

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 Subject to development and publication of international standards, the relevant NORSOK standard will be withdrawn.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 trykkipåkjent 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

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

MDS No.	Rev. No.	Standard and grade (see NOTE)	Products
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	-
			t > 19 mm: Cl. 22, 32, 42	-
Seamless pipes	ASTM A 106	B	-	S6
Forgings	ASTM A 105	-	-	S4
Plates	ASTM A 516	60, 70	-	-
				Page 1 of 1
1. SCOPE	This MDS specifies the selected options in the referred standard and additional requirements which shall be added or supersede the corresponding requirements in the referred standard.			
2. HEAT TREATMENT	<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. Magnetic particle testing: - All accessible surfaces (including internal surfaces) of all castings shall be examined with Magnetic Particle (MT). Surface examination of steel castings shall be in accordance with ASME VIII Div. 1 Appendix 7. The testing shall be carried out after final machining. Non-machined surfaces shall be pickled prior to the testing. Radiographic testing (RT): - Method of radiography and acceptance criteria shall be in accordance with ASME VIII Div. 1 Appendix 7. - Extent of 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. - Valve castings shall be examined in the areas as defined by ASME B16.34 for special class valves and other critical areas as defined by designer. In addition castings shall be examined at abrupt changes in sections and at the junctions of risers, gates or feeders to the castings. When random examination (10 %) is specified, minimum one casting of each pattern including feeder and riser system in any purchase order with the foundry shall be examined. If defect outside acceptance criteria is detected, two more castings shall be tested, and if any of these two fails all items represented shall be tested. - Other type of castings: Each casting shall be examined unless agreed otherwise. Testing shall be at abrupt changes in sections and at the junctions of risers, gates or feeders to the castings and other critical areas as defined by designer. Sketches of the areas to be tested shall be established and agreed.					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.

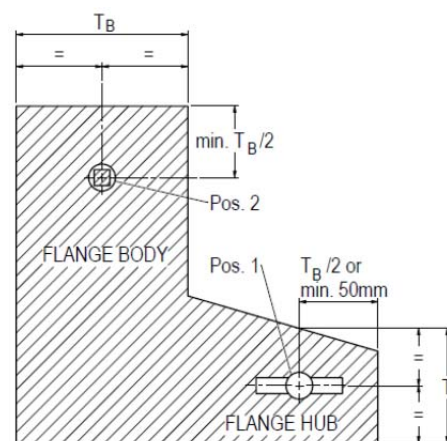


Fig. 1 - Location of test specimens for flanges

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.

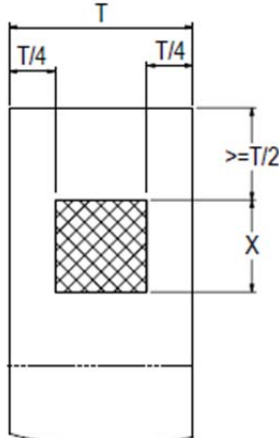
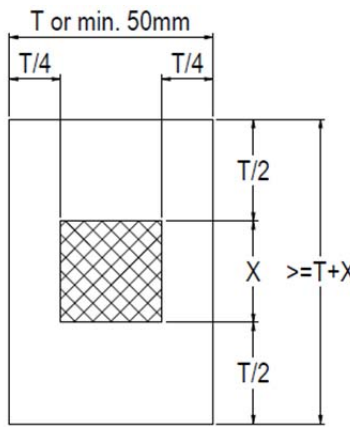
Test location other forgings and HIP products: For forgings having maximum section thickness, T ≤ 50 mm, the test specimen shall be taken at mid thickness and its mid length shall be at least 50 mm from any second surface or at equal distance from the second surfaces.

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.

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.   Fig.1 - Integral test block Fig. 2 - Gated test block			

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. Magnetic particle testing: - All accessible surfaces (including internal surfaces) of all castings shall be examined with Magnetic Particle (MT). Surface examination of steel castings shall be in accordance with ASME VIII Div. 1 Appendix 7. The testing shall be carried out after final machining. Non-machined surfaces shall be pickled prior to the testing. Radiographic testing (RT): - Method of radiography and acceptance criteria shall be in accordance with ASME VIII Div. 1 Appendix 7. - Extent of 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. - 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 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. 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 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.			

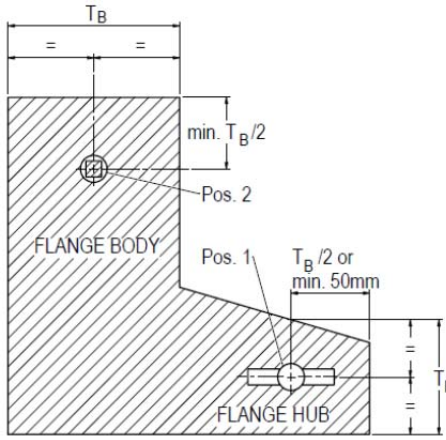
MATERIAL DATA SHEET			MDS D41	Rev. 5
TYPE OF MATERIAL: Ferritic/Austenitic Stainless Steel, Type 22Cr duplex				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Seamless pipes	ASTM A 790	UNS S31803 UNS S32205	-	-
				Page 2 of 2
14. MARKING	The component shall be marked to ensure full traceability to 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 HIP Products	ASTM A 815 ASTM A 988	UNS S31803 UNS S32205	WP-W, WP-S or WP-WX	S7
				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. 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.			

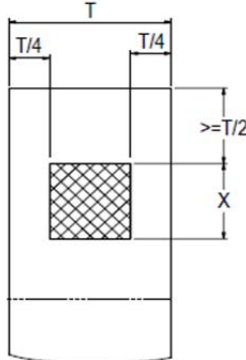
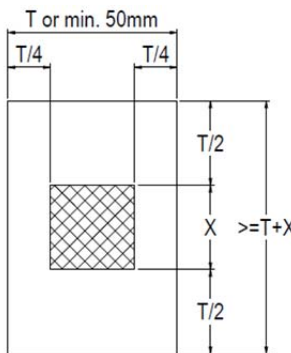
MATERIAL DATA SHEET			MDS D44	Rev. 5
TYPE OF MATERIAL: Ferritic / Austenitic Stainless Steel, Type 22Cr duplex				
PRODUCT	STANDARD	GRADE	ACCEPT. CLASS	SUPPL. REQ.
Forgings	ASTM A 182	F51, UNS S31803	-	S56
HIP Products	ASTM A 988	F60, UNS S32205		
				Page 2 of 3
8. EXTENT OF TESTING	One set of impact 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. - <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"																											
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	<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 phase 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 / 35 J single. Reduction factors for sub-size specimens shall be: 7,5 mm - 5/6 and 5 mm - 2/3.			
9. CORROSION TEST	Corrosion test according to ASTM G 48 Method A is required. Test temperature shall be 25 °C and the exposure time 24 hours. The test shall expose the external and internal surfaces and a cross section surface in full wall thickness. Cut edges shall be prepared according to ASTM G 48. The complete specimen shall be pickled before weighed and tested. Pickling may be performed for 5 minutes at 60 °C in a solution of 20 % HNO ₃ + 5 % HF. The acceptance criteria are: – No pitting 20 X magnification. – The weight loss shall be less than 4,0 g/m ² .			
10. EXTENT OF TESTING	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.			