Metallic seal rings

3. ASME/API RTJ FLANGES

The seal rings for the ASME ring type joint shall deform during make-up. The seal ring material shall therefore be in a softer material than the flange material to ensure that the deformation is taken in the ring and not in the flange ring groove.

All rings made in soft iron and UNS S31600 shall be delivered with a maximum hardness of 160 HB.

Material certificates to EN 10204 Type 2.2 is required. The certificate shall as minimum include the following:

- Material and dimensional reference standard
- Chemical composition
- Hardness

4. COMPACT FLANGES AND MECHANICAL JOINTS

4.1 General

The seal rings for compact flanges and mechanical joint connections are designed to work in the elastic range of the material as a spring. Neither the flange/hub material nor the seal ring shall yield during makeup or operation and therefore these rings may be reused.

4.2 Material specification

Seal rings shall be made of forged or worked material in accordance with the applicable reference standard specified in Table 2, and shall be delivered with a material certificate in accordance with EN 10204 Type 3.1.

All ferritic, ferritic/austenitic or martensitic materials shall be impact tested in accordance with applicable MDS, ref. Table 2. Alloy 630 shall be impact tested at - 101 °C or at minimum design temperature and the average absorbed energy shall be minimum 40 J.

Impact and hardness test shall be carried out to the same extent as tensile test.

The certificate shall as minimum include the following:

- Material reference standard
- Manufacturer of the starting material for the finished product
- Chemical composition
- Tensile test results
- Impact test results
- Hardness test results

Material	ASTM standard	MDS	Heat treatment condition	Maximum hardness
AISI 4140	A 788	X02		22 HRC
Type 22Cr	A 182	D44		-
Type 25Cr	A 182	D54		-
Alloy 630	A 705	-	H1150	33 HRC
Alloy 718	B 637	-	Precipitation hardened	35 HRC
Alloy 625	B 564	-	Annealed	35 HRC
Alloy 725	B 805	-	Precipitation hardened	40 HRC

Table[°]2 — Applicable specifications and maximum hardness requirements

Rev. 1

Page 2 of 2

EDS NTR1

ELEMENT DATA SHEET

Title: Trim materials for valves with body/bonnet in carbon steel

Page 1 of 2

Rev. 2

1. SCOPE

This EDS specifies acceptable trim materials for use in carbon steel valves, the corresponding standards and the general requirements to trim material. Where a MDS is referred to, the requirements on the MDS shall apply.

2. ACCEPTABLE TRIM MATERIAL

The table below lists the acceptable trim material for valves with body/bonnet in carbon steel. The trim materials are fully interchangeable.

Material type	Description	MDS
Type 13-4 ^{2, 4}	ASTM A 182 Grade F6NM (Forged) and A 352 Grade CA6NM (Cast) Heat treatment: 1. Austenitize at 1010 °C minimum and air cool or oil quench to ambient	
	 temperature. 2. Temper at 649 to 691 °C and air cool to ambient temperature. 3. Temper at 593 to 621 °C and air cool to ambient temperature. 	
	Maximum hardness: 23°HRC	
Precipitation Hardening	ASTM A 564, Type 630, condition H1150M; maximum hardness 33 HRC.	
Type 17-4 PH, UNS S17400 ^{3, 4}	ASTM A 705, Type 630, condition H1150M; maximum hardness 33 HRC.	
Type 316 ¹	ASTM A 182 Grade F316 or F316L	
	ASTM A 351 Grade CF8M or CF3M	
Type 22Cr Duplex	ASTM A 182 Grade F51, F60	<u>D44</u>
	ASTM A 890 UNS J92205	<u>D46</u>
	ASTM A 276 UNS S31803	<u>D47</u>
Type 25Cr Duplex	ASTM A 182 Grade F53, F55 or F61	<u>D54</u>
	ASTM A 890 Grade 5A or 6A	<u>D56</u>
	ASTM A 276 UNS S32550, S32750 or S32760	<u>D57</u>
Nickel Alloys	ASTM B 446/B 564, UNS N06625	<u>N01</u>
	ASTM A 494 Grade CW-6MC and CX2MW	<u>N02</u>
	ASTM B 637 UNS N07718 and N07750; Maximum hardness 35 HRC.	

NOTES:

1. Type 316 is not suitable for parts requiring hard facing.

Stainless steel grades F6NM and CA6NM are acceptable for use in H₂S containing service up to 10 kPa (100 mbar) partial pressure H₂S on conditions specified by ISO 15156-3, Table A.18. For service with higher partial pressure H₂S a nickel base alloy shall be used, e.g. alloy 718, 925.

Stainless steel UNS S17400 is acceptable for use in H₂S containing service up to 3,4 kPa (34 mbar) partial pressure H₂S and pH ≥ 4,5 on conditions specified by ISO 15156-3, Table A.27. For service with exceeding the specified conditions by ISO 15156-3 a nickel base alloy shall be used, e.g. alloy 718, 925.

4. Stainless steel type 13-4 and type 17-4 are prone to corrosion when exposed to marine atmosphere.

EDS NTR1

Rev. 2 Page 2 of 2

Title: Trim materials for valves with body/bonnet in carbon steel

3. MATERIAL REQUIREMENTS TO TRIM PARTS

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

Material to this EDS shall satisfy all requirements in ISO 15156 (all parts) for H₂S containing environments.

Repair welding of forgings are prohibited. Repair welding of castings shall be carried out to qualified welding procedures qualified on a cast plate of the same material grade which shall be welded.

All castings shall be 100 % liquid penetrant tested in accordance with ASME VIII, Div. 1, Appendix 7, after machining.

The material manufacturer shall have a quality system certified in accordance with ISO 9001 and the system shall have undergone a specific assessment for the relevant materials.

Material certificates to EN 10204 Type 3.1 is required.

EDS NTR2

ELEMENT DATA SHEET

Rev. 2

Title: Trim materials for valves with body/bonnet in SS Type 316

Page 1 of 2

1. SCOPE

This EDS specifies acceptable trim materials for use in type 316 valves, the corresponding standards and the general requirements to trim material. Where a material data sheet (MDS) is referred to, the requirements on the MDS shall apply.

2. ACCEPTABLE TRIM MATERIAL

The table below lists the acceptable trim material for valves with body/bonnet in stainless steel (SS) type 316. The trim materials are fully interchangeable.

Material type	Description	MDS
Type 316 ¹	ASTM A 182 Grade F316 or F316L	
	ASTM A 351 Grade CF8M or CF3M	
Туре 13-4 ^{2, 4}	 ASTM A 182 Grade F6NM or A 352 Grade CA6NM Heat treatment: Austenitize at 1010 °C minimum and air cool or oil quench to ambient temperature. Temper at 648 to 690 °C and air cool to ambient temperature. Temper at 593 to 620 °C and air cool to ambient temperature. Maximum hardness shall be 23°HRC Impact tested at -101 °C to give energy values of 27/20 J in average and minimum single values respectively. 	
Precipitation Hardening Type 17-4 ph, UNS S17400 ^{3, 4}	ASTM A 564/A705, Type 630, condition H1150M Maximum hardness 33 HRC. Impact tested at -101 °C to give energy values of 27/20 J in average and minimum single values respectively.	
Nickel Alloys	ASTM B 446, UNS N06625	<u>N01</u>
	ASTM B 564, UNS N06625	<u>N01</u>
	ASTM A 494 Grade CW-6MC and CX2MW	<u>N02</u>
	ASTM B 637 UNS N07718; Maximum hardness 35 HRC.	
Titanium	ASTM B 348 Grade 5 or ASTM B 381 Grade F5	
	ASIM B 348 Grade 5 or ASTM B 381 Grade F5	

NOTES:

1. Type 316 may not be suitable for metal to metal seal component.

 Stainless steel grades F6NM and CA6NM are acceptable for use in H₂S containing service up to 10 kPa partial pressure H₂S on conditions specified by ISO 15156-3:2009 Table A.18. For service with higher partial pressure H₂S a nickel base alloy shall be used, e.g. alloy 718, 925.

Stainless steel UNS S17400 is acceptable for use in H₂S containing service up to 3,4 kPa (34 mbar) partial pressure H₂S and pH ≥ 4,5 on conditions specified by ISO 15156-3:2009 Table A.27. For service with exceeding the specified conditions by ISO 15156-3:2009 a nickel base alloy shall be used, e.g. alloy 718, 925.

4. Stainless steel type 13-4 and type 17-4 are prone to corrosion when exposed to marine atmosphere.

ELEMENT DATA SHEET	EDS NTR2	Rev. 2
--------------------	----------	--------

Title: Trim materials for valves with body/bonnet in SS Type 316

3. GENERAL MATERIAL REQUIREMENTS

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

Material to this EDS shall satisfy all requirements in ISO 15156 (all parts) for H_2S containing environments. Repair welding of forgings are prohibited.

Repair welding of castings shall be carried out to qualified welding procedures qualified on a cast plate of the same material grade which shall be welded.

All castings shall be 100 % liquid penetrant tested in according to ASME VIII, Div. 1, Appendix 7, after machining.

The material manufacturer shall have a quality system certified in accordance with ISO 9001 and the system shall have undergone a specific assessment for the relevant materials.

Material certificates to EN 10204 Type 3.1 is required.

