

Material data sheets and element data sheets for piping

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Foreword

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

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 Subject to development and publication of international standards, the relevant NORSOK standard will be withdrawn.

The NORSOK standards are developed according to the consensus principle generally applicable 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 Industries, 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);
- requirements for corrosion testing of type 22Cr duplex is added, MDS D4x;
- 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);
- requirement for documentation of all major repairs of castings is added;
- a change of specific make or brand name for weld repair of castings in DSS is deleted (D46 and D56);
- testing requirements of bars for use of machining of components is added (D47, D57, R17 and R27);
- 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.

NOTE: Edition 6 of this standard was reissued in April 2014 due to following corrections:

- *misprints, D44, D55 and D60;*
- *incorrect implementation of agreed text for test sampling of castings C02, C12, D46, D56, N02, R16, S02, X03 and X06;*
- *requirement for radiographic testing of pilot cast of each pattern independent of the extent of testing was missed out, ref. C02, C12, D46, D56, D59, D60, N02, R16, S02, X03 and X06;*
- *addition of corrosion testing of WPQR for weld repair, D46;*
- *requirement for documentation of major weld repairs to ASTM A 703 SR S20 is modified, C12, D46, D56, R16, S02, X03 and X06;*
- *addition of maximum hardness value for strain hardened fasteners in type 25Cr duplex, D59; misprints, R14, R17, R24 and R27. The following two sentences were missed out: "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."*

Please note that the revision number of each MDS is not changed.

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 MDS' 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

EN 13480-4 Metallic industrial piping - Part 4: Fabrication and installation

NORSOK L-001, Piping and valves

NORSOK L-004, Piping fabrication, installation, flushing and testing

NORSOK L-005, Compact flanged connections.

NORSOK M-601, Welding and inspection of piping

ISO 6892-1 Metallic materials -- Tensile testing -- Part 1: Method of test at room temperature

ISO 9712 Non-destructive testing -- Qualification and certification of NDT personnel

ISO 15156-2, Petroleum and natural gas industries – Materials for use in H₂S-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 H₂S-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 $\leq$ 275 MPa and not impact tested

3.1.6**carbon steel type 235LT**

carbon steel with SMYS $\leq$ 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 °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 $\geq$ 40

3.1.10**stainless steel type 565**

austenitic stainless steel alloys with SMYS $\geq$ 450 MPa and PRE $\geq$ 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 $\geq$ 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 butadiene rubber
ISO	International Organization for Standardization
MDS	material data sheet
NBR	nitrile butadiene rubber
NDT	non destructive testing

PE	polyethylene
PEEK	polyether 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

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' do 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

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 $\leq 0,025$ %.

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 requirements 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 A 370 as specified the referenced product standards in the respective MDS'. 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 A 370 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 400 X or 500 X (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 etching solution or another etching agent 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 500 X 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 G 48 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.

Table 1 – Material selection menu for piping systems

Type of materials	Pipes seamless	Pipes welded	Fittings	Forgings	Plate	Castings	Bars/Fasteners	Tubes
Carbon steel Type 235^a	A 106 Grade B	API 5L Grade B A 672 CC60, CC70 Class 12, 22	A 234 Grade WPB	A 105	A 516 Grade 60/70	A 216 Grade WCB		
Carbon steel Type 235LT impact tested	A 333 Grade 6	A 671 Grade CC60, CC70 Class 12/22	A 420 Grade WPL 6	A 350 Grade LF2	A 516 Grade 60/70	A 352 Grade LCC		
Carbon steel Type 360LT impact tested^d	API 5L Grade X52		A 860 Grade WPHY 52	A 694 Grade F52				
Stainless steel Type 316	A 312 Grade TP 316	A 312 Grade TP316 A 358 Grade 316 Class 1/3/4/5	A 403 Grade WP 316 Class S/W/WX	A 182 Grade F316	A 240 Grade 316	A 351 Grade CF8M or CF3M	A 479 UNS S31600 A 320 Grade B8M A 194 Grade 8M	A 269 Grade 316
Stainless steel Type 22Cr Duplex	A 790 UNS S31803 UNS S32205	A 928 UNS S31803 UNS S32205 Class 1/3/5	A 815 UNS S31803 UNS S32205 Class S/W/WX	A 182 Grade F51 Grade F60	A 240 UNS S31803 UNS S32205	A 995 UNS Grade 4 (J92205)	A 479 UNS S31803 UNS S32205	A 789 UNS S31803 UNS S32205
Stainless steel Type 25Cr Duplex	A 790 UNS S32550 UNS S32750 UNS S32760 UNS S39274	A 928 UNS S32550 UNS S32750 UNS S32760 Class 1/3/5	A 815 UNS S32550 UNS S32750 UNS S32760 Class S/W/WX	A 182 F53/F55/F57/F61	A 240 UNS S32550 UNS S32750 UNS S32760	A 995 A5 (UNS J93404) A6 (UNS J93380)	A 479 UNS S32550 UNS S32750 UNS S32760 A 1082 UNS S32750 UNS S32760	A 789 UNS S32550 UNS S32750 UNS S32760 UNS S39274

Type of materials	Pipes seamless	Pipes welded	Fittings	Forgings	Plate	Castings	Bars/Fasteners	Tubes
Stainless steel Type 6Mo^b	A 312 UNS S31254 UNS N08367 UNS N08926	A 358 UNS S31254 UNS N08367 UNS N08926 Class 1/3/5	A 403 WP S31254 UNS N08367 UNS N08926 Class SW/WX	A 182 Grade F44 UNS N08367 UNS N08926	A 240 UNS S31254 UNS N08367 UNS N08926	A 351 CK-3MCuN CN-3MN	A 479 UNS S31254 UNS N08367 UNS N08926	A 269 UNS S31254 UNS N08367 UNS N08926
Stainless steel Type 565	A 312 UNS S34565	A 358 UNS S34565	A 403 UNS S34565	A 182 Grade F49	A 240 UNS S34565		A 479 UNS S34565	
Cu/Ni 90/10 and other copper alloys	B 466 UNS C70600	B 467 UNS C70600	UNS C70600	UNS C70600	B 171 UNS C70600	B 148 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 CX2MW	B 446 UNS N06625 A 453 Grade 660 A 1014 UNS N07718	B 444 UNS N06625
Titanium Grade 2^c	B 861 Grade 2	B 862 Grade 2	B 363 Grade WPT2 / WPT2W	B 381 Grade F2	B 265 Grade 2	B 367 Grade C2	B 348 Grade 2	B 338 Grade 2
High strength low alloyed steel	AISI 4130		A 234 AISI 4130	A 788 AISI 4140 API 6A 60K (AISI 4130) A 182 F22		A 487 Gr 2B/2C	A 320 Grade B7, B7M, L7, L7M A 194 Grade 2H, 2HM, 4, 7 and 7M	

^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 323.2.2A.^b The grades UNS N08367 and N08926 are considered equivalent to UNS S31254. The grade CN-3 MN is considered equivalent to CK-3MCuN.^c GOST VT-1-0 is considered equivalent to Grade 2.^d 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 235L.T.

4.8 Referenced standards (ASTM and ISO) and corresponding MDS

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

Table 2 – List of MDS' 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 Duplex			
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 Duplex			
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) Grade F53 (UNS S32750) Grade F57 (UNS S39277) Grade F55 (UNS S32760)	Forgings and HIP prod.
D55	5	A 240 UNS S32550, S32750 and S32760	Plates
D56	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	2	A 1082 UNS S32750, S32760	Studs, bolts, nuts
D60	2	A 1082 UNS S32750, S32760	Studs, bolts, nuts
Copper/nickel 90/10			
K01	3	B 466 UNS C70600 B 467 UNS C70600 B 151 UNS C70600 B 171 UNS C70600 UNS C70600 UNS C70600	Seamless pipes and tubes Welded pipes Rod and bar Plates and sheets Fittings Flanges
Aluminium - bronze sand castings			
K02	3	B 148 UNS C09580	Castings
Nickel alloy 625			
N01	5	B 366 UNS N06625 B 705 UNS N06625 B 564 UNS N06625 B 443 UNS N06625 B 446 UNS N06625 B 444 UNS N06625	Wrought fittings Pipes Forgings Plates Bars Pipes and tubes
N02	5	A 494 Grade CW-6MC, CX 2MW	Castings
N03	2	F 468/467 Grade Ni625	Studs, bolts, screws and nuts
N04	1	A 453 Grade 660	Studs, bolts, screws and nuts
N05	1	A 1014 UNS N07718	Studs, bolts, screws and nuts
Polymers			
P11	3	Hydrogenated nitrile (HNBR)	O-ring
P12	3	Fluorocarbon terpolymer (FKM)	O-ring
P13	3	Fluorocarbon low T terpolymer (FKM GLT)	O-ring

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MDS No.	Rev. No.	Standard and grade (see NOTE)	Products
T02	5	B 348 Grade 2	Bars
		B 338 Grade 2	Tubes
		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	Studs, bolts, screws
		A 194 Grade 4, 7 and 7M	Nuts
X08	2	A 193 Grade B7, B7M	Studs, bolts, screws
		A 194 Grade 2H, and 2HM	Nuts

5 Element data sheets (EDS')

The EDS' 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 EDS' 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 EDS' 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.

Table 3 – List of EDS' collected in Annex B

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

Annex A
(normative)
Material data sheets (MDS')

MATERIAL DATA SHEET			MDS C01	Rev. 5
TYPE OF MATERIAL: Carbon Steel Type 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 ≤ 19 mm: Cl. 12	-
Seamless pipes	ASTM A 106	B	t > 19 mm: Cl. 22, 32, 42	-
Forgings	ASTM A 105	-	-	S6
Plates	ASTM A 516	60, 70	-	S4
				-
				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	<i>Forgings to A 105:</i> Normalized. <i>Welded pipes to ISO 3183:</i> Stress relieved when the nominal thickness t ≤ 19,0 mm.			
3. CHEMICAL COMPOSITION	<i>All products:</i> C ≤ 0,20 %; S ≤ 0,025 %; P ≤ 0,030 %. $CE_{(IIW)} = C + Mn/6 + (Cr + Mo + V)/5 + (Cu + Ni)/15 \leq 0,43$.			
4. MECHANICAL PROPERTIES	<i>All products:</i> Elongation, A > 20 %.			
5. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual component.			
6. NON DESTRUCTIVE TESTING	<i>Pipes to ISO 3183:</i> RT of weld seam or RT at ends and UT/Eddy Current of the remaining weld. <i>Fittings to A 234:</i> UT is not acceptable as replacement of RT. <i>All products:</i> NDT operators shall be certified in accordance with ISO 9712 or equivalent.			
7. REPAIR OF DEFECTS	Weld repair of base material is not acceptable.			
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 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 SHEET			MDS C02		Rev. 5																																
TYPE OF MATERIAL: Carbon Steel Type 235																																					
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	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 COMPOSITION	$C \leq 0,22 \%$ and $CE_{(IIW)} = C + Mn/6 + (Cr + Mo + V)/5 + (Cu + Ni)/15 \leq 0,43$																																				
3. EXTENT OF TESTING	One set of tensile test is required for each melt and heat treatment load.																																				
4. TEST SAMPLING	Samples for mechanical testing shall realistically reflect the properties in the actual components. For castings with weight 250 kg or more the test blocks shall be integrally cast or gated onto the casting and shall accompany the castings through all heat treatment operations.																																				
5. NON DESTRUCTIVE TESTING	NDT operators shall be certified in accordance with ISO 9712 or equivalent. <i>Magnetic particle testing:</i> - 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 RT of valve castings shall be according to table. <table border="1"> <thead> <tr> <th colspan="8">Extent of RT based on pressure class and nominal outside diameter:</th> </tr> <tr> <th colspan="2">Pressure Class:</th> <th>≤ 150</th> <th>300</th> <th>600</th> <th>900</th> <th>1500</th> <th>≥ 2500</th> </tr> </thead> <tbody> <tr> <td rowspan="2">Extent of RT</td> <td>10 %</td> <td>$\geq 10''$</td> <td>$\geq 10''$</td> <td>$\geq 2''$</td> <td>$\geq 2''$</td> <td>$\geq 2''$</td> <td>$\geq 2''$</td> </tr> <tr> <td>100 %</td> <td>Not applicable</td> <td>Not applicable</td> <td>$\geq 20''$</td> <td>$\geq 16''$</td> <td>$\geq 6''$</td> <td>$\geq 6''$</td> </tr> </tbody> </table> - Independent of the extent specified in table above the pilot cast of each pattern shall be 100 % volumetrically RT. - <i>Valve castings</i> 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. - <i>Other type of castings:</i> 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.						Extent of RT based on pressure class and nominal outside diameter:								Pressure Class:		≤ 150	300	600	900	1500	≥ 2500	Extent of RT	10 %	$\geq 10''$	$\geq 10''$	$\geq 2''$	$\geq 2''$	$\geq 2''$	$\geq 2''$	100 %	Not applicable	Not applicable	$\geq 20''$	$\geq 16''$	$\geq 6''$	$\geq 6''$
Extent of RT based on pressure class and nominal outside diameter:																																					
Pressure Class:		≤ 150	300	600	900	1500	≥ 2500																														
Extent of RT	10 %	$\geq 10''$	$\geq 10''$	$\geq 2''$	$\geq 2''$	$\geq 2''$	$\geq 2''$																														
	100 %	Not applicable	Not applicable	$\geq 20''$	$\geq 16''$	$\geq 6''$	$\geq 6''$																														
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 SHEET			MDS C11	Rev. 5
TYPE OF MATERIAL: Carbon Steel Type 235LT				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Wrought fittings	ASTM A 420	WPL6	-	S51, S53, S69
Welded pipes	ASTM A 671	CC60, CC70	t ≤ 19 mm: Class 12 t > 19 mm: Class 22, 32, 42	S2, S7, S14 S2, S7, S14
Seamless pipes	ASTM A 333	6	-	-
Forgings	ASTM A 350	LF2	Class 1	S6, S55
Plates	ASTM A 516	60, 70		S5
				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. MANUFACTURING	Fittings and forgings: 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	All products: C ≤ 0,20 %; S ≤ 0,025 %; P ≤ 0,025 %; CE _(IIW) = C + Mn/6 + (Cr + Mo + V)/5 + (Cu + Ni)/15 ≤ 0,43. Seamless pipes to A 333: Cr ≤ 0,40 %; Ni ≤ 0,40 %; Mo ≤ 0,15 %; Cu ≤ 0,40 %; (Nb + V + Ti) ≤ 0,10.			
4. IMPACT TESTING	Charpy V-notch testing at - 46 °C is required for the thickness ≥ 6 mm. For flanges apply the thickness at the weld neck. The minimum absorbed energy for full size specimens shall be 27 J average and 20 J single. Reduction factors for sub-size specimens shall be: 7,5 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	Fittings to A 420: ASTM A 960 supplementary requirement S51 shall apply. Impact testing shall be carried out to the same extent as tensile testing. Pipes to A 671: Supplementary requirement S14 shall apply. Supplementary requirement S2 shall apply to the same extent as for tensile testing. Forgings to A 350:One set of tensile and impact testing shall be carried out for each heat and heat treatment load. A test lot shall not exceed 2000 kg for forgings with as forged weight ≤ 50 kg, and 5000 kg for forgings with as forged weight > 50 kg.			

MATERIAL DATA SHEET			MDS C11	Rev. 5
TYPE OF MATERIAL: Carbon Steel Type 235LT				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Wrought fittings	ASTM A 420	WPL6	-	S51, S53, S69
Welded pipes	ASTM A 671	CC60, CC70	t ≤ 19 mm: Class 12 t > 19 mm: Class 22, 32, 42	S2, S7, S14 S2, S7, S14
Seamless pipes	ASTM A 333	6	-	-
Forgings	ASTM A 350	LF2	Class 1	S6, S55
Plates	ASTM A 516	60, 70		S5
				Page 2 of 3

6. TEST SAMPLING

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

Wrought fittings

Sketches shall be established showing location for extractions of test specimens. The sketch shall be given a document identification number.

Forgings

For products forged by the closed die method, the test specimen shall be obtained from a sacrificial product.

Fig. 1 - Location of test specimens for flanges

For products forged by the open die or by the ring rolling method, the test specimen shall be obtained from a sacrificial forging or from an integral prolongation. For flanges the thickness of the prolongation shall minimum be equal to the hub thickness (T_H) as shown in fig. 1.

Integrated test blocks shall be used for components manufactured by HIP.

Test location flanges: The basic test location is mid-thickness of hub (T_H) in a distance $T_B/2$ or minimum 50 mm from weld end, see fig. 1, position 1.

If test specimens cannot be extracted from position 1 test specimens shall be extracted from flange body position 2.

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.

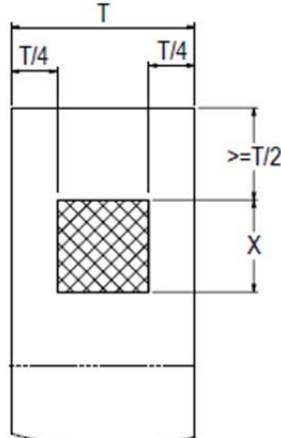
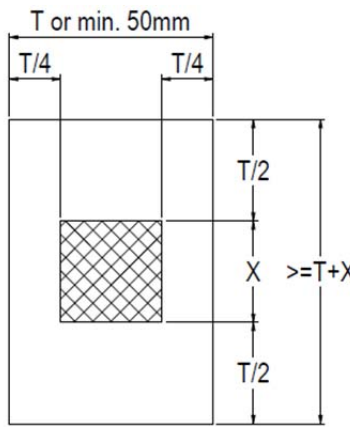
Test location other forgings and HIP products: For forgings having maximum section thickness, $T \leq 50$ mm, the test specimen shall be taken at mid thickness and its mid length shall be at least 50 mm from any second surface or at equal distance from the second surfaces.

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 alternative test may be used. Such alternative test sampling shall be qualified and shall comprise comparative testing of sacrificial forgings and the proposed alternative test sample.

MATERIAL DATA SHEET			MDS C11	Rev. 5
TYPE OF MATERIAL: Carbon Steel Type 235LT				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Wrought fittings	ASTM A 420	WPL6	-	S51, S53, S69
Welded pipes	ASTM A 671	CC60, CC70	t ≤ 19 mm: Class 12 t > 19 mm: Class 22, 32, 42	S2, S7, S14 S2, S7, S14
Seamless pipes	ASTM A 333	6	-	-
Forgings	ASTM A 350	LF2	Class 1	S6, S55
Plates	ASTM A 516	60, 70		S5
				Page 3 of 3
7. NON DESTRUCTIVE TESTING	All products: NDT operators shall be certified in accordance with ISO 9712 or equivalent. Fittings to A 420: Ultrasonic testing is not acceptable as replacement of radiographic testing. ASTM A 960 supplementary requirement, S53 and S69, magnetic particle testing, shall apply to 10 % of all fittings (same test lot as defined for mechanical testing) for nominal thickness < 12,7 mm and 100 % of all fittings for nominal thickness ≥ 12,7 mm. The testing shall be carried out after calibration. The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 6. Forgings to A 350: ASTM A 961 supplementary requirement S55, magnetic particle testing, shall apply to 10 % of all forgings (same test lot as defined for mechanical testing) with NPS 2 and above. The testing shall be carried out after final machining. The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 6.			
8. REPAIR OF DEFECTS	Weld repair of base material is not acceptable.			
9. MARKING	Heat treatment load number shall be permanently marked on the component where testing is required per heat treatment load.			
10. CERTIFICATION	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 SHEET			MDS C12	Rev. 5
TYPE OF MATERIAL: Carbon Steel Type 235LT				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Castings	ASTM A 352	LCC	-	S4, S20
				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. 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	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.			
4. IMPACT TESTING	The minimum absorbed energy for full size specimens shall be 27 J average and 20 J single.			
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	Samples for mechanical testing shall realistically reflect the properties in the actual components. Test blocks shall be integral or gated with the casting(s) they represent and shall accompany the castings through all heat treatment operations. Thickness of the test block shall be equal to the thickest part of the casting represented up to a maximum thickness of 100 mm. 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. 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.  			

MATERIAL DATA SHEET			MDS C12		Rev. 5																																
TYPE OF MATERIAL: Carbon Steel Type 235LT																																					
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.																																	
Castings	ASTM A 352	LCC	-	S4, S20																																	
				Page 2 of 2																																	
7. NON DESTRUCTIVE TESTING	NDT operators shall be certified in accordance with ISO 9712 or equivalent. <i>Magnetic particle testing:</i> - 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 RT of valve castings shall be according to table below. <table border="1"> <thead> <tr> <th colspan="8">Extent of RT based on pressure class and valve size:</th> </tr> <tr> <th colspan="2">Pressure Class:</th> <th>≤ 150</th> <th>300</th> <th>600</th> <th>900</th> <th>1500</th> <th>≥ 2500</th> </tr> </thead> <tbody> <tr> <td rowspan="2">Extent of RT</td> <td>10 %</td> <td>≥ 10"</td> <td>≥ 10"</td> <td>≥ 2"</td> <td>≥ 2"</td> <td>≥ 2"</td> <td>≥ 2"</td> </tr> <tr> <td>100 %</td> <td>Not applicable</td> <td>Not applicable</td> <td>≥ 20"</td> <td>≥ 16"</td> <td>≥ 6"</td> <td>≥ 6"</td> </tr> </tbody> </table> - Independent of the extent specified in table above the pilot cast of each pattern shall be 100 % volumetrically RT. - <i>Valve castings</i> 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. - <i>Other type of castings:</i> 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.						Extent of RT based on pressure class and valve size:								Pressure Class:		≤ 150	300	600	900	1500	≥ 2500	Extent of RT	10 %	≥ 10"	≥ 10"	≥ 2"	≥ 2"	≥ 2"	≥ 2"	100 %	Not applicable	Not applicable	≥ 20"	≥ 16"	≥ 6"	≥ 6"
Extent of RT based on pressure class and valve size:																																					
Pressure Class:		≤ 150	300	600	900	1500	≥ 2500																														
Extent of RT	10 %	≥ 10"	≥ 10"	≥ 2"	≥ 2"	≥ 2"	≥ 2"																														
	100 %	Not applicable	Not applicable	≥ 20"	≥ 16"	≥ 6"	≥ 6"																														
8. REPAIR OF DEFECTS	All weld repairs exceeding the size defined for requiring PWHT by A 352 shall be documented. 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 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: - heat treatment condition, for QT condition austenitisation and tempering temperature and quenching medium shall be stated.																																				

MATERIAL DATA SHEET			MDS C21	Rev. 5
TYPE OF MATERIAL: Carbon Steel Type 360LT				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Forgings	ASTM A 694	F52		S55
				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. HEAT TREATMENT	For products delivered in quenched and tempered condition and with weld end thickness > 19.0 mm the minimum tempering temperature shall be 620 °C. Components shall be placed in such a way as to ensure free circulation around each component during the heat treatment process including quenching.			
3. CHEMICAL COMPOSITION	C ≤ 0,20 %; Mn = 0,90 - 1,60 %; Si = 0,10 - 0,35 %; S ≤ 0,025°; P ≤ 0,035 %; Ti ≤ 0,05 %; Nb ≤ 0,04 %; Al ≤ 0,06 %; N ≤ 0,015 %; (V + Nb + Ti) ≤ 0,10 %; CE = C + Mn/6 + (Cr + Mo + V)/5 + (Cu + Ni)/15 ≤ 0,43.			
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. Fig. 1 - Location of test specimens for flanges For products forged by the open die or by the ring rolling method, the test specimen shall be obtained from a sacrificial forging or from an integral prolongation. For flanges the thickness of the prolongation shall minimum be equal to the hub thickness (T_H) as shown in fig. 1. Integrated test blocks shall be used for components manufactured by HIP. <u>Test location flanges:</u> The basic test location is mid-thickness of hub (T_H) in a distance $T_B/2$ or minimum 50 mm from weld end, see fig. 1, position 1. If test specimens cannot be extracted from position 1 test specimens shall be extracted from flange body position 2. 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, $T \leq 50$ 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 alternative test may be used. Such alternative test sampling shall be qualified and shall comprise comparative testing of sacrificial forgings and the proposed alternative test sample.			

MATERIAL DATA SHEET			MDS C21	Rev. 5
TYPE OF MATERIAL: Carbon Steel Type 360LT				
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 shall be to ASME VIII Div. 1, Appendix 6. NDT operators shall be certified in accordance with ISO 9712 or equivalent.			
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: - heat treatment condition, for QT condition, austenitisation and tempering temperature and quenching medium shall be stated; - copy of test sampling sketch.			

MATERIAL DATA SHEET			MDS C22	Rev. 5
TYPE OF MATERIAL: Carbon Steel Type 360LT				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Seamless pipes	ISO 3183 (API 5L)	L360N (X52N) L360Q (X52Q)	PSL 2	
				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. STEEL MAKING	Fine grain treatment shall be carried out.			
3. HEAT TREATMENT	For pipes delivered in quenched and tempered condition and with thickness > 19,0 mm the minimum tempering temperature shall be minimum 620 °C.			
4. CHEMICAL COMPOSITION	C ≤ 0,16 %; Ti ≤ 0,05 %; Nb ≤ 0,04 %; Al ≤ 0,06 %; N ≤ 0,015 %; (V + Nb + Ti) ≤ 0,10 %;			
5. IMPACT TESTING	Charpy V-notch testing according to ASTM A 370 at - 46 °C is required for the thickness ≥ 6 mm. The minimum absorbed energy for full size specimens shall be 40 J average and 30 J single. Reduction factors for sub-size specimens shall be: 7,5 mm - 5/6 and 5 mm - 2/3.			
6. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual component.			
7. NON DESTRUCTIVE TESTING	100 % ultrasonic surface testing (UT) with notch calibration on N5 notch shall be carried out. 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. NOTE: Pipes shall be subject to rejection if acceptable surface imperfection are not scattered, but appear over a large area in excess of what is considered a workmanlike finish.			
8. SURFACE FINISH	Shall be in accordance with ISO 3183 PSL 2.			
9. REPAIR OF DEFECTS	Weld repair is not acceptable.			
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: - melting and refining practice; - heat treatment condition, for QT condition austenitisation and tempering temperature and quenching medium shall be stated.			

MATERIAL DATA SHEET		MDS C23		Rev. 2
TYPE OF MATERIAL: Carbon Steel Type 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	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	For products delivered in quenched and tempered condition the minimum tempering temperature shall be 620 °C. Components shall be placed in such a way as to ensure free circulation around each component during the heat treatment process including quenching.			
3. CHEMICAL COMPOSITION	$(V + Nb + Ti) \leq 0,10 \%$			
4. WELDING	Welding shall be carried out by qualified welders according to qualified procedures approved by a 3rd party organization. The WPQ shall be qualified in accordance with ASME IX or ISO 15614-1.			
5. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual component. The impact test specimens shall be taken from mid-thickness position. Sketches shall be established showing location for extraction of test specimens. The sketch shall be given a document identification number.			
6. HARDNESS TESTING	Hardness test shall be made for each test lot.			
7. NON DESTRUCTIVE TESTING	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 certified in accordance with ISO 9712 or equivalent.			
8. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.			
9. 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: - manufacturer of the starting material for the finished product shall be stated on the certificate; - heat treatment condition, for QT condition, austenitisation and tempering temperature and quenching medium shall be stated; - copy of test sampling sketch.			

MATERIAL DATA SHEET			MDS D41	Rev. 5
TYPE OF MATERIAL: Ferritic/Austenitic Stainless Steel, 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	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 products according to this MDS shall be carried out according to the M-650 qualified Manufacturing Procedure.			
4. 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 quenching.			
5. STEEL MAKING	The steel melt shall be refined with AOD or equivalent.			
6. CHEMICAL COMPOSITION	UNS S31803: N = 0,14 - 0,20 %			
7. TENSILE TESTING	$R_{p0.2} \geq 450 \text{ MPa}$; $R_m \geq 620 \text{ MPa}$; $A \geq 25 \%$			
8. IMPACT TESTING	Charpy V-notch testing (3 specimens) according to ASTM A 370 at - 46 °C is required for the thickness $\geq 6 \text{ mm}$. 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 EXAMINATION	<i>General</i> The test specimen shall cover the near surfaces and mid-thickness area of the pipe. The specimen shall be polished and etched in 20 % NaOH etching solution or another etching agent 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/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 shall be within 35 - 55 %.			
10. 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/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 acceptable.			

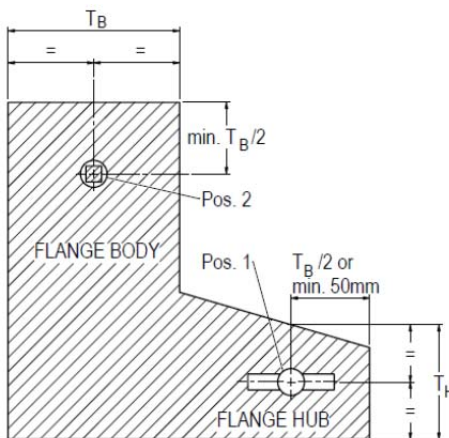
MATERIAL DATA SHEET			MDS D41	Rev. 5
TYPE OF MATERIAL: Ferritic/Austenitic Stainless Steel, Type 22Cr duplex				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Seamless pipes	ASTM A 790	UNS S31803 UNS S32205	-	-
				Page 2 of 2
14. MARKING	The component shall be marked to ensure full traceability to 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; - 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.)			

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 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. STEEL MAKING	The steel melt shall 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.			
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 quenching.			
6. CHEMICAL COMPOSITION	UNS S31803: N = 0,14 – 0,20 %			
7. TENSILE TESTING	Base material properties: $R_{p0.2} \geq 450$ MPa; $R_m \geq 620$ MPa; $A \geq 25$ %.			
8. MICROGRAPHIC EXAMINATION	<i>General</i> The test specimen shall cover the near surfaces and mid-thickness area of the pipe including the weld zone. The specimen shall be polished and etched in 20 % NaOH etching solution or another etching agent 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/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 shall be within 35 – 55 % for base material and 35 – 65 % for weld metal.			
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	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/m².			
11. EXTENT OF TESTING	Tensile test, impact test, corrosion test and microstructure examination shall be carried out for each lot. The lot is defined as follows: - For batch furnace a lot is defined as maximum 60 m of pipe of the same heat, size and heat treatment charge. - For continuous heat treatment furnace the lot definition in the ASTM standard 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 qualified in accordance with ISO 9712 or equivalent.			
14. REPAIR OF DEFECTS	Weld repair of base material is not acceptable. For repair of welds the same requirements to use of qualified WPS shall apply as for production welding.			
15. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.			
16. CERTIFICATION	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 refining practice; - heat treatment condition, solution annealing temperature, holding time and quench medium shall be stated.			

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 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. STEEL MAKING	The steel melt shall 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 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.			
6.CHEMICAL COMPOSITION	UNS S31803: N = 0,14 – 0,20 %			
7. MICROGRAPHIC EXAMINATION	<i>General</i> 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 etching solution or another etching agent 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/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 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 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.			
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 .			

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	Tensile test, impact test, corrosion test, hardness test and microstructure examination shall be carried out for each heat, heat treatment load within a wall thickness range of 5 mm and welded with the same WPS.			
11. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual components. Test sampling shall be made from an actual fitting or from a prolongation thereof. Sketches shall be established showing location for extraction of test specimens. The sketch shall be given a document identification number.			
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 of welding consumables requires requalification.			
13. NON DESTRUCTIVE TESTING	Supplementary requirement S7, liquid penetrant testing, shall apply to 10 % of seamless (from the test lot as defined above) and 100 % of welded fittings above NPS 2. The testing shall be carried out after calibration and pickling. For welded fittings the testing shall cover the weld only. The acceptance criteria shall be ASME VIII, Div. 1, Appendix 8. NDT operators shall be certified in accordance with ISO 9712 or equivalent.			
14. SURFACE FINISH	White pickled. Machined surfaces do not require pickling.			
15. REPAIR OF DEFECTS	Weld repair of base material is not acceptable. For repair of welds the same requirements to WPS shall apply as for production welding.			
16. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.			
17. CERTIFICATION	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 for the finished product; - steel melting and refining practice; heat treatment condition, solution annealing temperature, holding time and quench medium shall be stated; copy of test sampling sketch.			

MATERIAL DATA SHEET			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 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. This MDS is intended for components 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 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.			
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.			
6. CHEMICAL COMPOSITION	F51: N = 0,14 – 0,20 %			
7. 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.  For products forged by the open die or by the ring rolling method, the test specimen shall be obtained from a sacrificial forging or from an integral prolongation. For flanges the thickness of the prolongation shall minimum be equal to the hub thickness (T_H) as shown in fig. 1. Integrated test blocks shall be used for components manufactured by HIP. <u>Test location flanges:</u> The basic test location is mid-thickness of hub (T_H) in a distance $T_B/2$ or minimum 50 mm from weld end, see fig. 1, position 1. If test specimens cannot be extracted from position 1 test specimens shall be extracted from flange body position 2. 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, $T \leq 50$ 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 alternative test may be used. Such alternative test sampling shall be qualified and shall comprise comparative testing of sacrificial forgings and the proposed alternative test sample.			

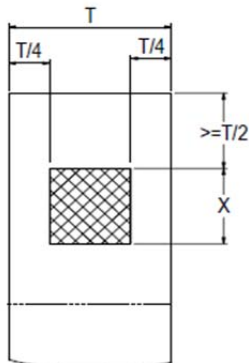
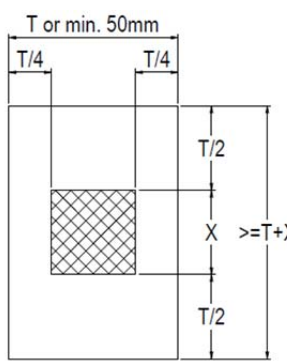
MATERIAL DATA SHEET			MDS D44	Rev. 5
TYPE OF MATERIAL: Ferritic / Austenitic Stainless Steel, Type 22Cr duplex				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Forgings	ASTM A 182	F51, UNS S31803	-	S56
HIP Products	ASTM A 988	F60, UNS S32205		
				Page 2 of 3
8. EXTENT OF TESTING	One set of impact test, tensile test, corrosion test and microstructure examination shall be carried out for each heat and heat treatment load. The testing shall be carried out on the component with heaviest wall thickness within the load. A test lot shall not exceed 2000 kg for forgings with as forged weight ≤ 50 kg, and 5000 kg for forgings with as forged weight > 50 kg.			
9. MICROGRAPHIC EXAMINATION	<i>General</i> 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 etching solution or another etching agent 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/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 %. 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 ≥ 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 % HNO₃ + 5 % HF. The acceptance criteria are: - No pitting 20 X magnification. - 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 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 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.			

MATERIAL DATA SHEET			MDS D45	Rev. 5
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 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 products according to this MDS shall be carried out according to the M-650 qualified Manufacturing Procedure.			
4. STEEL MAKING	The steel melt shall be refined with AOD or equivalent.			
5. HEAT TREATMENT	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 – 0,20 %			
7. MICROGRAPHIC EXAMINATION	<i>General</i> The test specimen shall cover the near surfaces and mid-thickness area. The specimen shall be polished and etched in 20 % NaOH etching solution or another etching agent 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/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 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 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 % HNO₃ + 5 % HF. The acceptance criteria are: No pitting 20 X magnification. The weight loss shall be less than 4,0 g/m².			
10. EXTENT OF TESTING	Impact test, tensile test, corrosion test, hardness test and micrographic examination 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 nominal thickness. For coils a complete set of tests shall be carried out at both ends of the coil.			

MATERIAL DATA SHEET			MDS D45		Rev. 5	
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. 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 medium shall be stated.					

MATERIAL DATA SHEET			MDS D46	Rev. 5
TYPE OF MATERIAL: Ferritic / Austenitic Stainless Steel, Type 22Cr duplex				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Castings	ASTM A 995	4A (UNS J92205)	-	
				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 be with AOD or equivalent refining.			
5. HEAT TREATMENT	The castings 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.			
6. CHEMICAL COMPOSITION	N = 0,14 - 0,30 %			
7. IMPACT TESTING	Charpy V-notch testing is required according to ASTM A 370 at - 46 °C. The minimum absorbed energy shall be 45 J average 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 etching solution or another etching agent 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 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 shall be within 35 - 55 %.			
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. 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 g/m².			
10. TEST SAMPLING	Samples for mechanical testing shall realistically reflect the properties in the actual components. Test blocks shall be integral or gated with the casting(s) they represent. During any reheat treatment the test block shall be tack welded onto the casting and shall accompany the castings through all heat treatment operations. 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. When thickness T of test block is ≤ 50 mm the longitudinal axis of test specimens shall be located in the centre of test blocks.			

MATERIAL DATA SHEET			MDS D46	Rev. 5																														
TYPE OF MATERIAL: Ferritic / Austenitic Stainless Steel, Type 22Cr duplex																																		
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.																														
Castings	ASTM A 995	4A (UNS J92205)	-																															
				Page 2 of 3																														
10. TEST SAMPLING (continued)	  Fig. 1 - Integral test block Fig. 2 - Gated test block																																	
11. EXTENT OF TESTING	A full set of tensile, impact, corrosion and microstructure examinations shall be made for each heat and heat treatment load including any PWHT. A test lot shall not exceed 5000 kg.																																	
12. NON DESTRUCTIVE TESTING	NDT operators shall be certified in accordance with ISO 9712 or equivalent. <i>Liquid penetrant testing:</i> - 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. <i>Radiographic testing (RT):</i> - Method of radiography and acceptance criteria shall be in accordance with ASME VIII Div. 1 Appendix 7. - Extent of RT of valve castings shall be according to table below. <table><tr><th colspan="7">Extent of RT based on pressure class and valve size:</th></tr><tr><th colspan="2">Pressure Class:</th><th>≤ 150</th><th>300</th><th>600</th><th>900</th><th>1500</th><th>≥ 2500</th></tr><tr><td rowspan="2">Extent of RT</td><td>10 %</td><td>≥ 10"</td><td>≥ 10"</td><td>≥ 2"</td><td>≥ 2"</td><td>≥ 2"</td><td>≥ 2"</td></tr><tr><td>100 %</td><td>Not applicable</td><td>Not applicable</td><td>≥ 20"</td><td>≥ 16"</td><td>≥ 6"</td><td>≥ 6"</td></tr></table> - Independent of the extent specified in table above the pilot cast of each pattern shall be 100 % volumetrically RT. - 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 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.				Extent of RT based on pressure class and valve size:							Pressure Class:		≤ 150	300	600	900	1500	≥ 2500	Extent of RT	10 %	≥ 10"	≥ 10"	≥ 2"	≥ 2"	≥ 2"	≥ 2"	100 %	Not applicable	Not applicable	≥ 20"	≥ 16"	≥ 6"	≥ 6"
Extent of RT based on pressure class and valve size:																																		
Pressure Class:		≤ 150	300	600	900	1500	≥ 2500																											
Extent of RT	10 %	≥ 10"	≥ 10"	≥ 2"	≥ 2"	≥ 2"	≥ 2"																											
	100 %	Not applicable	Not applicable	≥ 20"	≥ 16"	≥ 6"	≥ 6"																											
13. SURFACE FINISH	White pickled. Machined surfaces do not require pickling.																																	

MATERIAL DATA SHEET			MDS D46	Rev. 5
TYPE OF MATERIAL: Ferritic / Austenitic Stainless Steel, Type 22Cr duplex				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Castings	ASTM A 995	4A (UNS J92205)	-	
				Page 3 of 3
14. REPAIR OF DEFECTS	All major repairs as defined by A 995 shall be documented. 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 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 located in weld metal and fusion line, respectively. - Corrosion test as specified above. The specimen shall include weld zone.			
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 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 SHEET			MDS D47	Rev. 5
TYPE OF MATERIAL: Ferritic / Austenitic Stainless 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	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 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. <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. - The bar 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 valves and fittings without welding ends 27 J average is acceptable in transverse direction. - 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.			
5. HEAT TREATMENT	The bars shall be solution annealed followed by water quenching. The solution annealing temperature shall be as defined in ASTM A 182 for the actual grade/UNS number. 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 EXAMINATION	<i>General</i> 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 etching solution or another etching agent 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/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 shall be within 35 – 55 %.			
8. IMPACT TESTING	Charpy V-notch testing is required according to ASTM A 370 at - 46 °C. The minimum absorbed energy shall be 45 J average and 35 J single.			

MATERIAL DATA SHEET			MDS D47	Rev. 5
TYPE OF MATERIAL: Ferritic / Austenitic Stainless Steel, 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 % HNO₃ + 5 % HF. The acceptance criteria are: - No pitting 20 X magnification. - The weight loss shall be less than 4,0 g/m².			
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, $T \leq 50$ 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 $\frac{1}{4} T$ 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 acceptable.			
14. MARKING	The bar and/or finished product 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 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 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 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 products according to this MDS shall be carried out according to the M-650 qualified Manufacturing Procedure.			
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 heating and cooling media around each tube during the heat treatment process including accelerated cooling.			
6. CHEMICAL COMPOSITION	UNS S31803: N = 0,14 – 0,20 %			
7. MICROGRAPHIC EXAMINATION	General 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 etching solution or another etching agent 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. 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 %.			
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	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 g/m².			
10. EXTENT OF TESTING	Microstructure, hardness, corrosion, impact and tensile testing shall be carried out for each lot.			
11. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual components.			
12. SURFACE FINISH	White pickled or bright annealed.			
13. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment 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.			

MATERIAL DATA SHEET			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	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.			
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 products according to this MDS shall be carried out according to the M-650 qualified manufacturing procedure.			
4. STEEL MAKING	The steel melt shall be refined with AOD or equivalent.			
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 COMPOSITION	C ≤ 0,03 % PREN = (% Cr + 3,3 % Mo + 16 % N) ≥ 40,0			
7. TENSILE TESTING	R _{p0.2} ≥ 550 MPa; R _m ≥ 750 MPa; A ≥ 25 %			
8. MICROGRAPHIC EXAMINATION	<i>General</i> 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 etching solution or another etching agent 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/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 shall be within 35 – 55 %.			
9. IMPACT TESTING	Charpy V-notch testing according to ASTM A 370 at - 46 °C is required for thickness ≥ 6 mm. The minimum absorbed energy shall be 45 J average / 35 J single. Reduction factors for sub-size specimens shall be: 7,5 mm - 5/6 and 5 mm - 2/3.			
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 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.			

MATERIAL DATA SHEET			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 impact, microstructure, hardness, corrosion and tensile testing shall be carried out for each lot.			
12. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual components.			
13. SURFACE FINISH	White pickled or bright annealed.			
14. 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 Manufacturing Summary identification or QTR no. used; - steel producer of the starting material; - steel melting practice and refining method; - 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.).			

MATERIAL DATA SHEET			MDS D52	Rev. 5
TYPE OF MATERIAL: Ferritic / Austenitic Stainless Steel, Type 25Cr duplex				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Welded pipes	ASTM A 928	UNS S32550 UNS S32750 UNS S32760	Class 1, 3 and 5	S3
				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 A 240 UNS S32760.			
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 PROCESS	The manufacturing of products according to this MDS shall be carried out according to the M-650 qualified manufacturing procedure.			
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 around each pipe during the heat treatment process including quenching.			
6. MANUFACTURING	Welding shall be carried out by qualified welders according to qualified procedures approved by a 3 rd party organization.			
7. CHEMICAL COMPOSITION	C ≤ 0,03 % PREN = % Cr + 3,3 % Mo + 16 % N ≥ 40,0			
8. TENSILE TESTING	R _{p0.2} ≥ 550 MPa; R _m ≥ 750 MPa; A ≥ 25 %			
9. MICROGRAPHIC EXAMINATION	<i>General</i> The test specimen shall include base material and weld zone and shall be taken transverse to weld in mid-thickness location. The specimen shall be polished and etched in 20 % NaOH etching solution or another etching agent 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/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 shall be within 35 – 55 % for base material and 35 – 65 % for weld metal.			
10. IMPACT TESTING	Charpy V-notch testing according to ASTM A 370 at - 46 °C is required for thickness ≥ 6 mm. The minimum absorbed energy shall be 45 J average / 35 J single. Two sets, each 3 specimens, shall be carried out with notch located in base material and weld metal, respectively. Reduction factors for sub-size specimens shall be: 7,5 mm - 5/6 and 5 mm - 2/3.			
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 are: - 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.			

MATERIAL DATA SHEET			MDS D52	Rev. 5
TYPE OF MATERIAL: Ferritic / Austenitic Stainless Steel, Type 25Cr duplex				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Welded pipes	ASTM A 928	UNS S32550 UNS S32750 UNS S32760	Class 1, 3 and 5	S3
				Page 2 of 2
13. EXTENT OF TESTING	Tensile, impact, hardness, corrosion and microstructure examination shall be carried out for each lot. The lot is defined as follows: - For batch furnace a lot is defined as maximum 60 m of pipe of the same heat, size and heat treatment charge. - For continuous heat treatment furnace the lot definition in the ASTM standard applies.			
14. 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.			
15. 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 be certified in accordance with ISO 9712 or equivalent.			
16. SURFACE FINISH	White pickled.			
17. REPAIR OF DEFECTS	Weld repair of base material is not acceptable. For repair of welds the same requirements to use of qualified WPS shall apply as for production welding.			
18. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.			
19. CERTIFICATION	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 include the following information: - NORSOK M-650 Manufacturing Summary identification or QTR no. used; - manufacturer of the starting material for the finished product; - 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.			

MATERIAL DATA SHEET			MDS D53	Rev. 5
TYPE OF MATERIAL: Ferritic/Austenitic 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 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.			
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 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 manufacturing process.			
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 properties: R _{p0.2} ≥ 550 MPa; R _m ≥ 750 MPa; A ≥ 25 %			
8. MICROGRAPHIC EXAMINATION	<i>General</i> 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 etching solution or another etching agent 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/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 shall be within 35 - 55 % for base material and 35 - 65 % for weld metal.			
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 / 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 SHEET			MDS D53	Rev. 5
TYPE OF MATERIAL: Ferritic/Austenitic 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 are: - No pitting at 20 X magnification. - The weight loss shall be less than 4,0 g/m ² .			
11. EXTENT OF TESTING	Tensile testing, impact testing, hardness testing, corrosion testing and microstructure examination shall be carried out for each heat and heat treatment load within a wall thickness range of 5 mm and welded with the same WPS.			
12. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual components. Test sampling shall be made from an actual fitting or from a prolongation thereof. Sketches shall be established showing location for extraction of test specimens. The sketch shall be given a document identification number.			
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 requirements S7, penetrant testing, shall apply to 10 % of seamless (from the test lot as defined above) and 100 % of welded fittings above NPS 2. The examination shall be carried out after calibration and pickling. For welded fittings the examination shall cover the weld only. The weld of each examined fitting shall be ground flush in a length of 100 mm prior to penetrant testing. The acceptance criteria shall be ASME VIII, Div. 1, Appendix 8. NDT operators shall be certified in accordance with ISO 9712 or equivalent.			
15. SURFACE FINISH	White pickled.			
16. REPAIR OF DEFECTS	Weld repair of base material is not acceptable. For repair of welds the same requirements to use of qualified WPS shall apply as for production welding.			
17. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.			
18. CERTIFICATION	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; - manufacturer of the starting material; - steel manufacturer, melting and refining practice; - heat treatment condition, solution annealing temperature, holding time and quench medium shall be stated; - copy of test sampling sketch.			

MATERIAL DATA SHEET			MDS D54	Rev. 5
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 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. This MDS is intended for components with maximum section 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 PROCESS	The manufacturing of products according to this MDS shall be carried out according to the M-650 qualified manufacturing procedure. The component should be quenched in water after forging. The hot isostatic pressed (HIP) process is an acceptable alternative to forging.			
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	$C \leq 0,03 \%$, $PREN = (\% Cr + 3,3 \% Mo + 16 \% N) \geq 40,0$.			
7. TENSILE TESTING	$R_{p0,2} \geq 550 \text{ MPa}$; $R_m \geq 750 \text{ MPa}$; $A \geq 25 \%$.			
8. MICROGRAPHIC EXAMINATION	<i>General</i> The test specimen shall be taken in same area as of tensile test specimen. The specimen shall be polished and etched in 20 % NaOH etching solution or another etching agent 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/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 %. For forgings the ferrite content shall be within 35 – 55 % and for HIP products 40 – 60 %.			
9. IMPACT TESTING	Charpy V-notch testing according to ASTM A 370 at - 46 °C is required for the thickness $\geq 6 \text{ mm}$ (thickness at the weld neck). 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. For flanges test specimens shall be taken in axial direction to the bore of the flange, see fig. 1, position 1.			
10. EXTENT OF TESTING	One set of impact, tensile, hardness, corrosion testing and microstructure examination shall be carried out for each heat and heat treatment load. The testing shall be carried out on the component with heaviest wall thickness within the load. A test lot shall not exceed 2000 kg for forgings with as forged weight $\leq 50 \text{ kg}$, and 5000 kg for forgings with as forged weight $> 50 \text{ kg}$.			

MATERIAL DATA SHEET			MDS D54	Rev. 5
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 2 of 3
11. CORROSION TEST	Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. The corrosion test specimen shall be 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 whole 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.			
12. 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 ^{A)}. For products forged by the open die or by the ring rolling method, the test specimen shall be obtained from a sacrificial forging or from an integral prolongation. For flanges the thickness of the prolongation shall minimum be equal to the hub thickness (T_H) as shown in fig. 1. When prolongations are used test specimens shall be taken in a distance T_B/2 or minimum 50 mm from the end. Test location flanges: The basic test location is mid-thickness of hub (T_H) in a distance T_B/2 or minimum 50 mm from weld end, see fig. 1, position 1. If full size test specimens cannot be extracted from position 1 test specimens shall be extracted from flange body position 2. Test location other forgings: For forgings having maximum section thickness, T ≤ 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 ¼ 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. A) For closed die forged components and flanges exceeding 80 kg it is recognized that alternative test may be used. Such alternative test sampling shall be qualified and shall comprise comparative testing of sacrificial forgings and the proposed alternative test sample.			

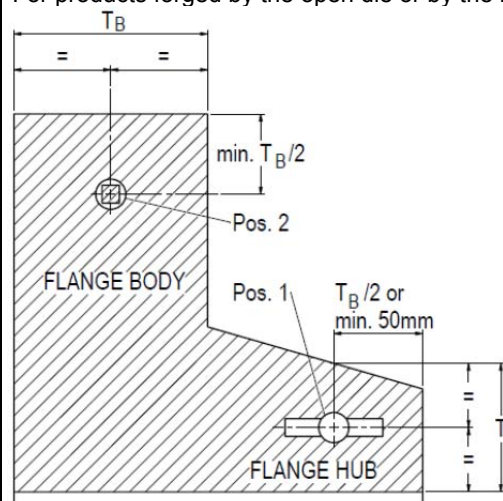


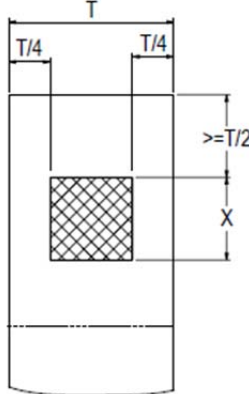
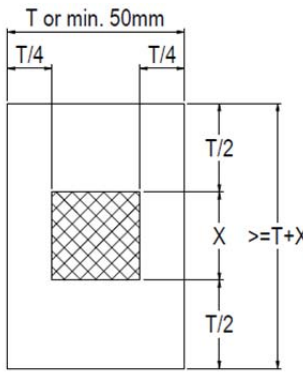
Fig. 1 - Location of test specimens for flanges

MATERIAL DATA SHEET			MDS D54	Rev. 5
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 shall be white pickled, including machined surfaces.			
15. REPAIR OF DEFECTS	Weld repair is not acceptable.			
16. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.			
17. CERTIFICATION	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 SHEET			MDS D55	Rev. 5
TYPE OF MATERIAL: Ferritic/Austenitic Stainless Steel, Type 25Cr duplex				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Plates	ASTM A 240	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.			
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 products according to this MDS shall be carried out according to the M-650 qualified manufacturing procedure.			
4. STEEL MAKING	The steel melt shall be refined with AOD or equivalent.			
5. HEAT TREATMENT	Solution annealing 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	C ≤ 0,03 % PREN = (%Cr + 3,3 % Mo + 16 % N) ≥ 40,0.			
7. TENSILE TESTING	R _{p0,2} ≥ 550 MPa; R _m ≥ 750 MPa; A ≥ 25 %.			
8. MICROGRAPHIC EXAMINATION	General: The test specimen shall cover areas near both surfaces and mid thickness of the plate. The specimen shall be polished and etched in 20 % NaOH etching solution or another etching agent 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 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 according to ASTM A 370 at - 46 °C is required for thickness ≥ 6 mm. The minimum absorbed energy shall be 45 J average / 35 J single. Reduction factors for sub-size specimens shall be: 7,5 mm - 5/6 and 5 mm - 2/3.			
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 % 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 TESTING	Impact test, tensile test, hardness test, corrosion test and micrographic examination 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 nominal thickness. For coils a complete set of tests shall be carried out at both ends of the coil.			

MATERIAL DATA SHEET			MDS D55	Rev. 5
TYPE OF MATERIAL: Ferritic/Austenitic 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 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 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.			

MATERIAL DATA SHEET			MDS D56	Rev. 5
TYPE OF MATERIAL: Ferritic/Austenitic Stainless Steel, Type 25Cr duplex				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Castings	ASTM A 995	5A (UNS J93404) 6A (UNS J93380)	-	
				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 be refined with AOD or equivalent process.			
5. HEAT TREATMENT	According to Grade 5A (UNS J93404) or 6A (UNS J93380). 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	S ≤ 0.025 % ; P ≤ 0.030 % PREN = (% Cr + 3,3 % Mo + 16 % N) ≥ 40,0.			
7. TENSILE TESTING	R _{p0.2} ≥ 450 MPa; R _m ≥ 700 MPa; A ≥ 18 %.			
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 etching solution or another etching agent qualified by the M-650 qualification program. <i>Intermetallic phases and nitride precipitates</i> The microstructure shall be examined 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 shall be within 35 - 55 %.			
9. IMPACT TESTING	Charpy V-notch testing is required according to ASTM A 370 at - 46 °C. The minimum absorbed energy shall be 45 J average / 35 J single.			
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 criteria are: - No pitting at 20 X magnification. - The weight loss shall be less than 4,0 g/m ² .			
11. EXTENT OF TESTING	A full set of mechanical and corrosion tests and microstructure examinations shall be made for each heat and heat treatment charge including any PWHT. A test lot shall not exceed 5000 kg.			

MATERIAL DATA SHEET			MDS D56	Rev. 5																															
TYPE OF MATERIAL: Ferritic/Austenitic Stainless Steel, Type 25Cr duplex																																			
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.																															
Castings	ASTM A 995	5A (UNS J93404) 6A (UNS J93380)	-																																
				Page 2 of 3																															
12. TEST SAMPLING	Samples for mechanical testing shall realistically reflect the properties in the actual components. Test blocks shall be integral or gated with the casting(s) they represent and shall accompany the castings through all heat treatment operations. During any reheat treatment the test block shall be tack welded onto the casting. 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. When thickness T of test block is ≤ 50 mm the longitudinal axis of test specimens shall be located in the centre of test blocks.   Fig.1 - Integral test block Fig. 2 - Gated test block																																		
13. NON DESTRUCTIVE TESTING	NDT operators shall be certified 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. 1, Appendix 7. - Extent of RT of valve castings shall be according to table below. <table><tr><th colspan="8">Extent of RT based on pressure class and nominal size:</th></tr><tr><th colspan="2">Pressure Class:</th><th>≤ 150</th><th>300</th><th>600</th><th>900</th><th>1500</th><th>≥ 2500</th></tr><tr><td rowspan="2">Extent of RT</td><td>10 %</td><td>≥ 10"</td><td>≥ 10"</td><td>≥ 2"</td><td>≥ 2"</td><td>≥ 2"</td><td>≥ 2"</td></tr><tr><td>100%</td><td>Not applicable</td><td>Not applicable</td><td>≥ 20"</td><td>≥ 16"</td><td>≥ 6"</td><td>≥ 6"</td></tr></table>				Extent of RT based on pressure class and nominal size:								Pressure Class:		≤ 150	300	600	900	1500	≥ 2500	Extent of RT	10 %	≥ 10"	≥ 10"	≥ 2"	≥ 2"	≥ 2"	≥ 2"	100%	Not applicable	Not applicable	≥ 20"	≥ 16"	≥ 6"	≥ 6"
Extent of RT based on pressure class and nominal size:																																			
Pressure Class:		≤ 150	300	600	900	1500	≥ 2500																												
Extent of RT	10 %	≥ 10"	≥ 10"	≥ 2"	≥ 2"	≥ 2"	≥ 2"																												
	100%	Not applicable	Not applicable	≥ 20"	≥ 16"	≥ 6"	≥ 6"																												

MATERIAL DATA SHEET			MDS D56	Rev. 5
TYPE OF MATERIAL: Ferritic/Austenitic Stainless Steel, Type 25Cr duplex				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Castings	ASTM A 995	5A (UNS J93404) 6A (UNS J93380)	-	
				Page 3 of 3
13. NON DESTRUCTIVE TESTING (continued)	- Independent of the extent specified in table above the pilot cast of each pattern shall be 100 % volumetrically RT. - <i>Valve castings</i> 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. - <i>Other type of castings:</i> 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 carried out after any blasting and shall include finished machined surfaces.			
15. REPAIR OF DEFECTS	All major repairs as defined by A 995 shall be documented. 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. 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: - 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 located in weld metal and fusion line, respectively. - Corrosion test as specified above. The specimen shall include weld zone.			
16. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.			
17. CERTIFICATION	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 certification 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 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				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	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 PROCESS	The manufacturing of products according to this MDS shall be carried out according to the M-650 qualified Manufacturing Procedure. <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. - 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.			
5. HEAT TREATMENT	The bars shall be solution annealed followed by water quenching. The solution annealing temperature shall be as defined in ASTM A 182 for the actual grade/UNS number. 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	$C \leq 0,03 \%$ $PREN = (\% Cr + 3,3 \% Mo + 16 \% N) \geq 40,0$.			
7. TENSILE TESTING	$R_{p0,2} \geq 550 \text{ MPa}$; $R_m \geq 750 \text{ MPa}$; $A \geq 25 \%$.			
9. MICROGRAPHIC EXAMINATION	<i>General</i> 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 etching solution or another etching agent qualified by the M-650 qualification program. <i>Intermetallic phases and 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/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 shall be within 35 – 55 %.			
8. IMPACT TESTING	Charpy V-notch testing is required according to ASTM A 370 at - 46 °C. The minimum absorbed energy shall be 45 J average / 35 J single.			

MATERIAL DATA SHEET			MDS D57	Rev. 5
TYPE OF MATERIAL: Ferritic/Austenitic Stainless Steel, Type 25Cr duplex				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Bars	ASTM A 479	UNS S32550 UNS S32750 UNS S32760	-	-
				Page 2 of 2
9. CORROSION TEST	Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. The 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 % HNO₃ + 5 % HF. The acceptance criteria are: - No pitting at 20 X magnification. - The weight loss shall be less than 4,0 g/m².			
10. 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.			
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, $T \leq 50$ 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 $\frac{1}{4} T$ from the nearest surface and at least T or 100 mm, whichever is less, from any second surface.			
12. SURFACE FINISH	Finished products including machined surfaces shall be white pickled.			
13. REPAIR OF DEFECTS	Weld repair is not acceptable.			
14. MARKING	The bar and/or finished product 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 quench medium shall be stated.			

MATERIAL DATA SHEET			MDS D58	Rev. 4
TYPE OF MATERIAL: Ferritic/Austenitic Stainless Steel, Type 25Cr duplex				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
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.			
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 products according to this MDS shall be carried out according to the M-650 qualified manufacturing procedure.			
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 COMPOSITION	C ≤ 0,03 % PREN = (% Cr + 3,3 % Mo + 16 % N) ≥ 40,0.			
7. TENSILE TESTING	R _{p0.2} ≥ 550 MPa; R _m ≥ 750 MPa; A ≥ 25 %.			
8. MICROGRAPHIC EXAMINATION	<i>General</i> 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 etching solution or another etching agent 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/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 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 % HNO ₃ + 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 TESTING	Microstructure, hardness, tensile, impact and corrosion testing shall be carried out for each lot.			

MATERIAL DATA SHEET			MDS D58 Rev. 4	
TYPE OF MATERIAL: Ferritic/Austenitic Stainless Steel, Type 25Cr duplex				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Tubes	ASTM A 789	UNS S32550 UNS S32750 UNS S32760 UNS S39274	-	
				Page 2 of 2
12. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual components.			
13. SURFACE FINISH	White pickled or bright annealed.			
14. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.			
15. CERTIFICATION	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 quench medium shall be stated.			

MATERIAL DATA SHEET			MDS D59	Rev. 2
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 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.			
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. CHEMICAL COMPOSITION	PREN = (% Cr + 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 strength 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. Nuts shall be from solution annealed and water quenched bar or forgings.			
6. HEAT TREATMENT	The bars shall be solution annealed followed by water quenching and cold strain hardened.			
7. EXTENT OF TESTING	A test lot shall be limited to each melt of material, same heat treatment batch, size of pre-material 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} ≥ 725 MPa; R _m ≥ 860 MPa; A ≥ 16 %; RA ≥ 30 %.			
9. MICROGRAPHIC EXAMINATION	<i>General:</i> The examination shall be taken in transverse direction to the main working direction at same location as tensile test specimen. The specimen shall be polished and etched in 20 % NaOH etching solution or another etching agent 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/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 % 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 %.			

MATERIAL DATA SHEET		MDS D59		Rev. 2
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 % HNO₃ + 5 % HF. The acceptance criteria are: - No pitting 20 X magnification. - The weight loss shall be less than 4,0 g/m².			
12. HARDNESS TEST	Maximum hardness of the strain hardened bar shall not exceed 35 HRC or 328 HB.			
13. 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 (1½ inch) or above proof load testing may be replaced with cross section hardness testing to ASTM A 370. The hardness shall be in the range of 248 to 328 HB or 24 to 35 HRC.			
14. DIMENSIONAL TOLERANCE	Product dimensions shall be checked or controlled to an extent as specified by ASME B18.18 Category 2.			
15. 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.			
16. REPAIR OF DEFECTS	Weld repair is not acceptable.			
17. 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.			
18. 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.			

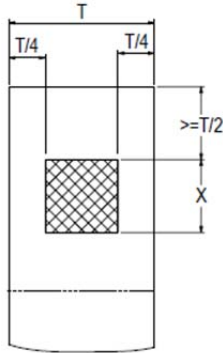
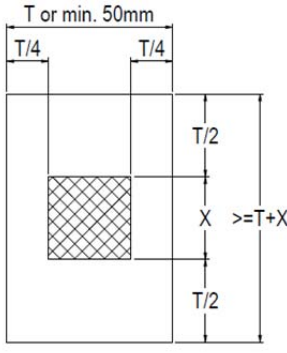
MATERIAL DATA SHEET			MDS D60	Rev. 2
TYPE OF MATERIAL: Ferritic / Austenitic Stainless Steel, Type 25Cr duplex				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Studs, bolts, nuts	ASTM A 1082	UNS S32550 UNS S32750 UNS S32760	-	S5
				Page 1 of 2
1. SCOPE	This MDS specifies the selected options in 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.			
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. CHEMICAL COMPOSITION	PREN = (% Cr + 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, 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. TENSILE TESTING	The minimum tensile test properties shall comply with the following requirements: R _{p0.2} ≥ 550 MPa; R _m ≥ 750 MPa; A ≥ 16 %; RA ≥ 30 %.			
7. 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 7M. For nuts with size M36 (1½ inch) or above proof load testing may be replaced with cross section hardness testing to ASTM A 370 (SR S6). The hardness shall be in the range of 248 to 328 HB or 24 to 35 HRC.			
8. MICROGRAPHIC EXAMINATION	The test specimen shall be taken from same location as the tensile test specimen. The specimen shall be polished and etched in 20% NaOH etching solution or another qualified etching agent. <i>Intermetallic phases and nitride precipitates:</i> 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. <i>Ferrite content:</i> 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 %.			
9. IMPACT TESTING	Charpy V-notch testing according to ASTM A 370 at - 50 °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.			

MATERIAL DATA SHEET			MDS D60	Rev. 2
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	-	S5
				Page 2 of 2
10. 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 % 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 .			
11. EXTENT OF TESTING	A test lot shall be limited to each cast of material, same heat treatment batch, size of pre-material and same type of product and size. Charpy V-notch impact, microstructure, corrosion, hardness and tensile testing shall be carried out for each lot.			
12. DIMENSIONAL TOLERANCE	Product dimensions shall be checked or controlled to an extent as specified by ASME B18.18 Category 2.			
13. 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.			
14. REPAIR OF DEFECTS	Weld repair is not acceptable.			
15. 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.			
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 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.			

MATERIAL DATA SHEET			MDS K01	Rev. 3
TYPE OF MATERIAL: Copper/Nickel 90/10				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Sml pipes & tubes	ASTM B 466	UNS C70600	-	-
Welded pipes	ASTM B 467	UNS C70600	-	-
Rod & bar	ASTM B 151	UNS C70600	-	-
Plates & sheets	ASTM B 171	UNS C70600	-	-
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.			
2. DESIGN AND DIMENSIONAL STANDARDS	The following EEMUA standards for: "90/10 Copper/Nickel Piping for Offshore Applications" shall be used: - EEMUA Publication no. 144: "Tubes, Seamless and Welded". - EEMUA Publication no. 145: "Flanges, Composite and Solid". - EEMUA Publication no. 146: "Fittings".			
3. MATERIALS	Materials for fittings and flanges shall comply with the above listed standards and this MDS.			
4. MANUFACTURING PROCESS	Forming: Cold forming or hot forming may be used according to written procedures established in cooperation with the material manufacturers. Welding: An electric fusion welding process shall be used.			
5. HEAT TREATMENT/ DELIVERY CONDITION	Hot formed components: Parts hot formed in the temperature range of 760 – 800 °C do not need annealing after forming. Cold formed components: Annealed. Welded components: Annealed, but acceptable as welded from annealed materials.			
6. CHEMICAL COMPOSITION	For subsequent welding the chemical composition shall be modified as stated: Zn ≤ 0.50 %, Pb ≤ 0.02 % and C ≤ 0.05 %.			
7. EXTENT OF TESTING	Tensile test specimens shall be taken from each lot. A lot is defined as all products of the same type and nominal size, which are produced from the same heat of material and subject to the same finishing operation.			
8. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual components. Test samples shall be cut from the products themselves. Sacrificial components or 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.			
9. WELDING	Welding procedures shall be established and qualified in accordance with ASME IX.			
10. NON DESTRUCTIVE TESTING	Welded Pipes to B 467: - Sch 10S: Welded pipes shall be spot radiographed to the extent of not less than 12 in (300 mm) 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 TESTS	Sml. pipes & tubes to B 466 and Welded pipes to B 467: - Each length of finished pipe shall be subjected to the hydrostatic test in accordance with ASTM A 530.			
12. CERTIFICATION	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 SHEET		MDS K02		Rev. 3												
TYPE OF MATERIAL: ALUMINIUM - BRONZE SAND CASTINGS																
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.												
Castings	ASTM B 148	UNS C95800	-	-												
				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 shall be carried out for each lot as defined by the in B 148.															
5. TEST SAMPLING	Samples for mechanical testing shall realistically reflect the properties in the actual components.															
6. NON DESTRUCTIVE TESTING	NDT operators shall be qualified in accordance with ISO 9712 or equivalent. <i>Liquid penetration testing:</i> - 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. <i>Radiographic testing (RT):</i> - Method of radiography and acceptance criteria shall be in accordance with ASME VIII Div. 1 Appendix 7. - Extent of RT for valve castings shall be according to table. <table border="1"> <thead> <tr> <th colspan="4"><i>Extent of RT based on pressure class and nominal size:</i></th> </tr> <tr> <th colspan="2"><i>Pressure Class:</i></th> <th>≤ 150</th> <th>300</th> </tr> </thead> <tbody> <tr> <td>Extent of RT</td> <td>10 %</td> <td>≥ 10"</td> <td>≥ 10"</td> </tr> </tbody> </table> - The pilot cast of each pattern shall be 100% RT. - <i>Valve castings</i> 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. - <i>Other type of castings:</i> 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.				<i>Extent of RT based on pressure class and nominal size:</i>				<i>Pressure Class:</i>		≤ 150	300	Extent of RT	10 %	≥ 10"	≥ 10"
<i>Extent of RT based on pressure class and nominal size:</i>																
<i>Pressure Class:</i>		≤ 150	300													
Extent of RT	10 %	≥ 10"	≥ 10"													
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. - Repairs by peening and impregnation are prohibited. - Change of filler metal brand names requires requalification.															
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 shall be issued in accordance with EN 10204 Type 3.1, and shall include the following information: - heat treatment condition (annealing temperature).															

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	<i>Welded pipes to B 705:</i> 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 B 705:</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.			

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 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 products to this MDS 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 quenching			
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 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 % 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 TESTING	Tensile test and corrosion test shall be made for each melt and heat treatment load. A test lot shall not exceed 5000 kg.			
8. TEST SAMPLING	Samples for mechanical testing shall realistically reflect the properties in the actual components. Test blocks shall be integral or gated with the casting(s) they represent and shall accompany the castings through all heat treatment operations. 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.  Fig. 1 - Integral test block  Fig. 2 - Gated test block			

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 2 of 3																																	
9. NON DESTRUCTIVE TESTING	NDT operators shall be qualified in accordance with ISO 9712 or equivalent. <i>Liquid penetrant testing:</i> - 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. <i>Radiographic testing (RT):</i> - Method of radiography and acceptance criteria shall be in accordance with ASME VIII Div. 1 Appendix 7. - Extent of RT of valve castings shall be according to table below. <table border="1"> <thead> <tr> <th colspan="8">Extent of RT based on pressure class and valve size:</th> </tr> <tr> <th colspan="2">Pressure Class:</th> <th>≤ 150</th> <th>300</th> <th>600</th> <th>900</th> <th>1500</th> <th>≥ 2500</th> </tr> </thead> <tbody> <tr> <td rowspan="2">Extent of RT</td> <td>10 %</td> <td>≥ 10"</td> <td>≥ 10"</td> <td>≥ 2"</td> <td>≥ 2"</td> <td>≥ 2"</td> <td>≥ 2"</td> </tr> <tr> <td>100 %</td> <td>Not applicable</td> <td>Not applicable</td> <td>≥ 20"</td> <td>≥ 16"</td> <td>≥ 6"</td> <td>≥ 6"</td> </tr> </tbody> </table> - Independent of the extent specified in table above the pilot cast of each pattern shall be 100 % volumetrically RT. - <i>Valve castings</i> 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 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. - <i>Other type of castings:</i> 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.						Extent of RT based on pressure class and valve size:								Pressure Class:		≤ 150	300	600	900	1500	≥ 2500	Extent of RT	10 %	≥ 10"	≥ 10"	≥ 2"	≥ 2"	≥ 2"	≥ 2"	100 %	Not applicable	Not applicable	≥ 20"	≥ 16"	≥ 6"	≥ 6"
Extent of RT based on pressure class and valve size:																																					
Pressure Class:		≤ 150	300	600	900	1500	≥ 2500																														
Extent of RT	10 %	≥ 10"	≥ 10"	≥ 2"	≥ 2"	≥ 2"	≥ 2"																														
	100 %	Not applicable	Not applicable	≥ 20"	≥ 16"	≥ 6"	≥ 6"																														
10. SURFACE FINISH	White pickled. Shall be carried out after any blasting and shall include finished machined surfaces.																																				
11. REPAIR OF DEFECTS	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.																																				
12. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment 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.			

MATERIAL DATA SHEET			MDS N03	Rev. 2
TYPE OF MATERIAL: Ni 625				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Studs, bolts, screws Nuts	ASTM F 468 ASTM F 467	Ni 625 (UNS N06625) Ni 625		
				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. HEAT TREATMENT	The bolts, cap screws and nuts shall be delivered in the annealed condition at 870 °C minimum. Heat treatment shall 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 the strength properties shall be agreed.			
4. EXTENT OF TESTING	One set of tensile test and hardness test shall be carried out for each lot defined as: - <i>Bars</i>: Each heat of material, size and heat treatment load/each 8 hours for continuous furnace. - <i>Fasteners and nuts heat treated after forming</i>: Heat of material, size and heat treatment load/each 8 hours for continuous furnace			
5. MARKING	Each bolt and nut shall be marked on the end/head to ensure full traceability to melt and heat treatment lot.			
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 certificates shall be in accordance with EN 10204 Type 3.1, and shall include the following information: - Heat treatment condition, annealing temperature and time shall be stated. - Original material certificate of the bar material shall be included in the documentation.			

MATERIAL DATA SHEET			MDS N04	Rev. 1
TYPE OF MATERIAL: Grade 660				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Studs, bolts, screws and Nuts	ASTM A 453	Grade 660 (UNS N66286)	Class D	
				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. 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	$R_{p0.2} \geq 725 \text{ MPa}$; $R_m \geq 895 \text{ MPa}$; $A \geq 15 \%$.			
4. HARDNESS	Hardness shall be in the range 24 – 35 HRC or 248 – 321 HB.			
5. 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.			
6. STRESS RUPTURE TEST	Not applicable.			
7. MARKING	Each bolt and nut shall be marked on the end/head to ensure full traceability to cast and heat treatment lot.			
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 certificates shall be in accordance with EN 10204 Type 3.1, and shall include the following information: - Heat treatment condition, annealing temperature and time shall be stated. - Original material certificate of the bar material shall be included in the documentation.			

MATERIAL DATA SHEET			MDS N05	Rev. 1
TYPE OF MATERIAL: Alloy 718				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Studs, bolts, screws and Nuts	ASTM A 1014	UNS N07718		S2, S4, S5
				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. 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	$R_{p0.2} = 725 - 1000 \text{ MPa}$; $R_m = 895 - 1250 \text{ MPa}$; $A \geq 30 \%$.			
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.			
7. MICROSTRUCTURAL EXAMINATION	Microstructural examination shall be carried out in accordance with the requirements specified in API 6A 718.			
8. STRESS RUPTURE TEST	Not applicable.			
9. PROOF LOAD TESTING	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.			
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 (S5).			
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 condition, 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 MATERIAL: Hydrogenated Nitrile Butadiene Rubber(HNBR)																							
PRODUCT		O-ring		TEMPERATURE RANGE																			
				-20 °C to 150 °C ^{1), 2), 3)}																			
				Page 1 of 1																			
1. SCOPE		This MDS specifies the technical requirements for the HNBR O-ring material.																					
2. PURCHASE INFORMATION		The purchase order shall contain the following information: Product type, size, grade designation and/or referenced drawing.																					
3. CHEMICAL COMPOSITION		36 – 40 % acrylonitrile content (ACN)																					
4. QUALIFICATION TEST REQUIREMENTS		The material shall be rapid pressure reduction resistant (ED resistant) and satisfy the following minimum requirements. The qualification shall be repeated if there are changes in the production route, manufacturing procedures, specified composition or properties of the product which exceeds the limits defined from qualification testing (each manufacturer and seal type shall be qualified). <i>ED-test:</i> Qualification test requirements: O-ring cross section diameter 5,33 mm, 20 % compression, test fixture, 70 – 85 % groove fill, test medium 3 % CO₂ in Methane, test temperature 100 °C, 72 hours initial soak at full pressure, followed by 5 cycles of: - 200 bar (24h); - depressurisation: 20-40 bar/min.; - 1 hour rest time; - re-pressurisation; - leakage test. No leakage shall occur in a leakage test at room temperature and service pressure following the 5 decompression cycles. Further, no cracks shall be longer than 80 % of the sample thickness, based on dissection, after the leakage test. <i>Mechanical properties:</i> <table><tr><td>- Hardness</td><td>ASTM D 2240</td><td>90 ± 5 Shore A</td></tr><tr><td>- Tensile strength</td><td>ASTM D 412/1414</td><td>min. 20 MPa</td></tr><tr><td>- Elongation at break</td><td>ASTM D 412/1414</td><td>min. 100 %</td></tr><tr><td>- Compression set</td><td>ASTM D 395</td><td>max. 25 % (after 24 hours at 150 °C)</td></tr><tr><td colspan="3">- Documentation of tensile strength and elongation at break at 150 °C.</td></tr></table> <i>Physical properties:</i> <table><tr><td>- Specific gravity</td><td>ASTM D 792</td><td>1,2 – 1,3 g/cm³</td></tr></table>				- Hardness	ASTM D 2240	90 ± 5 Shore A	- Tensile strength	ASTM D 412/1414	min. 20 MPa	- Elongation at break	ASTM D 412/1414	min. 100 %	- Compression set	ASTM D 395	max. 25 % (after 24 hours at 150 °C)	- Documentation of tensile strength and elongation at break at 150 °C.			- Specific gravity	ASTM D 792	1,2 – 1,3 g/cm ³
- Hardness	ASTM D 2240	90 ± 5 Shore A																					
- Tensile strength	ASTM D 412/1414	min. 20 MPa																					
- Elongation at break	ASTM D 412/1414	min. 100 %																					
- Compression set	ASTM D 395	max. 25 % (after 24 hours at 150 °C)																					
- Documentation of tensile strength and elongation at break at 150 °C.																							
- Specific gravity	ASTM D 792	1,2 – 1,3 g/cm ³																					
5. DIMENSIONS		According to ISO 3601-1 and -3.																					
6. PRODUCTION TEST REQUIREMENTS		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		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 have a quality system certified in accordance with ISO 9001 and the system shall have undergone a specific assessment for the relevant materials. Inspection certificate shall be to the requirements in ISO 10423, quality level PSL 3.																					
NOTES		1) Short time exposure down to - 46 °C is acceptable. 2) Materials properties in actual application to be documented, at combined dimensioning loads (mechanical, temperature, service). 3) Mechanical properties are reduced by increasing temperature and may be degraded by service.																					

MATERIAL DATA SHEET		MDS P12	Rev. 3																		
TYPE OF MATERIAL: Fluorocarbon terpolymer (FKM)																					
PRODUCT	O-ring	TEMPERATURE RANGE	- 10 °C to 150 °C ^{1) 2)}																		
			Page 1 of 1																		
1. SCOPE	This MDS specifies the technical requirements for the FKM O-ring material.																				
2. PURCHASE INFORMATION	The purchase order shall contain the following information: Product type, size, grade designation and/or referenced drawing.																				
3. CHEMICAL COMPOSITION	Vinylidene fluoride (VF2), hexafluoropropylene (HFP), and tetrafluoroethylene (TFE) with necessary fillers, stabilisers, cross-link agents.																				
4. QUALIFICATION TEST REQUIREMENTS	The material shall be rapid pressure reduction resistant (ED resistant) and satisfy the following minimum requirements. The qualification shall be repeated if there are changes in the production route, manufacturing procedures, specified composition or properties of the product which exceeds the limits defined from qualification testing (each manufacturer and seal type shall be qualified). <i>ED-test:</i> O-ring cross section diameter 5,33 mm, 20 % compression, test fixture, 70 – 85 % groove fill, test medium 3 % CO₂ in Methane, test temperature 100 °C, 72 hours initial soak at full pressure, followed by 5 cycles of: - 200 bar (24h); - depressurisation: 20-40 bar/min.; - 1 hour rest time; - re-pressurisation; - leakage test. No leakage shall occur in a leakage test at room temperature and service pressure following the 5 decompression cycles. Further, no cracks shall be longer than 80 % of the sample thickness, based on dissection, after the leakage test. <i>Mechanical properties:</i> <table><tr><td>- Hardness</td><td>ASTM D 2240</td><td>90 ± 5 Shore A</td></tr><tr><td>- Tensile strength</td><td>ASTM D 412/1414</td><td>min. 11 MPa</td></tr><tr><td>- Elongation at break</td><td>ASTM D 412/1414</td><td>min. 90 %</td></tr><tr><td>- Compression set</td><td>ASTM D 395</td><td>max. 40 % (after 24 hours at 150 °C)</td></tr><tr><td colspan="3">- Documentation of tensile strength and elongation at break at 150 °C.</td></tr></table> <i>Physical properties:</i> <table><tr><td>- Specific gravity</td><td>ASTM D 792</td><td>1,6 – 1,9 g/cm³</td></tr></table>			- Hardness	ASTM D 2240	90 ± 5 Shore A	- Tensile strength	ASTM D 412/1414	min. 11 MPa	- Elongation at break	ASTM D 412/1414	min. 90 %	- Compression set	ASTM D 395	max. 40 % (after 24 hours at 150 °C)	- Documentation of tensile strength and elongation at break at 150 °C.			- Specific gravity	ASTM D 792	1,6 – 1,9 g/cm ³
- Hardness	ASTM D 2240	90 ± 5 Shore A																			
- Tensile strength	ASTM D 412/1414	min. 11 MPa																			
- Elongation at break	ASTM D 412/1414	min. 90 %																			
- Compression set	ASTM D 395	max. 40 % (after 24 hours at 150 °C)																			
- Documentation of tensile strength and elongation at break at 150 °C.																					
- Specific gravity	ASTM 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 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	Seals shall be supplied in sealed airtight bags. Markings on the bags shall clearly indicate batch number, and such markings shall ensure traceability to raw materials, formulation and manufacturing details.																				
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. Inspection certificate shall be to the requirements in ISO 10423, quality level PSL 3.																				
NOTES	1) Short time exposure down to - 46 °C is acceptable 2) Materials properties in actual application to be documented, at combined dimensioning loads (mechanical, temperature, service). Mechanical properties are reduced by increasing temperature and may be degraded by service.																				

MATERIAL DATA SHEET		MDS P13	Rev. 3
TYPE OF MATERIAL: Low temperature Fluorocarbon Terpolymer (FKM GLT)			
PRODUCT	O-ring	TEMPERATURE RANGE	-30 °C to + 150 °C ^{1), 2), 3), 4)}
			Page 1 of 2
1. SCOPE	This MDS specifies the technical requirements for the FKM GLT O-ring material.		
2. PURCHASE INFORMATION	The purchase order shall contain the following information: Product type, size, grade designation and/or referenced drawing.		
3. CHEMICAL COMPOSITION	Vinylidene fluoride (VF2) and tetrafluoroethylene (TFE) with necessary fillers, stabilisers and cross-link agents.		
4. QUALIFICATION TEST REQUIREMENTS	The material shall be rapid pressure reduction resistant (ED resistant) and satisfy the following minimum requirements. The qualification shall be repeated if there are changes in the production route, manufacturing procedures, specified composition or properties of the product which exceeds the limits defined from qualification testing (each manufacturer and seal type shall be qualified). <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 % CO₂ in Methane, test temperature 100 °C, 72 hours initial soak at full pressure, followed by 5 cycles of: - 200 bar (24h); - depressurisation: 20-40 bar/min.; - 1 hour rest time; - re-pressurisation; - leakage test. No leakage shall occur in a leakage test at room temperature and service pressure following the 5 decompression cycles. Further, no cracks shall be longer than 80 % of the sample thickness, based on dissection, after the leakage test. <i>Mechanical properties</i> - Hardness ASTM D 2240 90 ±5 Shore A - Tensile strength ASTM D 412/1414 min. 11 MPa - Elongation at break ASTM D 412/1414 min. 90 % - Compression set ASTM D 395 max. 40 % (after 24 hours at 150 °C) - Documentation of tensile strength and elongation at break at 150 °C. <i>Physical properties</i> - Specific gravity ASTM D 792 1,6 – 1,9 g/cm³		
5. DIMENSIONS	According to ISO 3601-1 and -3.		
6. PRODUCTION TEST REQUIREMENTS	The production testing shall be performed according to the requirements in ISO 10423, section 7.4.8, table 17, PSL 3, and satisfy requirement for hardness as stated above and for the other parameters as stated in ISO 10423.		
7. MARKING & PACKAGING	O-rings shall be supplied in sealed airtight bags. Markings on the bags shall clearly indicate batch number, and markings shall ensure traceability to raw materials, formulation and manufacturing details.		

MATERIAL DATA SHEET		MDS P13	Rev. 3
TYPE OF MATERIAL: Low temperature Fluorocarbon Terpolymer (FKM GLT)			
PRODUCT	O-ring	TEMPERATURE RANGE	-30 °C to + 150 °C ^{1), 2), 3), 4)}
			Page 2 of 2
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 shall confirm that the products meet this specification and shall include the following information: - manufacturer part number; - specification number; - compound number; - batch number; - cure/mould date; and - shelf-life expiration date.		
NOTES	1) Only short time exposure below - 30 °C is acceptable. 2) Only to be used as a seal material based on specific assessment and in special cases where the seal material performs better than MDS P11 or P12. 3) Materials properties in actual application to be documented, at combined dimensioning loads (mechanical, temperature, service). 4) Mechanical properties are reduced by increasing temperature and may be degraded by service.		

MATERIAL DATA SHEET		MDS P14		Rev. 3																			
TYPE OF MATERIAL: Nitrile Butadiene Rubber (NBR)																							
PRODUCT		O-ring		TEMPERATURE RANGE																			
				-20 °C to 150 °C ^{1), 2), 3)}																			
				Page 1 of 1																			
1. SCOPE		This MDS specifies the technical requirements for the NBR O-ring material.																					
2. PURCHASE INFORMATION		The purchase order shall contain the following information: Product type, size, grade designation and/or referenced drawing.																					
3. CHEMICAL COMPOSITION		36 – 40% acrylonitrile content (ACN)																					
4. QUALIFICATION TEST REQUIREMENTS		The material shall be tested for oil resistance and satisfy the following minimum requirements. The qualification shall be repeated if there are changes in the production route, manufacturing procedures, specified composition or properties of the product which exceeds the limits defined from qualification testing (each manufacturer and seal type shall be qualified): <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 °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 %. <i>Mechanical properties</i> <table><tr><td>- Hardness</td><td>ASTM D 2240</td><td>70 ± 5 Shore A</td></tr><tr><td>- Tensile strength</td><td>ASTM D 412/1414</td><td>min. 15 MPa</td></tr><tr><td>- Elongation at break</td><td>ASTM D 412/1414</td><td>min. 350 %</td></tr><tr><td>- Compression set</td><td>ASTM D 395</td><td>max. 25 % (after 24 hours at 150 °C)</td></tr><tr><td>- Documentation of tensile strength and elongation at break at 100 °C.</td><td></td><td></td></tr></table> <i>Physical properties</i> <table><tr><td>- Specific gravity</td><td>ASTM D 792</td><td>1,2 – 1,3 g/cm³</td></tr></table>				- Hardness	ASTM D 2240	70 ± 5 Shore A	- Tensile strength	ASTM D 412/1414	min. 15 MPa	- Elongation at break	ASTM D 412/1414	min. 350 %	- Compression set	ASTM D 395	max. 25 % (after 24 hours at 150 °C)	- Documentation of tensile strength and elongation at break at 100 °C.			- Specific gravity	ASTM D 792	1,2 – 1,3 g/cm ³
- Hardness	ASTM D 2240	70 ± 5 Shore A																					
- Tensile strength	ASTM D 412/1414	min. 15 MPa																					
- Elongation at break	ASTM D 412/1414	min. 350 %																					
- Compression set	ASTM D 395	max. 25 % (after 24 hours at 150 °C)																					
- Documentation of tensile strength and elongation at break at 100 °C.																							
- Specific gravity	ASTM D 792	1,2 – 1,3 g/cm ³																					
5. DIMENSIONS		According to ISO 3601-1 and -3.																					
6. PRODUCTION TEST REQUIREMENTS		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		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 have a quality system certified in accordance with ISO 9001 and the system shall have undergone a specific assessment for the relevant materials. Inspection certificate shall be to the requirements in ISO 10423, quality level PSL 3.																					
NOTES		1) Only short time exposure below - 20 °C and/or above 100 °C is acceptable. 2) Not to be used for gas systems. Only to be used as a seal material based on specific assessment and in special cases with benign environment. 3) Mechanical properties are reduced by increasing temperature.																					

MATERIAL DATA SHEET		MDS P21	Rev. 3																																																												
TYPE OF MATERIAL: PEEK (Polyether ether ketone)																																																															
PRODUCT	Back-up rings and seat inserts	TEMPERATURE RANGE	-100 °C to 200 °C																																																												
			Page 1 of 1																																																												
1. SCOPE	This MDS specifies the technical requirements for the PEEK material.																																																														
2. PURCHASE INFORMATION	The purchase order shall contain the following information: Product type, size, grade designation and/or referenced drawing.																																																														
3. CHEMICAL COMPOSITION	Poly-ether-ether-ketone polymer with necessary stabilisers and processing aids.																																																														
4. QUALIFICATION TEST REQUIREMENTS	The material shall satisfy the following minimum requirements. The qualification shall be repeated if there are changes in the production route, manufacturing procedures, specified composition or properties of the product which exceeds the limits defined from qualification testing: <table> <tr> <th><i>Mechanical properties:</i></th><th><i>Test standard</i></th><th><i>Virgin</i></th><th><i>Glass filled</i></th></tr> <tr> <td>- Tensile strength</td><td>ASTM D638</td><td>95 MPa</td><td>> 150 MPa</td></tr> <tr> <td>- Tensile modulus</td><td>ASTM D 638</td><td>> 3000 MPa</td><td>> 3500 MPa</td></tr> <tr> <td>- Compressive strength</td><td>ASTM D 695</td><td>> 110 MPa</td><td>> 150 MPa</td></tr> <tr> <td>- HDT @ 1,81 MPa</td><td>ASTM D 648</td><td>150 °C</td><td>300 °C</td></tr> <tr> <td>- Impact strength (notched)</td><td>ASTM D 256</td><td>> 70 J/m</td><td>> 70 J/m</td></tr> <tr> <td>- Ultimate elongation</td><td>ASTM D 638</td><td>> 55 %</td><td>> 2 %</td></tr> <tr> <td colspan="4">Physical properties:</td></tr> <tr> <td>- Specific gravity</td><td>ASTM D 792</td><td>1,3 - 1,4 g/cm³</td><td>1,4 - 1,6 g/cm³</td></tr> <tr> <td>- Melting point</td><td>ASTM D 3418</td><td>340 °C</td><td>340 °C</td></tr> <tr> <td>- Water absorption (24 hrs.)</td><td>ASTM D 570</td><td>0,15 %</td><td>0,15 %</td></tr> <tr> <td colspan="4">Properties at elevated temp.:</td></tr> <tr> <td colspan="4">The following properties shall be documented at 150 °C and 200 °C:</td></tr> <tr> <td>- Tensile strength</td><td>ASTM D 638</td><td>Manufacturer requirements</td><td>Manufacturer requirements</td></tr> <tr> <td>- Ultimate elongation</td><td>ASTM D 638</td><td></td><td></td></tr> </table>			<i>Mechanical properties:</i>	<i>Test standard</i>	<i>Virgin</i>	<i>Glass filled</i>	- 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 D 638	> 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 requirements	Manufacturer requirements	- Ultimate elongation	ASTM D 638		
<i>Mechanical properties:</i>	<i>Test standard</i>	<i>Virgin</i>	<i>Glass filled</i>																																																												
- 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 D 638	> 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 requirements	Manufacturer requirements																																																												
- Ultimate elongation	ASTM D 638																																																														
5. DIMENSIONS	According to manufacturer's written specification.																																																														
6. PRODUCTION TEST REQUIREMENTS	The production testing shall be performed according to the requirements in ISO 10423, quality level PSL3, 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 in suitable packaging as to protect the items from physical damage prior to installation. Markings on the packaging shall clearly indicate material batch number, and such markings shall ensure traceability to raw materials, formulation and manufacturing details.																																																														
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. Inspection certificate shall be to the requirements in ISO 10423, quality level PSL 3.																																																														

MATERIAL DATA SHEET		MDS P22	Rev. 3		
TYPE OF MATERIAL: PTFE (Poly-tetra-fluoro-ethylene)					
PRODUCT	Lip-seals, back-up rings and seat inserts.	TEMPERATURE RANGE	-150 to 200 °C		
			Page 1 of 1		
1. SCOPE	This MDS specifies the technical requirements for the PTFE material.				
2. PURCHASE INFORMATION	The purchase order shall contain the following information: Product type, size, grade designation and/or referenced drawing.				
3. CHEMICAL COMPOSITION	Carbon and fluorine, polymeric di-fluoromethane with necessary fillers, stabilisers and process aids. Also with graphite, glass or carbon fibre fillers. The lip-seal must be energised internally by a metallic spring (UNS R30003) or similar.				
4. QUALIFICATION TEST REQUIREMENTS	The material shall satisfy the following minimum requirements. The qualification shall be repeated if there are changes in the production route, manufacturing procedures, specified composition or properties of the product which exceeds the limits defined from qualification testing:				
	Mechanical properties	Test standard	Virgin	25 % Glass	25 % Graphite
	- Tensile strength	ASTM D 638	> 25 MPa	> 15 MPa	> 15 MPa
	- Hardness	ASTM D 785	50-60 Shore D	50-60 Shore D	60-70 Shore D
	- Compressive strength, 1%	ASTM D 695	> 4 MPa	> 6 MPa	> 6 MPa
	- Compressive modulus	ASTM D 695	> 400 MPa	> 600 MPa	> 600 MPa
	- Compressive modulus	ASTM D 648	54 °C	110 °C	95 °C
	- HDT @ 1,81 MPa	ASTM D 256	> 145 J/m	> 130 J/m	> 140 J/m
	- Impact strength (notched)	ASTM D 638	> 220 %	> 180 %	> 75 %
	- Ultimate elongation				
Physical properties	ASTM D 792	2,0-2,2 g/cm³	2,0-2,3 g/cm3	1,9-2,1 g/cm3	
- Specific gravity	ASTM D 3418	325 °C	325 °C	325 °C	
- Melting point	ASTM D 570	0,01 %	0,02 %	0,01 %	
- Water absorption (24 hrs)					
Properties at elevated T					
The following properties shall be documented at 150 °C and 200 °C:					
- Tensile strength	ASTM D 638	Manufacturer requirements	Manufacturer requirements	Manufacturer requirements	
- Ultimate elongation	ASTM D 638				
5. DIMENSIONS	According to manufacturer's written specification.				
6. PRODUCTION TEST REQUIREMENTS	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 in suitable packaging as to protect the items from physical damage prior to installation. Markings on the packaging shall clearly indicate material batch number, and such markings shall ensure traceability to raw materials, formulation and manufacturing details.				
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. Inspection certificate shall be to the requirements in ISO 10423, quality level PSL 3.				

MATERIAL DATA SHEET		MDS P41	Rev. 1
TYPE OF MATERIAL: 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	<i>Water service:</i> -40 to 40 °C continuous, maximum 80 °C short term. <i>Other types of services:</i> Special evaluations.		
			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. MANUFACTURING	Pipes and fittings shall be made from black polymer compounds. Pipes shall be made by extrusion. Fittings shall be made by moulding or by welding/ fusion methods of piping materials. Recycled material shall not be used. For potable water service the polyethylene material used shall comply with National Health Authorities requirements (SIFF).		
3. MATERIAL PROPERTIES	Material designation: PE 100 Required material properties at room temperature: Minimum required strength: 10.0 N/mm² (long term) Min. yield strength 6.3 N/mm² Design Coefficient: 1,6 E- module 800 – 900 MPa (short time 100 sec) 200 MPa (long time 50 - 100 years) Design lifetime Min. 50 years Deformation Max. 9 % (short term) Max. 15 % after 50 years Chemical Resistance shall be documented in 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. <u>Additional tests required for PE- pipe/fitting production:</u> <i>Test 1: Determination of longitudinal reversion</i> Test to be performed in accordance with EN 743, Method A. Frequency: Start and end of production for each diameter The test shall be to the following parameters: Fluid temperature: 110 °C Submerged time : 30 minutes Test piece length: 30 cm Acceptance criteria: Max. 3 % change in length, and no visual imperfections, incl. defects, cracks, dents, or blisters.		

MATERIAL DATA SHEET		MDS P41	Rev. 1
TYPE OF MATERIAL: 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	<i>Water service:</i> -40 to 40 °C continuous, maximum 80 °C short term. <i>Other types of services:</i> Special evaluations.		
			Page 2 of 2
4. TESTING (continued)	<i>Test 2 Residual stresses:</i> Due to normally used processing/cooling parameters during extrusion of PE pipes, there will be certain “frozen in”/ residual stresses in the pipe wall, tensile stresses on the inside and balancing compression stresses on the outside. Frequency: The tests shall be done at start and end of production for each diameter of pipe. The following method shall be used to determine internal stresses in extruded PE-pipes: A piece of pipe with a length, for instance equal to the pipe diameter, is cut off. A thin rod is sawed out axially from this pipe piece to leave an axial opening in the pipe. This opening will normally be reduced by hoop shrinkage of the pipe. 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 a book by Lars-Eric Janson: Plastics pipes for water supply and sewage disposal, section 3,3) The residual stresses indicated by this method 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 operators, certified to <i>class B, NEMKO SBC NO 60</i>, and to qualified and accepted welding procedure specifications (WPS). The WPS qualification shall include test methods (1 & 2) for residual stress level below 2,5 MPa, as specified under Section 4. Welding equipment shall be certified and calibrated to DS/INF 70. Whenever access allows, all fittings shall have the weld bead ground to ensure smooth inner surfaces.		
7. VISUAL INSPECTION	100 % visual inspection shall be carried out. All surfaces shall be even, smooth and scratch free. All cut surfaces shall be homogenous.		
8. MARKING	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 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.		

MATERIAL DATA SHEET			MDS R11	Rev. 5
TYPE OF MATERIAL: Austenitic stainless 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	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 products according to this MDS shall be carried out according to the M-650 qualified manufacturing procedure.			
4. STEEL MAKING	The steel melt shall be refined by AOD or equivalent.			
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 quenching			
6. TENSILE TESTING	R _{p0.2} ≥ 310 MPa; R _M ≥ 655 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 are: - No pitting at 20 X magnification. - The weight loss shall be less than 4,0 g/m ² .			
8. EXTENT OF TESTING	For all specified destructive tests one test shall be 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 annealed.			
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 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. (Holding time is not applicable for pipes produced hot finished/direct quenched.)			

MATERIAL DATA SHEET			MDS R12	Rev. 5
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 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. STEEL MAKING	Steel melt shall be refined with AOD or equivalent refining.			
4. MANUFACTURING PROCESS	The manufacturing of products according to this MDS shall be carried out according to the M-650 qualified manufacturing procedure.			
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 quenching. 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	$R_{p0,2} \geq 310 \text{ MPa}$; $R_M \geq 655 \text{ MPa}$; $A \geq 35 \%$.			
7. CORROSION TESTING	Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. The 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 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 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 qualified 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 requalification.			
11. NON DESTRUCTIVE TESTING	Eddy current testing according to ASTM A 450 is acceptable as replacement for radiography for wall thickness less than 4,0 mm. Supplementary requirement S3, penetrant testing, shall apply according to ASME V Article 6, to the weld area of 10 % of the pipes (same test lot as defined for mechanical testing) delivered. The weld of each examined pipe shall be ground flush in a length of 100 mm prior to penetrant testing. The testing shall be carried out after calibration and pickling. Acceptance criteria shall be to ASME VIII, Div. 1, Appendix 8. NDE operators shall be qualified in accordance with ISO 9712 or equivalent.			
12. SURFACE FINISH	White pickled.			

MATERIAL DATA SHEET			MDS R12 Rev. 5	
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	Weld repair of base material is not acceptable. For repair of welds the same requirements to use qualified WPS as for production welding shall apply.			
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 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.			

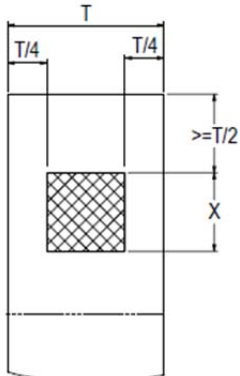
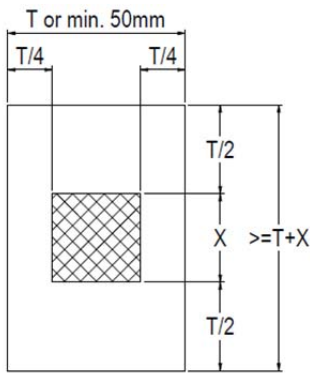
MATERIAL DATA SHEET			MDS R13	Rev. 5
TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Wrought fittings HIP products	ASTM A 403 ASTM A 988	WP S31254 UNS N08367 UNS N08926	WP-S, WP-WX and WP-W	
				Page 1 of 2
1. SCOPE	This MDS specifies the selected 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. STEEL MAKING	Steel melt shall 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 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. Fittings machined directly from solution annealed forging or bar-stock need not be resolution annealed provided tested and certified in accordance with MDS R14 or R17.			
6. TENSILE TESTING	$R_{p0.2} \geq 300 \text{ MPa}$; $R_M \geq 655 \text{ MPa}$; $A \geq 35 \%$.			
7. CORROSION TESTING	Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. The 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	Samples for production testing shall realistically reflect the properties in the actual components. Test sampling shall be made from an actual fitting or from a prolongation thereof. Sketches shall be established showing location for extraction of test specimens. The sketch shall be given a document identification number.			
10. WELDING	The welding procedure shall be qualified 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 requalification.			
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.			

MATERIAL DATA SHEET			MDS R13	Rev. 5
TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Wrought fittings HIP products	ASTM A 403 ASTM A 988	WP S31254 UNS N08367 UNS N08926	WP-S, WP-WX and WP-W	
				Page 2 of 2
13. REPAIR OF DEFECTS	Weld repair of base material is not acceptable. For repair of welds the same requirement to use qualified WPS shall apply as for production testing.			
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 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.			

MATERIAL DATA SHEET			MDS R14	Rev. 5
TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Forgings	ASTM A 182	F44 UNS N08367 UNS N08926	-	S56
				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 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 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.			
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.			
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. For products forged by the open die or by the ring rolling method, the test specimen shall be obtained from a sacrificial forging or from an integral prolongation. For flanges the thickness of the prolongation shall minimum be equal to the hub thickness (T_H) as shown in fig. 1. Integrated test blocks shall be used for components manufactured by HIP. Test location flanges: The basic test location is mid-thickness of hub (T_H) in a distance $T_B/2$ or minimum 50 mm from weld end, see fig. 1, position 1. If test specimens cannot be extracted from position 1 test specimens shall be extracted from flange body position 2. 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. Test location other forgings and HIP products: For forgings having maximum section thickness, $T \leq 50$ 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 alternative test may be used. Such alternative test sampling shall be qualified and shall comprise comparative testing of sacrificial forgings and the proposed alternative test sample.			

MATERIAL DATA SHEET			MDS R14	Rev. 5
TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Forgings	ASTM A 182	F44 UNS N08367 UNS N08926	-	S56
				Page 2 of 2
7. EXTENT OF TESTING	One set of tensile test and corrosion test shall be carried out for each heat and heat treatment load. The testing shall be carried out on the component with heaviest wall thickness within the load. A test lot shall not exceed 2000 kg for forgings with as forged weight ≤ 50 kg, and 5000 kg for forgings with as forged weight > 50 kg.			
8. TENSILE TESTING	$R_{p0.2} \geq 300$ MPa; $R_M \geq 655$ MPa; $A \geq 35$ %.			
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. 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 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 .			
10. NON DESTRUCTIVE TESTING	Supplementary requirement ASTM A 961 S56, penetrant testing, shall apply to 10 % of all forgings (from the lot as defined for mechanical testing) above NPS 2. The testing shall be carried out after final machining and pickling. The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 8. NDT operators shall be qualified in accordance with ISO 9712 or equivalent.			
11. SURFACE FINISH	White pickled including machined surfaces.			
12. REPAIR OF DEFECTS	Weld repair is not acceptable.			
13. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.			
14. CERTIFICATION	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 ann. temp., holding time and quench medium shall be stated; - copy of test sampling sketch.			

MATERIAL DATA SHEET			MDS R15	Rev. 5
TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Plates	ASTM A 240	UNS S31254 UNS N08367 UNS N08926	-	-
				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 PROCESS	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 be refined with AOD or equivalent.			
5. HEAT TREATMENT	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	$R_{p0.2} \geq 310 \text{ MPa}$; $R_M \geq 655 \text{ MPa}$; $A \geq 35 \%$.			
7. CORROSION TESTING	Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. The 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 are: - No pitting at 20 X magnification. - The weight loss shall be less than 4,0 g/m ² .			
8. 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			
9. 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) ≤ 40 mm and in location t/4 for thicknesses (t) > 40 mm, ref. ASTM E 8. For coils a complete set of tests shall be carried out at both ends of the coil.			
10. SURFACE FINISH	White pickled.			
11. REPAIR OF DEFECTS	Weld repair is not acceptable.			
12. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.			
13. CERTIFICATION	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 refining practice; - heat treatment condition, solution annealing temperature, holding time and quench medium shall be stated.			

MATERIAL DATA SHEET			MDS R16	Rev. 5
TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Castings	ASTM A 351	CK-3MCuN CN-3MN	-	
				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 be refined with AOD or equivalent process. Remelting of AOD or equivalent steel in an electric furnace is acceptable. Use of internal scrap is not acceptable.			
5. HEAT TREATMENT	Solution annealed at temperature ≥ 1225 °C. 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.			
6. CHEMICAL COMPOSITION	P $\leq 0,030$ %			
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	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.			
9. TEST SAMPLING	Samples for mechanical testing shall realistically reflect the properties in the actual components. Test blocks shall be integral or gated with the casting(s) they represent and shall accompany the castings through all heat treatment operations. 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.  Fig. 1 - Integral test block  Fig. 2 - Gated test block			

MATERIAL DATA SHEET			MDS R16	Rev. 5																															
TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo																																			
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.																															
Castings	ASTM A 351	CK-3MCuN CN-3MN	-																																
				Page 2 of 3																															
10. NON DESTRUCTIVE TESTING	NDT operators shall be qualified in accordance with ISO 9712 or equivalent. <i>Liquid penetrant testing:</i> - 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. <i>Radiographic testing (RT):</i> - Method of radiography and acceptance criteria shall be in accordance with ASME VIII, Div. 1 Appendix 7. - Extent of RT of valve castings shall be according to table below. <table border="1"> <thead> <tr> <th colspan="8">Extent of RT based on pressure class and valve size:</th> </tr> <tr> <th colspan="2">Pressure Class:</th> <th>≤ 150</th> <th>300</th> <th>600</th> <th>900</th> <th>1500</th> <th>≥ 2500</th> </tr> </thead> <tbody> <tr> <td rowspan="2">Extent of RT</td> <td>10 %</td> <td>≥ 10"</td> <td>≥ 10"</td> <td>≥ 2"</td> <td>≥ 2"</td> <td>≥ 2"</td> <td>≥ 2"</td> </tr> <tr> <td>100 %</td> <td>Not applicable</td> <td>Not applicable</td> <td>≥ 20"</td> <td>≥ 16"</td> <td>≥ 6"</td> <td>≥ 6"</td> </tr> </tbody> </table> - Independent of the extent specified in table above the pilot cast of each pattern shall be 100 % volumetrically RT. - <i>Valve castings</i> 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. - <i>Other type of castings:</i> 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.				Extent of RT based on pressure class and valve size:								Pressure Class:		≤ 150	300	600	900	1500	≥ 2500	Extent of RT	10 %	≥ 10"	≥ 10"	≥ 2"	≥ 2"	≥ 2"	≥ 2"	100 %	Not applicable	Not applicable	≥ 20"	≥ 16"	≥ 6"	≥ 6"
Extent of RT based on pressure class and valve size:																																			
Pressure Class:		≤ 150	300	600	900	1500	≥ 2500																												
Extent of RT	10 %	≥ 10"	≥ 10"	≥ 2"	≥ 2"	≥ 2"	≥ 2"																												
	100 %	Not applicable	Not applicable	≥ 20"	≥ 16"	≥ 6"	≥ 6"																												
11. SURFACE FINISH	White pickled. Shall be carried out after any blasting and shall include finished machined surfaces.																																		
12. REPAIR OF DEFECTS	All major repairs as defined by A 351 shall be documented. Post weld heat treatment (PWHT) is required after all weld repairs. For weld repairs, less than defined by ASTM A 351, 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 corrosion test as specified above shall be carried out. - Change specific make of filler metal (brand name) requires requalification. All casting with major repairs shall be given a solution heat treatment after welding.																																		

MATERIAL DATA SHEET			MDS R16	Rev. 5
TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Castings	ASTM A 351	CK-3MCuN CN-3MN	-	
				Page 3 of 3
13. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment load.			
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 certification 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 in case remelted ingots are used, ref. Section 4. above; - 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.
Bars	ASTM A 479	UNS S31254 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. This MDS is intended for bars with maximum thickness of 200 mm. For larger thickness special agreements shall be made in each case and based on the result of qualification testing specified in NORSOK M-650.			
2. QUALIFICATION	Manufacturers 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 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. - The product shall be tested and certified according to this MDS. - 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. - 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.			
5. HEAT TREATMENT	Solution annealing followed by water quenching. 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. TENSILE TESTING	R _{p0.2} ≥ 300 MPa; R _M ≥ 655 MPa; A ≥ 35 %; RA ≥ 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. For bars 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 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/m².			
8. EXTENT OF TESTING	One tensile test and corrosion test shall be carried out for each heat and heat treatment load.			

MATERIAL DATA SHEET		MDS R17		Rev. 5
TYPE OF MATERIAL: Austenitic Stainless Steel, Type 6Mo				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Bars	ASTM A 479	UNS S31254 UNS N08367 UNS N08926	-	-
				Page 2 of 2
9. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual components. Test location shall be: - For bars having section thickness, $T \leq 50$ 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 $\frac{1}{4} T$ from the nearest surface and at least T or 100 mm, whichever is less, from any second surface.			
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.			
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 products according to this MDS shall be carried out according to the M-650 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 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 % 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 .			
7. EXTENT OF TESTING	All destructive tests shall be carried out for each lot.			
8. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual components.			
9. REPAIR OF DEFECTS	Weld repair is not acceptable.			
10. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.			
11. CERTIFICATION	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.			

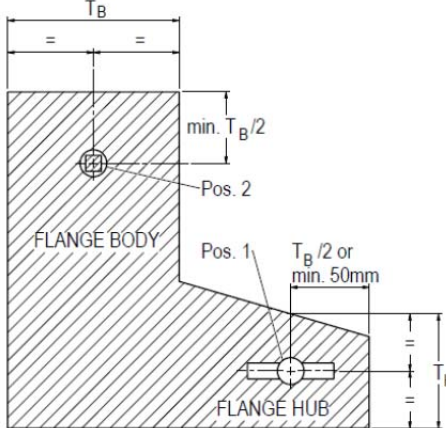
MATERIAL DATA SHEET			MDS R21	Rev. 2
TYPE OF MATERIAL: Austenitic stainless steel, Type 565				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Seamless pipes	ASTM A 312	UNS S34565	-	-
				Page 1 of 1
1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements 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 PROCESS	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 be refined by AOD or equivalent.			
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 quenching			
6. TENSILE TESTING	$R_{p0.2} \geq 415 \text{ MPa}$; $R_M \geq 795 \text{ MPa}$; $A \geq 35 \%$			
7. CORROSION TESTING	Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. The 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 are: - No pitting at 20 X magnification. - The weight loss shall be less than 4,0 g/m².			
8. EXTENT OF TESTING	Corrosion test shall be carried out to the same extent as stated for mechanical tests in the referred standard.			
9. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual components.			
10. SURFACE FINISH	White pickled.			
11. REPAIR OF DEFECTS	Weld repair is not acceptable.			
12. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.			
13. CERTIFICATION	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.)			

MATERIAL DATA SHEET			MDS R22	Rev. 2
TYPE OF MATERIAL: Austenitic Stainless Steel Type 565				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Welded Pipes	ASTM A 358	UNS S34565	Class 1 and 3	S3
				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. STEEL MAKING	Steel melt shall be refined with AOD or equivalent refining.			
4. MANUFACTURING PROCESS	The manufacturing of products according to this MDS shall be carried out according to the M-650 qualified manufacturing procedure.			
5. HEAT TREATMENT	The pipes shall be solution annealed at 1120 – 1150 °C 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 quenching. Post weld solution annealing is not required of pipes with nominal wall thickness up to 7,11 mm manufactured out of solution annealed plate material as stated in chapter 6.3.2.2 of A 358.			
6. TENSILE TESTING	R _{p0,2} ≥ 415 MPa; R _M ≥ 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 % 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 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	The component shall be marked to ensure full traceability to melt and heat treatment lot.			

MATERIAL DATA SHEET			MDS R22	Rev. 2
TYPE OF MATERIAL: Austenitic Stainless Steel Type 565				
PRODUCT	STANDARD	GRADE	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 SHEET			MDS R23	Rev. 2
TYPE OF MATERIAL: Austenitic Stainless Steel Type 565				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Wrought fittings HIP products	ASTM A 403 ASTM A 988	WP S34565	WP-S, WP-WX	
				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. STEEL MAKING	Steel melt shall 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 manufacturing process.			
5. HEAT TREATMENT	The fittings shall be solution annealed at 1120 – 1150 °C followed by quenching in water. 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. Fittings machined directly from solution annealed forging or bar-stock need not be resolution annealed provided pre-material is tested and certified in accordance with MDS R24 or R27.			
6. TENSILE TESTING	$R_{p0.2} \geq 415 \text{ MPa}$; $R_M \geq 795 \text{ MPa}$; $A \geq 35 \%$.			
7. CORROSION TESTING	Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. The 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	Samples for production testing shall realistically reflect the properties in the actual components. Test sampling shall be made from an actual fitting or from a prolongation thereof. Sketches shall be established showing location for extraction of test specimens. The sketch shall be given a document identification number.			
10. WELDING	The welding procedure 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 $\leq$ 0,03 % and S $\leq$ 0,015 %. - The WPQR shall be corrosion tested as specified above. - The qualification shall be carried out on the same material grade as used in production. - Change of specific make (brand name) of welding consumables requires requalification.			
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 traceability to melt and heat treatment lot.			

MATERIAL DATA SHEET			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 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.			

MATERIAL DATA SHEET			MDS R24	Rev. 2
TYPE OF MATERIAL: Austenitic Stainless Steel, Type 565				
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 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 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.			
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.			
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.  For products forged by the open die or by the ring rolling method, the test specimen shall be obtained from a sacrificial forging or from an integral prolongation. For flanges the thickness of the prolongation shall minimum be equal to the hub thickness (T_H) as shown in fig. 1. Integrated test blocks shall be used for components manufactured by HIP. Test location flanges: The basic test location is mid-thickness of hub (T_H) in a distance $T_B/2$ or minimum 50 mm from weld end, see fig. 1, position 1. If test specimens cannot be extracted from position 1 test specimens shall be extracted from flange body position 2. 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. Test location other forgings and HIP products: For forgings having maximum section thickness, $T \leq 50$ 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 alternative test may be used. Such alternative test sampling shall be qualified and shall comprise comparative testing of sacrificial forgings and the proposed alternative test sample.			

MATERIAL DATA SHEET			MDS R24 Rev. 2	
TYPE OF MATERIAL: Austenitic Stainless Steel, Type 565				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Forgings	ASTM A 182	UNS S34565	-	S56
				Page 2 of 2
7. EXTENT OF TESTING	One set of tensile test and corrosion test shall be carried out for each heat and heat treatment load. The testing shall be carried out on the component with heaviest wall thickness within the load. A test lot shall not exceed 2000 kg for forgings with as forged weight ≤ 50 kg, and 5000 kg for forgings with as forged weight > 50 kg.			
8. TENSILE TESTING	$R_{p0.2} \geq 415$ MPa; $R_M \geq 795$ MPa; $A \geq 35$ %			
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. 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 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/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 machined surfaces.			
12. REPAIR OF DEFECTS	Weld repair is not acceptable.			
13. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.			
14. CERTIFICATION	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 refining practice; - heat treatment condition, solution annealing temperature, holding time and quench medium shall be stated; - copy of test sampling sketch.			

MATERIAL DATA SHEET				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	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 products according to this MDS shall be carried out according to the M-650 qualified manufacturing procedure.				
4. STEEL MAKING	The steel melt shall be refined with AOD or equivalent.				
5. HEAT TREATMENT	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. 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 are: - No pitting at 20 X magnification. - The weight loss shall be less than 4,0 g/m ² .				
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 nominal thickness.				
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) ≤ 40 mm and in location t/4 for thicknesses (t) > 40 mm, 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.				
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: - 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 R27	Rev. 2
TYPE OF MATERIAL: Austenitic Stainless Steel, Type 565				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Bars	ASTM A 479	UNS S34565	-	-
				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 bars with maximum thickness of 200 mm. For larger thickness special agreements shall be made in each case and based on the result of qualification testing specified in NORSOK M-650.			
2. QUALIFICATION	Manufacturers 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 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. - The product shall be tested and certified according to this MDS. - 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. - 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.			
5. HEAT TREATMENT	Solution annealing followed by water quenching. 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. TENSILE TESTING	$R_{p0,2} \geq 415 \text{ MPa}$; $R_M \geq 795 \text{ MPa}$; $A \geq 35 \%$.			
7. CORROSION TESTING	Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. The corrosion test specimens shall be at the same location as those for mechanical testing. For bars 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 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/m².			
8. EXTENT OF TESTING	One tensile test and corrosion test shall be carried out for each heat and heat 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, $T \leq 50 \text{ mm}$, 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, $T > 50 \text{ mm}$, the test specimen shall be taken at least $\frac{1}{4} T$ from the nearest surface and at least T or 100 mm, whichever is less, from any second surface.			

MATERIAL DATA SHEET			MDS R27	Rev. 2
TYPE OF MATERIAL: Austenitic Stainless Steel, Type 565				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Bars	ASTM A 479	UNS S34565	-	-
				Page 2 of 2
10. SURFACE FINISH	Finished product shall be white pickled. Machined surfaces do not require pickling.			
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 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				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Wrought fittings	ASTM A 403	WP316	W/S/WX	-
Welded pipes	ASTM A 358	316	Class 1, 3, 4 or 5	-
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 PROCESS	<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	<i>All products:</i> C ≤ 0,035 % <i>Welded pipes and plates to A 240:</i> S ≤ 0,015 %			
4. TENSILE TESTING	Grade 316L is acceptable with: $R_{p0.2} \geq 205 \text{ MPa}$; $R_M \geq 515 \text{ MPa}$; A > 35 %.			
5. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual component. <i>Plates:</i> Tensile test specimens shall be sampled in transverse direction and shall be located in mid-thickness for thickness (t) ≤ 40 mm and in location t/4 for thicknesses (t) > 40 mm, ref. ASTM E 8. <i>Bars A 479:</i> 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.			
6. NON DESTRUCTIVE TESTING	<i>Welded tubes to A 269:</i> Non-destructive electric testing is required. <i>All products:</i> NDT operators shall be qualified in accordance with ISO 9712 or equivalent.			
7. SURFACE FINISH	<i>All products:</i> White pickled or bright annealed. Machined surfaces do not require pickling. <i>Tubes to A 269:</i> 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	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.																															
Castings	ASTM A 351	CF8M CF3M	- -																																
					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. EXTENT OF TESTING	Tensile testing is required for each heat and heat treatment load including any PWHT.																																		
3. 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 accompany the castings through all heat treatment operations. During any PWHT the test block shall be tack welded onto the casting.																																		
4. NON DESTRUCTIVE TESTING	NDT operators shall be qualified in accordance with ISO 9712 or equivalent. <i>Liquid penetrant testing:</i> - 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. <i>Radiographic testing (RT):</i> - Method of radiography and acceptance criteria shall be in accordance with ASME VIII Div. 1 Appendix 7. - Extent of RT of valve castings shall be according to table below. <table border="1"> <thead> <tr> <th colspan="7">Extent of RT based on pressure class and nominal size:</th> </tr> <tr> <th colspan="2">Pressure Class:</th> <th>≤ 150</th> <th>300</th> <th>600</th> <th>900</th> <th>1500</th> <th>≥ 2500</th> </tr> </thead> <tbody> <tr> <td rowspan="2">Extent of RT</td> <td>10 %</td> <td>≥ 10"</td> <td>≥ 10"</td> <td>≥ 2"</td> <td>≥ 2"</td> <td>≥ 2"</td> <td>≥ 2"</td> </tr> <tr> <td>100 %</td> <td>Not applicable</td> <td>Not applicable</td> <td>≥ 20"</td> <td>≥ 16"</td> <td>≥ 6"</td> <td>≥ 6"</td> </tr> </tbody> </table> - Independent of the extent specified in table above the pilot cast of each pattern shall be 100 % volumetrically RT. - 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.					Extent of RT based on pressure class and nominal size:							Pressure Class:		≤ 150	300	600	900	1500	≥ 2500	Extent of RT	10 %	≥ 10"	≥ 10"	≥ 2"	≥ 2"	≥ 2"	≥ 2"	100 %	Not applicable	Not applicable	≥ 20"	≥ 16"	≥ 6"	≥ 6"
Extent of RT based on pressure class and nominal size:																																			
Pressure Class:		≤ 150	300	600	900	1500	≥ 2500																												
Extent of RT	10 %	≥ 10"	≥ 10"	≥ 2"	≥ 2"	≥ 2"	≥ 2"																												
	100 %	Not applicable	Not applicable	≥ 20"	≥ 16"	≥ 6"	≥ 6"																												
5. REPAIR OF DEFECTS	All major repairs as defined by A 351 shall be documented. The repair welding procedure shall be qualified in accordance with A 488 or ISO 11970 and this MDS.																																		
6. SURFACE FINISH	White pickled. Machined surfaces do not require pickling.																																		

MATERIAL DATA SHEET			MDS S02	Rev. 5
TYPE OF MATERIAL: Austenitic Stainless Steel Castings				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Castings	ASTM A 351	CF8M CF3M	- -	
				Page 2 of 2
7. 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 S03		Rev. 1
TYPE OF MATERIAL: Austenitic Stainless Steel, Type 316				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Studs, bolts, screws	ASTM A 320	B8M	1 or 2	
Nuts	ASTM A 194	8M		
				Page 1 of 1
1. SCOPE	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 certificates shall be in accordance with EN 10204 Type 3.1.			

MATERIAL DATA SHEET			MDS T01	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	-	-
Bars	ASTM B 348	2	-	-
Tubes	ASTM B 338	2	-	-
				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	<i>Alternatively:</i> Chemical composition according to GOST VT 1-0 is acceptable.			
3. HEAT TREATMENT	<i>Wrought fittings to B 363, Forgings to B 381, Plates to B 265 and Bars to B 348:</i> - Annealed condition if not the tensile properties in the referred standard can be achieved in as formed condition.			
4. EXTENT OF TESTING	<i>Fittings to B 363:</i> Tensile test shall be carried out for each heat, heat treatment load, type and size. <i>Products to B 381/B 348:</i> Tensile test specimen shall be taken from each lot. A lot is defined as all products of the same heat and heat treatment load with a maximum deviation from the test block thickness of 10 mm.			
5. TEST SAMPLING	<i>All products:</i> Samples for production testing shall realistically reflect the properties in the actual component.			
6. WELDING	<i>Welded pipes to B 862:</i> Welding procedures shall be qualified in accordance with ASME IX or ISO 15614-5.			
7. REPAIR	Repair welding of forgings is not permitted.			
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 shall be issued in accordance with EN 10204 Type 3.1 and shall include the following information: - manufacturer of the starting material			

MATERIAL DATA SHEET			MDS T02	Rev. 5
TYPE OF MATERIAL: Titanium Grade 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 product to this MDS shall be qualified in accordance with NORSOK Standard M-650.			
3. MANUFACTURING PROCESS	The manufacturing of products according to this MDS shall be carried out according to the M-650 qualified manufacturing procedure.			
4. HOT ISOSTATIC PRESSING	All castings shall be subject to Hot Isostatic Pressing (HIP). All castings, which due to size limitations cannot be HIP, shall be heat treated and radiographed. Heat treatment is also required for all weld repairs carried out after HIP.			
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 required for each heat and HIP batch or heat treatment load.			
7. TEST SAMPLING	Samples for mechanical testing shall realistically reflect the properties in the actual components. Samples for production testing shall be cut from the gating system of the casting. For castings 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 $t \leq 30$ mm. - T = 50 mm for $30 < t \leq 60$ mm - T = 75 mm for $t > 60$ mm NOTE: t = section (shell) thickness of castings. For flanged components the largest flange thickness is the ruling thickness. Test samples shall accompany the castings through HIP and any heat treatment, chemical cleaning process or any other operation that may alter metallurgical or mechanical properties.			

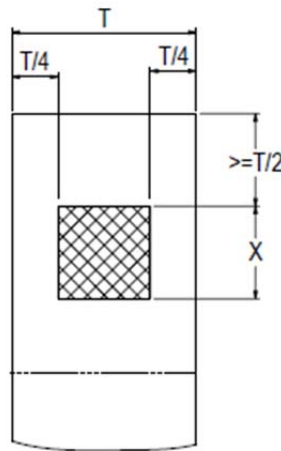
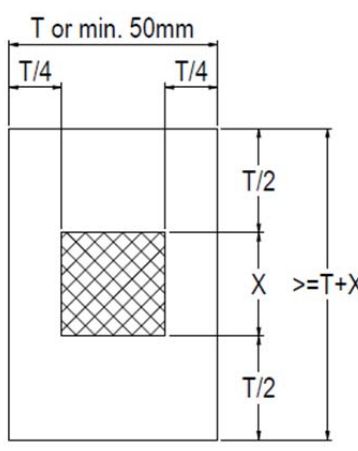
MATERIAL DATA SHEET		MDS T02		Rev. 5												
TYPE OF MATERIAL: Titanium Grade 2																
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.												
Castings	ASTM B 367	C2	-	S2												
				Page 2 of 2												
8. NON DESTRUCTIVE TESTING	NDT operators shall be qualified in accordance with ISO 9712 or equivalent. <i>Liquid penetrant testing:</i> - 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. <i>Radiographic testing (RT):</i> - Method of radiography and acceptance criteria shall be in accordance with ASME VIII, Div. 1, Appendix 7. - Extent of RT for valve castings shall be according to table below. <table border="1"> <thead> <tr> <th colspan="4"><i>Extent of RT based on pressure class and nominal size:</i></th> </tr> </thead> <tbody> <tr> <td colspan="2"><i>Pressure Class:</i></td> <td>≤ 150</td> <td>300</td> </tr> <tr> <td>Extent of RT</td> <td>10 %</td> <td>$\geq 10''$</td> <td>$\geq 10''$</td> </tr> </tbody> </table> - The pilot cast of each pattern shall be 100 % volumetrically RT. - 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.				<i>Extent of RT based on pressure class and nominal size:</i>				<i>Pressure Class:</i>		≤ 150	300	Extent of RT	10 %	$\geq 10''$	$\geq 10''$
<i>Extent of RT based on pressure class and nominal size:</i>																
<i>Pressure Class:</i>		≤ 150	300													
Extent of RT	10 %	$\geq 10''$	$\geq 10''$													
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: - 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			MDS X01	Rev. 3
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 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 delivered in the liquid quenched and tempered condition. The tempering temperature shall be minimum 650 °C.			
3. MANUFACTURING PROCESS	Only seamless fittings are acceptable.			
4. CHEMICAL COMPOSITION	The steel shall be produced by open-hearth, basic oxygen, electric-furnace, or vacuum-induction melting (VIM). The steel shall be fully killed. $S \leq 0,015 \%$; $P \leq 0,025 \%$			
5. TENSILE TESTING	Minimum yield strength: $R_{eh} \geq 415 \text{ MPa}$ Minimum tensile strength: $R_m \geq 620 \text{ MPa}$ Minimum elongation: $A \geq 18 \%$ Minimum red. of area: $Z \geq 35 \%$			
6. IMPACT TESTING	Charpy V-notch impact testing shall be carried out according to ASTM A 370 for thicknesses $t \geq 6 \text{ mm}$. Full sized Charpy V-notch specimens shall be used wherever possible. The test specimen shall be taken in the transverse to the major material flow direction, and the notch shall be perpendicular to the surface. The test temperature shall be - 30 °C. The minimum absorbed energy for full size specimens shall be 42 J average and 30 J single. Reduction factors for sub size specimens shall be: 7,5 mm - 5/6 and 5 mm - 2/3.			
7. HARDNESS TESTING	Maximum hardness readings shall not exceed 250 Hv10, 237 HB or 22 HRC.			
8. EXTENT OF TESTING	One set of tensile and impact test shall be carried out for each lot. A lot is defined as all products of the same type, nominal size and wall thickness, produced from the same heat and heat treatment load. For pipes heat treated in continuous furnace the maximum lot size shall be			
9. TEST SAMPLING	Samples for production testing shall realistically reflect the properties in the actual component. <i>Pipes:</i> Supplementary requirement S2 shall apply. <i>Wrought fittings:</i> Sketches shall be established showing location for extractions of test specimens. The sketch shall be given a document identification number.			
10. NON DESTRUCTIVE TESTING	<i>Pipes:</i> 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. <i>Fittings:</i> 100 % magnetic particle testing in accordance with ASME VIII, Div. 1, Appendix 6.			
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.			

MATERIAL DATA SHEET			MDS X01	Rev. 3
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	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 SHEET			MDS X02	Rev. 4
TYPE OF MATERIAL: High Strength Low Alloyed Steel Type AISI 4140				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Forgings	ASTM A 788	AISI 4140	-	S18
				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. NOTE: Not suitable for sour service applications with the specified tensile properties.			
2. MANUFACTURING	The forgings shall be finished hot-worked.			
3. HEAT TREATMENT	The forgings shall be austenitised, liquid quenched and tempered. Components shall be placed in such a way as to ensure free circulation around each component during the heat treatment process including quenching.			
4. CHEMICAL COMPOSITION	According to ASTM A 29, AISI 4140			
5. EXTENT OF TESTING	One set of tensile and impact test shall be carried out for each melt, section thickness +/- 25 % and heat treatment load.			
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. For products forged by the open die or by the ring rolling method, the test specimen shall be obtained from a sacrificial forging or from an integral prolongation. For flanges the thickness of the prolongation shall minimum be equal to the hub thickness (T_H) as shown in fig. 1. Integrated test blocks shall be used for components manufactured by HIP. Test location flanges: The basic test location is mid-thickness of hub (T_H) in a distance $T_B/2$ or minimum 50 mm from weld end, see fig. 1, position 1. If test specimens cannot be extracted from position 1 test specimens shall be extracted from flange body position 2. 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. Test location other forgings and HIP products: For forgings having maximum section thickness, $T \leq 50$ 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 alternative test may be used. Such alternative test sampling shall be qualified and shall comprise comparative testing of sacrificial forgings and the proposed alternative test sample. Fig. 1 - Location of test specimens for flanges 50 mm from the second heat treated surface.			
7. TENSILE TESTING	Minimum yield strength: $R_{eh} \geq 515$ MPa Minimum tensile strength: $R_M \geq 690$ MPa Minimum elongation: $A \geq 15$ %			

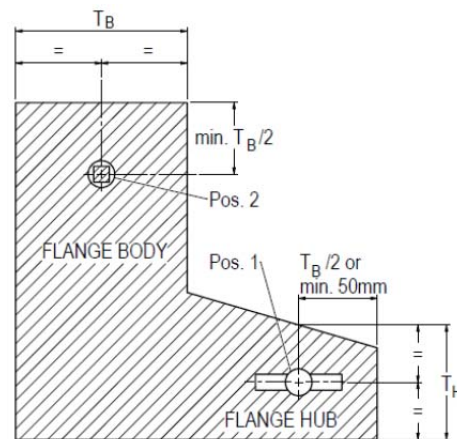
MATERIAL DATA SHEET			MDS X02	Rev. 4
TYPE OF MATERIAL: High Strength Low Alloyed Steel Type AISI 4140				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Forgings	ASTM A 788	AISI 4140	-	S18
				Page 2 of 2
8. IMPACT TESTING	Charpy V-notch testing is required according to ASTM A 370 at - 46 °C. The notch shall be perpendicular to the surface. The minimum absorbed energy for full size specimens shall be 42 J average and 30 J single. For flanges test specimens shall be taken in axial direction to the bore of the flange, see fig. 1, position 1.			
9. HARDNESS TESTING	Except when only one forging is produced, a minimum of two forgings shall be hardness tested per batch or continuous run to ensure that forgings are within the hardness limits 328 HB or 35 HRC.			
10. NON DESTRUCTIVE TESTING	Supplementary Requirement, S18, magnetic particle testing, shall apply to all forgings. The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 6.			
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 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 SHEET			MDS X03	Rev. 4
TYPE OF MATERIAL: High Strength Low Alloy Steel				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Castings	ASTM A 487	Grade 2	Class B and C	
				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. IMPACT TESTING	Charpy V-notch testing is required according to ASTM A 370 at - 30 °C. The notch shall be perpendicular to the surface. The minimum absorbed energy shall be 42 J average of (3 specimens) and 30 J single value.			
3. HARDNESS TESTING	Except when only one casting is produced, a minimum of two castings shall be hardness tested per batch or continuous run to ensure that castings are within the hardness limits 237 HB or 22 HRC.			
4. EXTENT OF TESTING	One set of tensile and impact test is required for each melt and heat treatment load. A test lot shall not exceed 5000 kg.			
5. TEST SAMPLING	Samples for mechanical testing shall realistically reflect the properties in the actual components. Test blocks shall be integral or gated with the casting(s) they represent and shall accompany the castings through all heat treatment operations. 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.  			

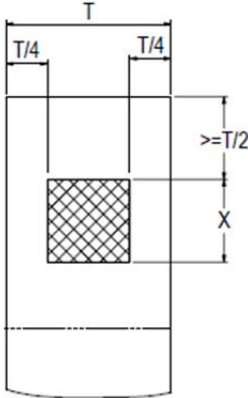
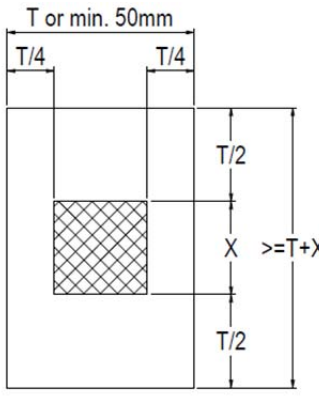
MATERIAL DATA SHEET		MDS X03		Rev. 4																															
TYPE OF MATERIAL: High Strength Low Alloy Steel																																			
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.																															
Castings	ASTM A 487	Grade 2	Class B and C																																
					Page 2 of 2																														
6. NON DESTRUCTIVE TESTING	NDT operators shall be qualified in accordance with ISO 9712 or equivalent. <i>Magnetic particle testing:</i> - 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 RT of valve castings shall be according to table below. <table border="1"> <thead> <tr> <th colspan="7"><i>Extent of RT based on pressure class and valve size:</i></th> </tr> <tr> <th colspan="2"><i>Pressure Class:</i></th> <th>≤ 150</th> <th>300</th> <th>600</th> <th>900</th> <th>1500</th> <th>≥ 2500</th> </tr> </thead> <tbody> <tr> <td rowspan="2">Extent of RT</td> <td>10 %</td> <td>$\geq 10''$</td> <td>$\geq 10''$</td> <td>$\geq 2''$</td> <td>$\geq 2''$</td> <td>$\geq 2''$</td> <td>$\geq 2''$</td> </tr> <tr> <td>100 %</td> <td>Not applicable</td> <td>Not applicable</td> <td>$\geq 20''$</td> <td>$\geq 16''$</td> <td>$\geq 6''$</td> <td>$\geq 6''$</td> </tr> </tbody> </table> - Independent of the extent specified in table above the pilot cast of each pattern shall be 100 % volumetrically RT. - <i>Valve castings</i> 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. - <i>Other type of castings:</i> 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.					<i>Extent of RT based on pressure class and valve size:</i>							<i>Pressure Class:</i>		≤ 150	300	600	900	1500	≥ 2500	Extent of RT	10 %	$\geq 10''$	$\geq 10''$	$\geq 2''$	$\geq 2''$	$\geq 2''$	$\geq 2''$	100 %	Not applicable	Not applicable	$\geq 20''$	$\geq 16''$	$\geq 6''$	$\geq 6''$
<i>Extent of RT based on pressure class and valve size:</i>																																			
<i>Pressure Class:</i>		≤ 150	300	600	900	1500	≥ 2500																												
Extent of RT	10 %	$\geq 10''$	$\geq 10''$	$\geq 2''$	$\geq 2''$	$\geq 2''$	$\geq 2''$																												
	100 %	Not applicable	Not applicable	$\geq 20''$	$\geq 16''$	$\geq 6''$	$\geq 6''$																												
7. REPAIR OF DEFECTS	All repairs exceeding the size defined by A 487 Section 9.41 and/or 9.4.2 shall be documented. All weld repairs shall be postweld 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.																																		
8. MARKING	The component shall be marked to ensure full traceability to melt and heat treatment lot.																																		
9. 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 SHEET			MDS X04	Rev. 3
TYPE OF MATERIAL: High Strength Low Alloyed Steel Type AISI 4130				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Forgings	API 6A	60K (AISI 4130)	PSL 3	-
				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. MANUFACTURING	The flanges shall be forged to shape. Flanges machined out of bar and or plate are not accepted.			
3. HEAT TREATMENT	The flanges shall be austenitised, liquid quenched and tempered. Components shall be placed in such a way as to ensure free circulation around each component during the heat treatment process including quenching.			
4. CHEMICAL COMPOSITION	The steel chemistry should comply with the requirements of AISI 4130, but modified in accordance with the requirements PSL 3 of API 6A. The chemical composition shall be agreed.			
5. EXTENT OF TESTING	One set of tensile and impact test shall be carried out for each melt, section thickness according to API 6A, PSL 3, and heat treatment load. A test lot shall not exceed 2000 kg.			
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. For products forged by the open die or by the ring rolling method, the test specimen shall be obtained from a sacrificial forging or from an integral prolongation. For flanges the thickness of the prolongation shall minimum be equal to the hub thickness (T_H) as shown in fig. 1. Integrated test blocks shall be used for components manufactured by HIP. Test location flanges: The basic test location is mid-thickness of hub (T_H) in a distance $T_B/2$ or minimum 50 mm from weld end, see fig. 1, position 1. If test specimens cannot be extracted from position 1 test specimens shall be extracted from flange body position 2. 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. Test location other forgings and HIP products: For forgings having maximum section thickness, $T \leq 50$ 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 alternative test			
7. IMPACT TESTING	Charpy V-notch testing at - 46 °C is required. The minimum absorbed energy for full size specimens shall be 42 J average and 30 J single. For flanges test specimens shall be taken in axial direction to the bore of the flange, see fig. 1, position 1.			
8. HARDNESS TESTING	Except when only one forging is produced, a minimum of two forgings shall be hardness tested per batch or continuous run to ensure that forgings are within the hardness limits 237 HB or 22 HRC.			

MATERIAL DATA SHEET			MDS X04	Rev. 3
TYPE OF MATERIAL: High Strength Low Alloyed Steel 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 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 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 SHEET			MDS X05	Rev. 3
TYPE OF MATERIAL: High Strength Low Alloyed Steel Type F22				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Forgings	ASTM A 182	F22	3	S4
				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. HEAT TREATMENT	Normalized and tempered. Components shall be placed in such a way as to ensure free circulation around each component during the heat treatment process including quenching.			
3. EXTENT OF TESTING	One set of tensile and impact test shall be carried out for each heat and heat treatment load. A test lot shall not exceed 2000 kg.			
4. 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.  For products forged by the open die or by the ring rolling method, the test specimen shall be obtained from a sacrificial forging or from an integral prolongation. For flanges the thickness of the prolongation shall minimum be equal to the hub thickness (T_H) as shown in fig. 1. Integrated test blocks shall be used for components manufactured by HIP. <u>Test location flanges:</u> The basic test location is mid-thickness of hub (T_H) in a distance $T_B/2$ or minimum 50 mm from weld end, see fig. 1, position 1. If test specimens cannot be extracted from position 1 test specimens shall be extracted from flange body position 2. 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, $T \leq 50$ 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 alternative test may be used. Such alternative test sampling shall be qualified and shall comprise comparative testing of sacrificial forgings and the proposed alternative test sample.			
5. IMPACT TESTING	Charpy V-notch testing at - 46 °C is required. The minimum absorbed energy for full size specimens shall be 27 J average and 20 J single. Reduction factors for 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.			
6. DIMENSIONAL TOLERANCES	Flanges to MSS SP-44 shall have a maximum wall thickness under tolerance of 0,3 mm for the hub at the welding end.			
7. NON DESTRUCTIVE TESTING	Supplementary Requirement, S4, Magnetic Particle testing, shall apply to all forgings. The acceptance criteria shall be to ASME VIII, Div. 1, Appendix 6.			

MATERIAL DATA SHEET		MDS X05		Rev. 3
TYPE OF MATERIAL: High Strength Low Alloyed Steel 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 SHEET			MDS X06	Rev. 3
TYPE OF MATERIAL: High Strength Low Alloy Steel for application down to -46°C				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Castings	ASTM A 487	Grade 2	Class B and C	S20
				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. CHEMICAL COMPOSITION	$C \leq 0,14 \%$; $Si \leq 0,50 \%$; $Mn \leq 1,60 \%$; $Cr \leq 0,20 \%$; $Ni = 0,90-1,10 \%$; $Mo = 0,15-0,25 \%$			
3. IMPACT TESTING	Charpy V-notch testing is required according to ASTM A 370 at - 46 °C. The notch shall be perpendicular to the surface. The minimum absorbed energy shall be 42 J average and 30 J single value.			
4. HARDNESS TESTING	Except when only one forging is produced, a minimum of two castings shall be hardness tested per batch or continuous run to ensure that forgings are within the hardness limits 237 HB or 22 HRC.			
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	Samples for mechanical testing shall realistically reflect the properties in the actual components. Test blocks shall be integral or gated with the casting(s) they represent and shall accompany the castings through all heat treatment operations. 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.  Fig.1 - Integral test block  Fig. 2 - Gated test block			

MATERIAL DATA SHEET		MDS X06		Rev. 3																																
TYPE OF MATERIAL: High Strength Low Alloy Steel for application down to -46°C																																				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.																																
Castings	ASTM A 487	Grade 2	Class B and C	S20																																
					Page 2 of 2																															
7. NON DESTRUCTIVE TESTING	NDT operators shall be qualified in accordance with EN 473 or equivalent. <i>Magnetic particle testing:</i> - 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 RT of valve castings shall be according to table below. <table border="1"> <thead> <tr> <th colspan="8">Extent of RT based on pressure class and valve size:</th> </tr> <tr> <th colspan="2">Pressure Class:</th> <th>≤ 150</th> <th>300</th> <th>600</th> <th>900</th> <th>1500</th> <th>≥ 2500</th> </tr> </thead> <tbody> <tr> <td rowspan="2">Extent of RT</td> <td>10 %</td> <td>≥ 10"</td> <td>≥ 10"</td> <td>≥ 2"</td> <td>≥ 2"</td> <td>≥ 2"</td> <td>≥ 2"</td> </tr> <tr> <td>100 %</td> <td>Not applicable</td> <td>Not applicable</td> <td>≥ 20"</td> <td>≥ 16"</td> <td>≥ 6"</td> <td>≥ 6"</td> </tr> </tbody> </table> - Independent of the extent specified in table above the pilot cast of each pattern shall be 100 % volumetrically RT. - <i>Valve castings</i> shall be examined in the areas as defined by ASME B16.34 and critical areas as defined by designer for special class valves. 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. - <i>Other type of castings:</i> 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.					Extent of RT based on pressure class and valve size:								Pressure Class:		≤ 150	300	600	900	1500	≥ 2500	Extent of RT	10 %	≥ 10"	≥ 10"	≥ 2"	≥ 2"	≥ 2"	≥ 2"	100 %	Not applicable	Not applicable	≥ 20"	≥ 16"	≥ 6"	≥ 6"
Extent of RT based on pressure class and valve size:																																				
Pressure Class:		≤ 150	300	600	900	1500	≥ 2500																													
Extent of RT	10 %	≥ 10"	≥ 10"	≥ 2"	≥ 2"	≥ 2"	≥ 2"																													
	100 %	Not applicable	Not applicable	≥ 20"	≥ 16"	≥ 6"	≥ 6"																													
8. REPAIR OF DEFECTS	All repairs exceeding the size defined by A 487 Section 9.4.1 and/or 9.4.2 shall be documented. All weld repairs shall be postweld 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.																																			
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: - heat treatment condition, for QT condition, austenitisation and tempering temperature and quenching medium shall be stated.																																			

MATERIAL DATA SHEET			MDS X07	Rev. 2
TYPE OF MATERIAL: Low alloyed steel				
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. <i>SCOPE</i>	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. NOTE: This MDS is derived from NORSOK EDS NBO1.			
2. <i>IMPACT TESTING</i>	<i>Nuts to A 194:</i> Supplementary requirement S3 low temperature requirements shall apply.			
3. <i>PROOF LOAD TESTING</i>	<i>Nuts to A 194:</i> Supplementary requirement S4 Proof load testing shall apply.			
4. <i>DIMENSIONS</i>	<i>Studs:</i> The stud length shall be according to ASME B16.5 or NORSOK L-005 (ISO 27509). 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. <i>Nuts:</i> 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. <i>SURFACE PROTECTION</i>	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. <i>CERTIFICATION</i>	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	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. <i>Note:</i> This MDS is derived from NORSOK EDS NBO1.			
2. DIMENSIONS	Studs Stud bolt length shall be according to ASME B16.5 or NORSOK L-005 (ISO 27509). 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 (EDS')

ELEMENT DATA SHEET	EDS NBE1	Rev. 5
Title: Cold bending		Page 1 of 4

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 $\pm 40^\circ$ from the neutral plan.

3.3 Welding

No welding shall be performed in the plastically deformed zone nor closer than 2 times wall thickness, 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.

ELEMENT DATA SHEET	EDS NBE1	Rev. 5
Title: Cold bending		Page 2 of 4

Table 1 — Limitations and special requirements for cold bent pipes

Material	Service	Limitations and/or additional requirements
CMn-steel for LT service MDS C01, C11, C22	Utility service and non-sour hydro-carbon service	The maximum hardness requirements shall be 35 Hv10 or 35 HRC. 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, MDS D41, D42, D48, D51, D52 and D58	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 shall be 328 HB or 35 HRC and SSC testing to ISO 15156 is required.
SS Type 6Mo MDS R11, R12 and R18	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 shall be 328 HB or 35 HRC and SSC testing to ISO 15156 is required.
Titanium Grade 2 MDS T01	Utility service	
	H ₂ S containing service within the limitations of ISO 15156-3.	Not accepted.

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 H₂S 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 ≥ 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.

ELEMENT DATA SHEET	EDS NBE1	Rev. 5
Title: Cold bending		Page 3 of 4

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.

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

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

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.

ELEMENT DATA SHEET	EDS NBE1	Rev. 5
Title: Cold bending		Page 4 of 4

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.

ELEMENT DATA SHEET	EDS NBE2	Rev. 2
Title: Hot induction bending		Page 1 of 4

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 15590-1 except that the modifications specified in Table 1 shall apply, additionally, any change of the clad welding procedure shall be an essential variable.

Table 1 — Essential variables

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

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.

ELEMENT DATA SHEET	EDS NBE2	Rev. 2
Title: Hot induction bending		Page 2 of 4

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 168 mm 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.

Table 2 —MPS qualification test for bend in carbon and stainless steels, nickel alloys and clad pipe^a

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

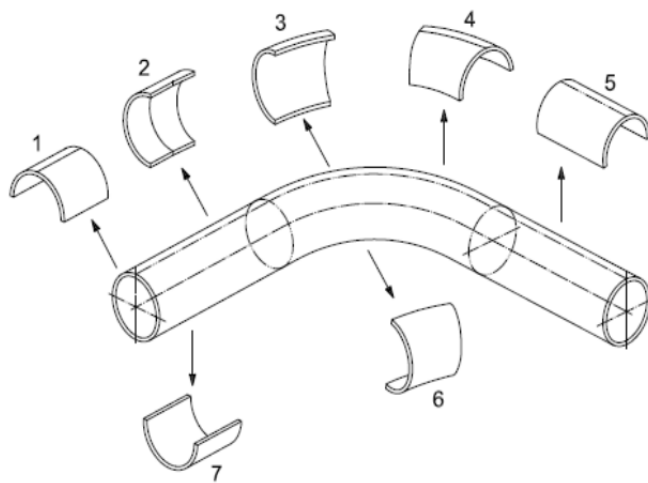
^g The cladding of carbon or low-alloyed steel shall be 100 % inspected with LP and bond line integrity with UT per API 6A/ISO 10423 PSL 3.

ELEMENT DATA SHEET	EDS NBE2	Rev. 2
Title: Hot induction bending		Page 3 of 4

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

ELEMENT DATA SHEET	EDS NBO2	Rev. 3
Title: Body/Bonnet bolting for valves		Page 1 of 2

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	Ti
A 320 Gr L7/A 194 Gr 7	X07	1	I/TB	I/TB	I/TB	I/TB	I/TB	I/TB	I	
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	I	I	I	I	
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 respect to thermal expansion and allowable stress.										
Legends CS carbon steel LTCS low temperature carbon steel 6Mo HC type 6Mo for hydrocarbon service 6Mo SW type 6Mo for seawater service Ti titanium grade 2					Legends I accepted for integrated fasteners TB accepted for "Trough-bolted" fasteners VDS valve data sheet					

ELEMENT DATA SHEET	EDS NBO2	Rev. 3
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.

ELEMENT DATA SHEET	EDS NHF1	Rev. 5
Title: Hardfacing by overlay welding		Page 1 of 2

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.

ELEMENT DATA SHEET	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 qualification 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 qualification 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. Non destructive testing

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.)

ELEMENT DATA SHEET	EDS NHF2	Rev. 5
Title: Hardfacing by thermal spraying of Tungsten Carbide		Page 1 of 2

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 $\mu Ra = 4$.

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 $R_a = 0,15 \mu m$.

ELEMENT DATA SHEET	EDS NHF2	Rev. 5
Title: Hardfacing by thermal spraying of Tungsten Carbide		Page 2 of 2

3. PROCEDURE QUALIFICATION TESTING

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

- the type of equipment used;
- nozzle length;
- fuel and gas flow rate, $\pm 5\%$;
- spray distance, $\pm 5\%$;
- spray rate, $\pm 5\%$;
- 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 ° 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.

ELEMENT DATA SHEET	EDS NHF7	Rev. 2
Title: Corrosion resistant overlay welding		Page 1 of 1

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 deposit 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.)

ELEMENT DATA SHEET	EDS NHF8	Rev. 2
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 $K_{Ic} = 9,5$ 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 bi-directional 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.

ELEMENT DATA SHEET	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.

ELEMENT DATA SHEET	NSR1	Rev. 1
Title: Metallic seal rings		Page 1 of 2

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 (ISO 27509) 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	
Type 316	Alloy 630 ^{2, 3, 4}	Alloy 630 ^{2, 3, 4}	UNS S31600 ⁵
Type 6Mo	Type 25Cr ^{3, 4}	Type 25Cr ^{3, 4}	
Type 22Cr duplex	Alloy 630 ^{2, 3}	Type 22/25Cr	
Type 25Cr duplex	Type 25Cr ⁴	Type 25Cr ⁴	
Alloy 625	Alloy 625 or 725	Alloy 625 or 725	
Notes:			
1. Alternatively, low steels with another chemistry may be applied. Minimum tensile strength requirement is specified by NORSOK L-005 (ISO 27509).			
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.			
5. Seal ring for flanges/hubs in Type 22/25Cr duplex and 6Mo in service where traces of oxygen may be present, e.g. produced 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.

ELEMENT DATA SHEET	NSR1	Rev. 1
Title: Metallic seal rings		Page 2 of 2

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 make-up 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.

Table 2 — Applicable specifications and maximum hardness requirements

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

ELEMENT DATA SHEET	EDS NTR1	Rev. 2
Title: Trim materials for valves with body/bonnet in carbon steel		Page 1 of 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 Type 17-4 PH, UNS S17400 ^{3, 4}	ASTM A 564, Type 630, condition H1150M; maximum hardness 33 HRC.	
	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	D44
	ASTM A 890 UNS J92205	D46
	ASTM A 276 UNS S31803	D47
Type 25Cr Duplex	ASTM A 182 Grade F53, F55 or F61	D54
	ASTM A 890 Grade 5A or 6A	D56
	ASTM A 276 UNS S32550, S32750 or S32760	D57
Nickel Alloys	ASTM B 446/B 564, UNS N06625	N01
	ASTM A 494 Grade CW-6MC and CX2MW	N02
	ASTM B 637 UNS N07718 and N07750; Maximum hardness 35 HRC.	

NOTES:

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

ELEMENT DATA SHEET	EDS NTR1	Rev. 2
Title: Trim materials for valves with body/bonnet in carbon steel		Page 2 of 2

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.

ELEMENT DATA SHEET	EDS NTR2	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	
Type 13-4 ^{2, 4}	ASTM A 182 Grade F6NM or A 352 Grade CA6NM Heat treatment: 1. Austenitize at 1010 °C minimum and air cool or oil quench to ambient temperature. 2. Temper at 648 to 690 °C and air cool to ambient temperature. 3. 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	N01
	ASTM B 564, UNS N06625	N01
	ASTM A 494 Grade CW-6MC and CX2MW	N02
	ASTM B 637 UNS N07718; Maximum hardness 35 HRC.	
Titanium	ASTM B 348 Grade 5 or ASTM B 381 Grade F5	

NOTES:

1. Type 316 may not be suitable for metal to metal seal component.
2. 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.
3. 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		Page 2 of 2

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 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 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.

