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# Oil and gas industries including lower carbon energy — Piping systems on offshore platforms and onshore plants —

## Part 2: **Materials**

*Industries du pétrole et du gaz, y compris les énergies à faible teneur en carbone — Conception et installation des systèmes de tuyauterie sur les plates-formes de production en mer et les installations à terre —*

*Partie 2: Matériels*



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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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# Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 67, *Oil and gas industries including lower carbon energy*, Subcommittee SC 6, *Process equipment, piping, systems, and related safety,* in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 12, *Oil and gas industries including lower carbon energy*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This first edition of ISO 13703-2, together with ISO 13703-1 and ISO 13703-3, cancels and replaces ISO 13703:2000, which has been technically revised. It also incorporates the Technical Corrigendum ISO 13703:2000/Cor.1:2002.

The main changes compared to the previous edition are as follows:

— deletion of the installation and quality control requirements in Clause 10;

— deletion of former Annex C as requirements are addressed in ASME B31.3;

— addition of material data sheets.

A list of all parts in the ISO 13703 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

# Introduction

Requirements are defined in material datasheets and element datasheets, which can be used for the specification and procurement of materials for piping systems. Common fabrication, welding, inspection, examination and testing requirements of piping systems are covered by ISO 13703-3.

Local, national or regional regulations can also affect the specification of piping materials.

# Oil and gas industries including lower carbon energy — Piping systems on offshore platforms and onshore plants —

## Part 2: Materials



## 1 Scope

This document provides a set of common supplementary requirements for the most frequently used materials in upstream oil and gas piping systems.

This document is applicable to offshore and onshore production facilities, processing and gas liquefaction plants. The materials covered in this document are intended to be used in the following piping systems services:

— category D, category M, normal and high pressure, according to ASME B31.3;

— sour environments as defined in the ISO 15156 series.

NOTE For the purposes of this document, ANSI/NACE MR0175 is equivalent to the ISO 15156 series, and ANSI/NACE MR0103 is equivalent to ISO 17945.

This document does not provide guidelines for material selection. The selection of suitable materials for a specific service including any necessary additional material requirements remains the responsibility of the end user.

This document does not cover requirements related to:

— sulfide stress cracking (SSC) in corrosive petroleum refining environments included in ISO 17945;

— non-metallic piping systems according to ASME B31.3 or the ISO 14692 series;

— marine piping systems, e.g. ballasting piping system, covered by classification rules;

— subsea production systems;

— downhole equipment;

— transportation pipeline systems, including flowlines, designed in accordance with a recognized pipeline design code.

Common requirements related to manufacture, inspection and procurement of piping and valve parts are included in Annex A and Annex B, providing material datasheets and element datasheets, respectively. These material and element datasheets can be applied for applications other than piping systems, e.g. pressure vessels and pumps based upon assessment of the end user and conformance with the selected design code for the relevant equipment. This document is not intended to limit the use of alternative materials or grades within a referenced material standard. Where the use of alternative materials/grades are considered appropriate, the end user is responsible for specifying any additional requirements necessary to meet the design code or specification.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3452 (all parts), *Non-destructive testing — Penetrant testing*

ISO 4499-2, *Hardmetals — Metallographic determination of microstructure — Part 2: Measurement of WC grain size*

ISO 4499-4, *Hardmetals — Metallographic determination of microstructure — Part 4: Characterisation of porosity, carbon defects and eta-phase content*

ISO 4624, *Paints and varnishes — Pull-off test for adhesion*

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

ISO 9606, *Qualification testing of welders — Fusion welding*

ISO 10474, *Steel and steel products — Inspection documents*

ISO 10684, *Fasteners — Hot dip galvanized coatings*

ISO 10893-11, *Non-destructive testing of steel tubes — Part 11: Automated ultrasonic testing of the weld seam of welded steel tubes for the detection of longitudinal and/or transverse imperfections*

ISO 11970, *Specification and qualification of welding procedures for production welding of steel castings*

ISO 14732, *Welding personnel — Qualification testing of welding operators and weld setters for mechanized and automatic welding of metallic materials*

ISO 15156 (all parts), *Petroleum and natural gas industries — Materials for use in $H_2S$-containing environments in oil and gas production*

ISO 15614-1, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys*

ISO 15614-5, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 5: Arc welding of titanium, zirconium and their alloys*

ISO 15614-7, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 7: Overlay welding*

ISO 17637, *Non-destructive testing of welds — Visual testing of fusion-welded joints*

ISO 17781, *Petroleum, petrochemical and natural gas industries — Test methods for quality control of microstructure of ferritic/austenitic (duplex) stainless steels*

ISO 17782, *Petroleum, petrochemical and natural gas industries — Scheme for conformity assessment of manufacturers of special materials*

ISO 27509, *Petroleum and natural gas industries — Compact flanged connections with IX seal ring*

ISO 28079, *Hardmetals — Palmqvist toughness test*

ISO 6507-1, *Metallic materials — Vickers hardness test — Part 1: Test method*

ANSI/MSS SP-55, *Quality standard for steel castings for valves, flanges, fittings, and other piping components - visual method for evaluation of surface irregularities*

ANSI/NACE TM0284, *Evaluation of pipeline and pressure vessel steels for resistance to hydrogen-induced cracking*

ANSI/NACE MR0175, *Petroleum and natural gas industries — Materials for use in $H_2S$-containing environments in oil and gas production*

API RP 934-A, *Materials and fabrication of 2 1/4 Cr-1Mo, 2 1/4 Cr-1Mo 1/4 v, 3Cr-1Mo, and 3Cr-1Mo-1/4 V steel heavy wall pressure vessels for high-temperature, high pressure Hydrogen service*

API RP 934-C, *Materials and fabrication of 1 1/4 Cr-1/2 Mo steel heavy wall pressure vessels for high-pressure Hydrogen service operating at or below 825 degrees F (440 degrees C)*

API Spec 5L, *Specification for line pipe*

API Std 6ACRA, *Age-hardened Nickel-based alloys for oil and gas drilling and production equipment*

ASME B16.20, *Metallic gaskets for pipe flanges*

ASME B16.34, *Valves – Flanged, threaded and welding end*

ASME B31.3, *Process piping*

ASME Boiler and pressure vessel code (BPVC), Section V: *Nondestructive examination*

ASME Boiler and pressure vessel code (BPVC), Section VIII, Division 1: *Rules for construction of pressure vessels*

ASME Boiler and pressure vessel code (BPVC), Section VIII, Division 2: *Alternative rules*

ASME Boiler and pressure vessel code (BPVC), Section VIII, Division 3: *Alternative rules for high pressure vessels*

ASME Boiler and pressure vessel code (BPVC), Section IX: *Welding and brazing qualifications*

ASTM A20/A20M, *Standard specification for general requirements for steel plates for pressure vessels*

ASTM A29/A29M, *Standard specification for general requirements for steel bars, Carbon and alloy, hot-wrought*

ASTM A105/A105M, *Standard specification for Carbon steel forgings for piping applications*

ASTM A106/A106M, *Standard specification for seamless Carbon steel pipe for high-temperature service*

ASTM A182/A182M, *Standard specification for forged or rolled alloy and stainless Steel pipe flanges, forged fittings, and valves and parts for high-temperature service*

ASTM A193/A193M, *Standard specification for alloy-steel and stainless steel bolting for high temperature or high pressure service and other special purpose applications*

ASTM A194/A194M, *Standard specification for Carbon steel, alloy steel, and stainless steel nuts for bolts for high pressure or high temperature service, or both*

ASTM A203/A203M, *Standard specification for pressure vessel plates, alloy steel, Nickel*

ASTM A216/A216M, *Standard specification for steel castings, Carbon, suitable for fusion welding, for high-temperature service*

ASTM A217/217M, *Standard Specification for Steel Castings, Martensitic Stainless and Alloy, for Pressure-Containing Parts, Suitable for High-Temperature Service*

ASTM A234/A234M, *Standard specification for piping fittings of wrought Carbon steel and alloy steel for moderate and high temperature service*

ASTM A240/A240M, *Standard specification for Chromium and Chromium-Nickel stainless steel plate, sheet, and strip for pressure vessels and for general applications*

ASTM A269/A269M, *Standard specification for seamless and welded austenitic stainless steel tubing for general service*

ASTM A276/A276M, *Standard specification for stainless steel bars and shapes*

ASTM A312/A312M, *Standard specification for seamless, welded, and heavily cold worked austenitic stainless steel pipes*

ASTM A320/A320M, *Standard specification for alloy-steel and stainless steel bolting for low-temperature service*

ASTM A333/A333M, *Standard specification for seamless and welded steel pipe for low-temperature service and other applications with required notch toughness*

ASTM A334/A334M, *Standard specification for seamless and welded Carbon and alloy-steel tubes for low-temperature service*

ASTM A335/A335M, *Standard specification for seamless Ferritic alloy-steel pipe for high-temperature service*

ASTM A350/A350M, *Standard specification for Carbon and low-alloy steel forgings, requiring notch toughness testing for piping components*

ASTMA351/A351M, *Standard specification for castings, austenitic, for pressure-containing parts*

ASTM A352/A352M, *Standard specification for steel castings, ferritic and martensitic, for pressure-containing parts, suitable for low-temperature service*

ASTM A358/A358M, *Standard specification for electric-fusion-welded austenitic Chromium-Nickel stainless steel pipe for high-temperature service and general applications*

ASTM A363, *Standard specification for Zinc-coated (galvanized) steel overhead ground wire strand*

ASTM A370, *Standard test methods and definitions for mechanical testing of steel products*

ASTM A387/A387M, *Standard specification for pressure vessel plates, alloy steel, Chromium-Molybdenum*

ASTM A388/A388M, *Standard practice for ultrasonic examination of steel forgings*

ASTM A403/A403M, *Standard specification for wrought austenitic stainless steel piping fittings*

ASTM A420/A420M, *Standard specification for piping fittings of wrought Carbon steel and alloy steel for low-temperature service*

ASTM A453/A453M, *Standard specification for high-temperature bolting, with expansion coefficients comparable to austenitic stainless steels*

ASTM A479/A479M, *Standard specification for stainless steel bars and shapes for use in boilers and other pressure vessels*

ASTM A484/A484M, *Standard specification for general requirements for stainless steel bars, billets, and forgings*

ASTM A488/A488M, *Standard practice for steel castings, welding, qualifications of procedures and personnel*

ASTM A494/A494M, *Standard specification for castings, Nickel and Nickel alloy*

ASTM A508/A508M, *Standard specification for quenched and tempered vacuum-treated Carbon and alloy steel forgings for pressure vessels*

ASTM A516/A516M, *Standard specification for pressure vessel plates, Carbon steel, for moderate- and lower-temperature service*

ASTM A564/A564M, *Standard specification for hot-rolled and cold-finished age-hardening stainless steel bars and shapes*

ASTM A578/A578M, *Standard specification for straight-beam ultrasonic examination of rolled steel plates for special applications*

ASTM A671/A671M, *Standard specification for electric-fusion-welded steel pipe for atmospheric and lower temperatures*

ASTM A672/A672M, *Standard specification for electric-fusion-welded steel pipe for high-pressure service at moderate temperatures*

ASTM A691/A691M, *standard specification for Carbon and alloy steel pipe, electric-fusion-welded for high-pressure service at high temperatures*

ASTM A694/A694M, *Standard specification for Carbon and alloy steel forgings for pipe flanges, fittings, valves, and parts for high-pressure transmission service*

ASTM A696, *Standard specification for steel bars, Carbon, hot-wrought or cold-finished, special quality, for pressure piping components*

ASTM A703/A703M, *standard specification for steel castings, creep-strength enhanced ferritic alloy, for pressure-containing parts, suitable for high temperature service*

ASTM A705/A705M, *Standard specification for age-hardening stainless steel forgings*

ASTM A739, *Standard specification for steel bars, alloy, hot-wrought, for elevated temperature or pressure-containing parts, or both*

ASTM A781/A781M, *Standard specification for castings, steel and alloy, common requirements, for general industrial use*

ASTM A788/A788M, *Standard specification for steel forgings, general requirements*

ASTM A789/A789M, *Standard specification for seamless and welded ferritic/austenitic stainless steel tubing for general service*

ASTM A790/A790M, *Standard specification for seamless and welded ferritic/austenitic stainless steel pipe*

ASTM A815/A815M, *Standard specification for wrought ferritic, ferritic/austenitic, and martensitic stainless steel piping fittings*

ASTM A860/A860M, *Standard specification for wrought high-strength ferritic steel butt-welding fittings*

ASTM A928/A928M, *Standard specification for ferritic/austenitic (duplex) stainless steel pipe electric fusion welded with addition of filler metal*

ASTM A957/A957M, *Standard specification for investment castings, steel and alloy, common requirements, for general industrial use*

ASTM A960/A960M, *Standard specification for common requirements for wrought steel piping fittings*

ASTM A961/A961M, *Standard specification for common requirements for steel flanges, forged fittings, valves, and parts for piping applications*

ASTM A962/A962M, *Standard specification for common requirements for bolting intended for use at any temperature from cryogenic to the creep range*

ASTM A966/A966M, *Standard practice for magnetic particle examination of steel forgings using alternating current*

ASTM A985/A985M, *Standard specification for steel investment castings general requirements, for pressure-containing parts*

ASTM A988/A988M, *Standard specification for hot isostatically-pressed stainless steel flanges, fittings, valves, and parts for high temperature service*

ASTM A995/995M, *Standard specification for castings, austenitic-ferritic (duplex) stainless steel, for pressure-containing parts*

ASTM A1058, *Standard Test Methods for Mechanical Testing of Steel Products — Metric*

ASTM A1080/A1080M, *Standard practice for hot isostatic pressing of steel, stainless steel, and related alloy castings*

ASTM A1082/A1082M, *Standard specification for high strength precipitation hardening and duplex stainless steel bolting for special purpose applications*

ASTM B124/B124M, *Standard Specification for Copper and Copper Alloy Forging Rod, Bar, and Shapes*

ASTM B148, *Standard specification for Aluminum-Bronze sand castings*

ASTM B150/150M, *Standard Specification for Aluminum Bronze Rod, Bar, and Shapes*

ASTM B151/B151M, *Standard specification for Copper-Nickel-Zinc alloy (Nickel Silver) and Copper-Nickel rod and bar*

ASTM B171/B171M, *Standard specification for Copper-alloy plate and sheet for pressure vessels, condensers, and heat exchangers*

ASTM B265, *Standard specification for Titanium and Titanium alloy strip, sheet, and plate*

ASTM B338, *Standard specification for seamless and welded Titanium and Titanium alloy tubes for condensers and heat exchangers*

ASTM B348, *Standard specification for Titanium and Titanium alloy bars and billets*

ASTM B363, *Standard specification for seamless and welded unalloyed Titanium and Titanium alloy welding fittings*

ASTM B366/B366M, *Standard specification for factory-made wrought Nickel and Nickel alloy fittings*

ASTM B367, *Standard specification for Titanium and Titanium alloy castings*

ASTM B381, *Standard specification for Titanium and Titanium alloy forgings*

ASTM B423, *Standard Specification for Nickel-Iron-Chromium-Molybdenum-Copper Alloy Seamless Pipe and Tube*

ASTM B424, *Standard Specification for Nickel-Iron-Chromium-Molybdenum-Copper Alloys Plate, Sheet, and Strip*

ASTM B425, *Standard Specification for Nickel-Iron-Chromium-Molybdenum-Copper Alloys Rod and Bar*

ASTM B443, *Standard specification for Nickel-Chromium-Molybdenum-Columbium alloy and Nickel-Chromium-Molybdenum-Silicon alloy plate, sheet, and strip*

ASTM B444, *Standard specification for Nickel-Chromium-Molybdenum-Columbium alloys (UNS N06625 and UNS N06852) and Nickel-Chromium-Molybdenum-Silicon alloy (UNS N06219) pipe and tube*

ASTM B446, *Standard specification for Nickel-Chromium-Molybdenum-Columbium Alloy (UNS N06625), Nickel-Chromium-Molybdenum-Silicon alloy (UNS N06219), and Nickel-Chromium-Molybdenum-Tungsten alloy (UNS N06650) rod and bar*

ASTM B499, *Standard test method for measurement of coating thicknesses by the magnetic method: nonmagnetic coatings on magnetic basis metals*

ASTM B564, *Standard specification for Nickel alloy forgings*

ASTM B571, *Standard practice for qualitative adhesion testing of metallic coatings*

ASTM B578, *Standard test method for microhardness of electroplated coatings*

ASTM B602, *Standard test method for attribute sampling of metallic and inorganic coatings*

ASTM B637, *Standard specification for precipitation-hardening and cold worked Nickel alloy bars, forgings, and forging stock for moderate or high temperature service*

ASTM B705, *Standard specification for Nickel-alloy (UNS N06625, N06219 and N08825) welded pipe*

ASTM B733, *Standard specification for autocatalytic (electroless) Nickel-Phosphorus coatings on metal*

ASTM B834, *Standard specification for pressure consolidated powder metallurgy Iron-Nickel-Chromium-Molybdenum (UNS N08367), Nickel-Chromium-Molybdenum-Columbium (Nb) (UNS N06625), Nickel-Chromium-Iron alloys (UNS N06600 and N06690), and Nickel-Chromium-Iron-Columbium-Molybdenum (UNS N07718) alloy pipe flanges, fittings, valves, and parts*

ASTM B861, *Standard specification for Titanium and Titanium alloy seamless pipe*

ASTM B862, *Standard specification for Titanium and Titanium alloy welded pipe*

ASTM C633, *Standard test method for adhesion or cohesion strength of thermal spray coatings*

ASTM E8/E8M, *Standard test methods for tension testing of metallic materials*

ASTM E94/E94M, *Standard guide for radiographic examination using industrial radiographic film*

ASTM E112, *Standard test methods for determining average grain size*

ASTM E165/E165M, *Standard practice for liquid penetrant testing for general industry*

ASTM E186, *Standard reference radiographs for heavy-walled (2 to 412 in. (50,8 to 114 mm)) steel castings*

ASTM E280, *Standard reference radiographs for heavy-walled (412 to 12 in. (114 to 305 mm)) steel castings*

ASTM E446, *Standard reference radiographs for steel castings up to 2 in. (50,8 mm) in thickness*

ASTM F467/F467M, *Standard specification for nonferrous nuts for general use*

ASTM F468/F468M, *Standard specification for nonferrous bolts, hex cap screws, socket head cap screws, and studs for general use*

ASTM F788/F788M, *Standard specification for surface discontinuities of bolts, screws, studs, and rivets, inch and metric series*

ASTM F812, *Standard specification for surface discontinuities of nuts, inch and metric series*

ASTM F2329/F2329M, *Standard specification for Zinc coating, hot-dip, requirements for application to Carbon and alloy steel bolts, screws, washers, nuts, and special threaded fasteners*

ASTM G28, *Standard Test Methods for Detecting Susceptibility to Intergranular Corrosion in Wrought, Nickel-Rich, Chromium-Bearing Alloys*

ASTM G48, *Standard test methods for pitting and crevice corrosion resistance of stainless steels and related alloys by use of ferric chloride solution*

EEMUA 234, *90/10 Copper nickel alloy piping for offshore applications*

EN 10204, *Metallic products — Types of inspection documents*

EN 10228-4:2016, *Non-destructive testing of steel forgings - Part 4: Ultrasonic testing of austenitic and austenitic-ferritic stainless steel forgings*

MSS SP-93-2020, *Quality standard for steel castings and forgings for valves, flanges, fittings, and other piping components — Liquid penetrant examination method*

MSS SP-147, *Quality standard for steel castings used in standard class steel valves — sampling method for evaluating casting quality*

NORSOK M-650, *Qualification of manufacturers of special materials*

## 3 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

**3.1**
**austenitic stainless steel**
stainless steel whose microstructure at room temperature consists predominantly of austenite

**3.2**
**carbon steel**
alloy of carbon and iron containing up to 2 % mass fraction carbon and up to 1,65 % mass fraction manganese and residual quantities of other elements, except those intentionally added in specific quantities for deoxidation (usually silicon and/or aluminium)

Note 1 to entry: Carbon steels used in the petroleum industry usually contain less than 0,8 % mass fraction carbon.

**3.3**
**end user**
organization that is responsible for the operation of an installation/facility and its component (e.g. piping, valve)

Note 1 to entry: In the context of this document, the end user is normally an oil and gas company.

**3.4**
**low alloy steel**
steel containing a total alloying element content of less than 5 % mass fraction, or less than 10,5 % mass fraction chromium, but more than that specified for *carbon steel* (3.2)

**3.5**
**manufacturer**
organization, including subcontractors, which carries out operations (e.g. forming, heat treatment, welding) that affect the material properties of the finished product

**3.6**
**nickel-based alloys**
metallic material in which nickel is the major element

**3.7**
**pilot casting**
casting made and tested as part of the initiation and development of the production method such as the first casting from a new or modified pattern produced using identical foundry practices as the production castings it is intended to represent

**3.8**
**purchaser**
organization that purchases a product from a *manufacturer* (3.5)

Note 1 to entry: A purchaser can be an oil and gas company, a contractor or a buyer.

**3.9**
**stainless steel**
steel containing 10,5 % mass fraction or more chromium, possibly with other elements added to secure special properties

**3.10**
**austenitic stainless steel type 304**
*austenitic stainless steel* (3.1) certified to meet both 304/304L properties

**3.11**
**austenitic stainless steel type 316**
*austenitic stainless steel* (3.1) certified to meet both 316/316L properties

**3.12**
**austenitic stainless steel type UNS S34565**
highly alloyed *austenitic stainless steel* (3.1) alloys with SMYS ≥ 450 MPa and PREN ≥ 40

**3.13**
**austenitic stainless steel type 6Mo**
highly alloyed *austenitic stainless steel* (3.1) alloys with 6 % Mo and PREN ≥ 40,0

**3.14**
**ferritic-austenitic stainless steel type 22Cr duplex**
ferritic-austenitic stainless steel alloys with 30,0 ≤ PREN < 40,0 and Cr ≥ 19 % (by mass)

**3.15**
**ferritic-austenitic stainless steel type 25Cr duplex**
ferritic-austenitic stainless steel alloys with 40,0 ≤ PREN < 48,0

Note 1 to entry: Stainless steel type 25Cr duplex is often referred to as "super duplex".

**3.16**
**ferritic-austenitic stainless steel type lean duplex**
ferritic-*austenitic stainless steel* alloys with PREN ≥ 28

Note 1 to entry: In this document, stainless steel type lean duplex concerns UNS numbers S32003, S32304 and S82441.

## 4 Abbreviated terms

| | |
|---|---|
| ANSI | American National Standards Institute |
| AOD | argon oxygen decarburization |
| API | American Petroleum Institute |
| ASTM | American Society of Testing and Materials |
| ASME | American Society of Mechanical Engineers |
| BPVC | boiler and pressure vessel code |

| | |
|---|---|
| CE | carbon equivalent, , calculated as follows: (% C + % Mn / 6 + (% Cr + % Mo + % V) / 5 + (% Ni + % Cu) / 15), with chemical element concentration expressed in mass fraction percent |
| CLR | crack length ratio |
| CSR | crack sensitivity ratio |
| CTR | crack thickness ratio |
| DN | nominal diameter |
| EBW | electron beam welding |
| EDS | element data sheet |
| EEA | European Economic Area |
| FCAW | flux-cored arc welding |
| GTAW | gas tungsten arc welding |
| EEMUA | Engineering Equipment & Materials Users Association |
| EN | European standard |
| HAZ | heat-affected zone |
| HBW | Brinell hardness with Tungsten ball |
| HFW | high frequency welded |
| HIC | hydrogen-induced cracking |
| HIP | hot isostatic pressing |
| HR | Rockwell hardness |
| HRB | Rockwell hardness, B scale |
| HRC | Rockwell hardness, C scale |
| HV | Vickers hardness |
| HVAF | high velocity air fuel |
| HVOF | high velocity oxygen fuel |
| ISO | International Organization for Standardization |
| LBW | laser beam welding |
| MDS | material data sheet |
| MPCR | manufacturing procedure conformity record |
| MPS | manufacturing procedure summary |
| MSS | Manufacturers Standardization Society |
| MT | magnetic particle testing |

| | |
|---|---|
| NACE | National Association of Corrosion Engineers |
| NDT | non-destructive testing |
| NORSOK | the Norwegian shelf's competitive position |
| NPS | nominal pipe size |
| OD | outer diameter |
| PED | Pressure Equipment Directive (European Directive 2014/68/EU) |
| PREN | pitting resistance equivalent number, calculated as follows: (%Cr + 3,3 × %(Mo + 0,5W) + 16 × %N), with chemical element concentration expressed in mass fraction percent |
| PSL | product specification level |
| PT | penetrant testing |
| PTAW | plasma transfer arc welding |
| PWHT | post weld heat treatment |
| QL | quality level |
| QTR | qualification test record |
| RT | radiographic testing |
| SAW | submerged arc welding |
| SAWL | submerged arc longitudinally welded |
| SMAW | shielded-metal arc welding |
| SMYS | specified minimum yield strength |
| SSC | sulfide stress cracking |
| UNS | unified numbering system |
| UT | ultrasonic testing |
| VT | visual testing |
| WC | Tungsten carbide |



# 5 Material and element datasheets

## 5.1 General

The material datasheets are collated in Annex A. Each MDS defines the requirements that supplement or amend the referenced material standard or specification. The material shall be delivered in accordance with the standard specification referenced in the MDS including any additional requirements specified therein. Unless otherwise specified in the MDS, all the requirements of the referenced standard specification shall be applied.

MDSs for welded parts specifying acceptance classes give weld joint quality factors ranging from 0,8 to 1,0 according to ASME B31.3. The required class shall be specified on the piping class sheet. The purchase order shall specify acceptable class for each relevant item.

The element datasheets are included in Annex B. Each EDS defines the requirements for special processes and parts used in connection with manufacturing and/or assembly of piping and valves. Processes and parts shall conform with the requirement specified in the EDS in Annex B.

## 5.2 Numbering system

Each MDS number consists of a one-letter prefix indicating the material type and a three-digit sequential number. The following one-letter prefixes apply:

— C – carbon steels;

— D – ferritic austenitic stainless steels (duplex stainless steels);

— K – copper-nickel alloy 90-10 and other copper alloys including nickel-aluminium bronze;

— L – nickel alloyed steel;

— M – martensitic stainless steel;

— N – nickel-based alloys;

— R – highly alloyed austenitic stainless steels;

— S – austenitic stainless steels;

— T – titanium;

— V – Cr and Cr-Mo alloyed steels;

— X – high strength low alloy steels.

The supplementary suffix “S” is used to designate a material delivered in accordance with the MDS plus the supplementary requirements for sour service but excluding HIC testing.

The supplementary suffix “SH” is used to designate a material conforming with the MDS including the supplementary requirements for sour service plus HIC testing and UT examination, where applicable to the material and product form.

An MDS designated with supplementary suffix “S” or “SH” also satisfies all the MDS requirements for general, non-sour service.

The supplementary suffix “K” is used to designate material suitable for hydrogen service at elevated temperature.

The supplementary suffix “L” is used to designate material with lower impact testing temperature than the original MDS.

The EDS number consists of the three-letter prefix “EDS” and a two-digit sequential number.

## 5.3 Deviations to ASME B31.3

The use of the MDSs in this document can result in deviations from ASME B31.3. All identified deviations have been carefully considered and are regarded as industry standard. The following deviations are identified:

— the thickness for requiring impact testing is specified to be ≥6 mm;

— if sub-size Charpy V-notch impact test specimens are used, the test temperature is not reduced;

NOTE 1 Instead of reduction in test temperature, the specified absorbed energy value is increased compared to ASME B31.3, and the reduction factors for sub-size specimens are modified to be: 7,5 mm - 5/6 and 5 mm - 2/3.

— eddy current testing is accepted as replacement for spot radiography of longitudinal welds in type 6Mo 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 are accepted in the as welded condition, provided the plate material used is solution annealed.

— HFW pipe according to API Spec 5L is allowed as an equal alternative to SAWL with automated ultrasonic and/or electromagnetic testing of the weld.

In general, the MDSs have supplementary requirements beyond the product standard to ensure a safe use of the material grades.

## 5.4 High pressure systems according to ASME B31.3

Materials for high pressure systems shall conform to the requirements in ASME B31.3. MDSs for selected piping materials have been included in Clause A.3. The following requirements have been added to the high pressure MDSs:

a) All pipe and fittings shall be in heat-treated condition, i.e. normalized, normalized and tempered, quenched and tempered, annealed or solution annealed.

b) Impact test specimens shall be oriented in the transverse direction, where possible, and energy values shall be aligned with ASME B31.3.

c) Impact testing at -46 °C is included with reduction factors for sub-size specimens: 7,5 mm - 5/6 and 5 mm - 2/3.

d) Ultrasonic testing of base material of longitudinal welded pipes for longitudinal defects.

e) Ultrasonic testing of forgings with thickness above 50 mm as described in 5.5.

f) NDT of the pipe base material is carried out according to ASME BPVC VIII Div. 3 instead of according to ASME B31.3.

## 5.5 Parts designed to ASME BPVC VIII Div. 2

The material test requirements of parts shall be in accordance with BPVC VIII Div. 2 for pressure design even if the part is intended to be used in piping systems assembled according to ASME B31.3 normal service or another code with less stringent requirements than the actual design code for the parts.

ASME BPVC VIII Div. 2 specifies that carbon steel and low alloyed steel must be impact tested and the impact test specimens may be oriented longitudinally and transverse, respectively, provided that the shape and size of part permit the removal of transverse specimens. The minimum absorbed impact energy requirement is made dependent of SMYS and section thickness.

All parts designed to ASME BPVC VIII Div. 2 shall be ultrasonically tested if the section thickness is 50 mm or above in nominal thickness.

The MDSs listed in Annex A are not considered in conformance with the requirements of ASME BPVC VIII Div. 2.

## 5.6 Qualification of manufacturers to ISO 17782 or NORSOK M-650

Existing qualifications signed off in conformance with ISO 17782 or NORSOK M-650 with test scope and requirements to other user specifications or standards, such as NORSOK M-630, IOGP S-563, or IOSS P201-1, IOSS P201-2 and IOSS P201-3 are permitted subject to end user's acceptance. Production testing shall be carried out in according with the MDSs in this document.

## 5.7 Machining of valves or valve parts from bar

When allowed by the product standard specification, hollow cylindrically shaped parts, including valve bodies with weld-end or integral flanges, and pressure-controlling parts of valves, may be manufactured from cylindrically shaped bars, provided the requirements in the relevant MDS are met in full.

## 5.8 NDT of piping and valves

Where MDSs specify NDT requirements, these requirements describe the minimum level of NDT that shall be performed at the material manufacturing stage.

NDT of fabricated piping systems are covered by ISO 13703-3 and not included in the MDSs in this document.

Additional NDT can be required for valve parts when this is specified by the purchaser in the valve data sheet or purchase order documentation. For details of any additional NDT requirements for finished valve parts or piping assembly, reference shall be made to the applicable valve specification or piping fabrication specification.

Where the MDS does not specify additional NDT requirements, the relevant material standard shall apply. At least one item per lot shall be examined if a frequency of inspection less than 100 % is specified. If defects outside the acceptance criteria are detected, two or more items from the same lot shall be tested. If any of these two tests fails, all items in the lot shall be examined.

## 5.9 Pilot castings

### 5.9.1 General

The casting foundry/manufacturer shall produce a pilot casting prior to the production of castings, in accordance with MSS SP-147.

The pilot casting may be taken from the first production order of castings, subject to purchaser approval. Acceptance of a production casting as pilot casting shall require that NDT conforms with the requirements for pilot casting and all testing specified in the MDS for production casting shall be met.

### 5.9.2 Material qualification ranges for pilot castings

A new pilot casting shall be produced when the casting material is outside the qualification ranges given in Table 1.

**Table 1 — Pilot casting material qualification ranges**

| Pilot casting material type | Qualification range for pilot casting material |
|---|---|
| Carbon steel | All grades of carbon steel and low alloyed steel |
| Low-alloy steel | All grades of carbon steel and low alloyed steel |
| Martensitic stainless steel | All grades of martensitic stainless steel |
| Austenitic stainless steel | All grades of austenitic stainless steel except super austenitic including 6Mo and Nickel-based alloys |
| 22Cr and 25Cr duplex stainless steel | All grades of 22Cr and 25Cr duplex stainless steel |
| 6Mo or super austenitic stainless steel | All grades of 6Mo and super austenitic stainless steel |
| Nickel-based alloys | All nickel-based alloys |
| Titanium (un-alloyed) | All un-alloyed grades of titanium |
| Nickel-Aluminium bronze | All grades of Nickel-Aluminium bronze |

### 5.9.3 NDT of pilot castings

All pilot castings shall be evaluated by the foundry/manufacturer prior to any weld repairs.

After preparing/dressing the surface, all accessible internal and external surfaces of the pilot casting shall be inspected by VT, RT and PT or MT. Defects that can lead to masking of any possible volumetric defects shall be repaired prior to RT. The repair may involve grinding and welding. If welding is performed, the excavations shall be tested, documented by photographs and mapped with actual dimensions.

The extent of volumetric testing shall be in accordance with the applicable MDS. The acceptance criteria shall be as stated in the applicable MDS, unless agreed otherwise with the end user.

Dimensional inspection shall be in accordance with the casting design drawing.

A pilot casting that fails to conform with the requirements of the MDS shall be rejected or repaired to the extent found acceptable to foundry/manufacturer and end user. Corrective actions shall be implemented by the foundry/manufacturer. If deemed necessary, a new pilot casting shall be made to confirm effectiveness of the corrective actions.

Upon completion of all required testing, the documentation for the pilot casting shall be retained and be available for review at the casting foundry/manufacturer.

## 5.10 Ferritic-austenitic stainless steels

The compositional and microstructural requirements including ferrite content and acceptance criteria for intermetallic phases and precipitates in parent material and welds are specified in accordance with ISO 17781. Conformance with ISO 17781 is considered fulfilling the microstructural requirements of ISO 15156-3.

NOTE For the purposes of this document, ANSI/NACE MR0175 is equivalent to ISO 15156-3.

## 5.11 Mechanical testing

Tensile testing shall be carried out in accordance with the referenced standard specifications in the respective MDS as included in Annex A. Where testing to ASTM A370 is specified, testing in accordance with ISO 6892-1 is considered equivalent and thereby also acceptable. The elongation shall be measured and reported in accordance with the selected tensile test standard ASTM A370 or ISO 6892-1. For specimens according to ASTM A370, the gauge length shall be 50 mm as far as is practically possible. For specimens according to ISO 6892-1, test specimens with proportional gauge length shall be used. Since ASTM A370 and ISO 6892-1 have different gauge length, the specified minimum required elongation "A" shall apply as relevant for each applicable standard.

Impact testing shall be carried out in accordance with the referenced standard specifications in the respective MDS as included in Annex A. Where testing to ASTM A370 is specified, testing in accordance with ISO 148-1 using a striker radius of 8 mm is considered equivalent and thereby also acceptable.

The impact test temperature for carbon steel and duplex stainless steels is in general specified to be −46 °C. A lower test temperature may be used by applying the specified minimum absorbed energy, unless otherwise agreed with the end user (equipment user).

Hardness testing shall be performed in conformance with the methods described in the MDS in Annex A and EDS in Annex B, as applicable. The use of alternative methods permitted by the product standard and use of conversion tables or other correlations for individual materials shall be approved by the end user (equipment user). In case of dispute, the hardness scale stated in the MDS or EDS shall prevail. The use of portable hardness testing methods shall be approved by the end user (equipment user).

# Annex A
(normative)

# Material datasheets

## A.1 General

This annex lists the material datasheets. Table A.1 provides a list of MDSs for normal pressure service and Table A.2 provides a list of MDSs for high pressure service according to ASME B31.3. The tables include reference to MDS numbers. Clause A.2 contains the MDSs to which reference is made in Table A.1 and Clause A.3 contains to the MDSs to which reference is made in Clause A.3.

**Table A.1 — List of material datasheets for normal pressure service**

| Type of material | Material standard and grade(s) | Product form | MDS No. [a] | MDS Rev. |
|---|---|---|---|---|
| **Non-impact tested carbon steel type 235** | ASTM A106/A106M grade B<br>API Spec 5L grade B PSL1 | Seamless pipes | C001 | 1 |
| | ASTM A672 grade C60, C65, C70<br>API Spec 5L grade B PSL1 | Welded pipes | C002 | 1 |
| | ASTM A234/A234M grade WPB, WPBW | Wrought fittings | C003 | 1 |
| | ASTM A105/A105M | Forgings | C004 | 1 |
| | ASTM A516/A516M grade 60, 65, 70 | Plates | C005 | 1 |
| | ASTM A216/A216M grade WCB, WCC | Castings | C006 | 1 |
| | ASTM A696 grade B, C<br>ASTM A105/A105M | Bars | C007 | 1 |
| **Impact tested (-46 °C) carbon steel type 235LT, 42KSI, 52KSI, 60KSI and 65KSI** | ASTM A333/A333M grade 6 | Seamless pipes | C101 | 1 |
| | ASTM A671/A671M grade CC60, CC65, CC70 | Welded pipes | C102 | 1 |
| | ASTM A420/A420M grade WPL 6, WPL6W | Wrought fittings | C103 | 1 |
| | ASTM A350/A350M grade LF2 and LF6 | Forgings | C104 | 1 |
| | ASTM A516/A516M grade 60, 65, 70 | Plates | C105 | 1 |
| | ASTM A352/A352M grade LCC | Castings | C106 | 1 |
| | ASTM A696 grade B, C<br>ASTM A350/A350M grade LF2, LF6 | Bars | C107 | 1 |
| | API Spec 5L grade X42, X52 | Seamless pipes | C201 | 1 |
| | API Spec 5L grade X42, X52 SAWL or HFW | Welded pipes | C202 | 1 |
| | ASTM A860/A860M WPHY 42, WPHY 52 | Wrought fittings | C203 | 1 |
| | ASTM A694/A694M grade F42, F52 | Forgings | C204 | 1 |

[a] The MDS number may also have a suffix with additional requirements for certain services as described in 5.2.

**Table A.1** *(continued)*

| Type of material | Material standard and grade(s) | Product form | MDS No. [a] | MDS Rev. |
|---|---|---|---|---|
| | API Spec 5L grade X60, X65 | Seamless pipes | C211 | 1 |
| | API Spec 5L grade X60, X65 SAWL or HFW | Welded pipes | C212 | 1 |
| | ASTM A860/A860M grade WPHY 60, WPHY 65 | Wrought fittings | C213 | 1 |
| | ASTM A694/A694M grade F60, F65 | Forgings | C214 | 1 |
| **Ferritic-austenitic stainless steel type lean duplex** | ASTM A790/A790M grade UNS S32003, S32304, S82441 | Seamless pipes | D101 | 1 |
| | ASTM A928/A928M grade UNS S32003, S32304, S82441 | Welded pipes | D102 | 1 |
| | ASTM A815/A815M grade UNS S32003, S32304, S82441 | Wrought fittings | D103 | 1 |
| | ASTM A182/A182M grade F68 (S32304) | Forgings | D104 | 1 |
| | ASTM A240/A240M grade UNS S32003, S32304, S82441 | Plates | D105 | 1 |
| | ASTM A276/A276/A479/A479M grade UNS S32003, S32304, S82441<br>ASTM A182/A182M grade F68 (S32304) | Bars | D107 | 1 |
| | ASTM A789/A789M grade UNS S32003, S32304, S82441 | Tubes | D108 | 1 |
| **Ferritic-austenitic stainless steel type 22Cr Duplex** | ASTM A790/A790M grade UNS S31803, UNS S32205 | Seamless pipes | D141 | 1 |
| | ASTM A928/A928M grade UNS S31803, UNS S32205 | Welded pipes | D142 | 1 |
| | ASTM A815/A815M grade UNS S31803, UNS S32205 | Wrought fittings | D143 | 1 |
| | ASTM A182/A182M grade F51 (S31803), F60 (S32205) | Forgings | D144 | 1 |
| | ASTM A240/A240M grade UNS S31803, UNS S32205 | Plates | D145 | 1 |
| | ASTM A995/A995M grade 4A (UNS J92205) | Castings | D146 | 1 |
| | ASTM A276/A276M/A479/A479M grade UNS S31803, UNS S32205<br>ASTM A182/A182M grade F51 (S31803), F60 (S32205) | Bars | D147 | 1 |
| | ASTM A789/A789M grade UNS S31803, UNS S32205 | Tubes | D148 | 1 |
| | ASTM A988/A988M grade UNS S31803, S32205 | HIP products | D149 | 1 |
| **Ferritic-austenitic stainless steel type 25Cr Duplex** | ASTM A790/A790M grade UNS S32550, S32750, S32760 | Seamless pipes | D251 | 1 |
| | ASTM A928/A928M grade UNS S32550, S32750, S32760 | Welded pipes | D252 | 1 |

[a] The MDS number may also have a suffix with additional requirements for certain services as described in 5.2.

**Table A.1** *(continued)*

| Type of material | Material standard and grade(s) | Product form | MDS No. [a] | MDS Rev. |
|---|---|---|---|---|
| | ASTM A815/A815M grade UNS S32550, S32750, S32760 | Wrought fittings | D253 | 1 |
| | ASTM A182/A182M grade F53 (UNS S32750), grade F55 (UNS S32760), grade F61 (UNS S32550) | Forgings | D254 | 1 |
| | ASTM A240/A240M grade UNS S32550, S32750, S32760 | Plates | D255 | 1 |
| | ASTM A995/A995M grade 6A (UNS J93380), grade 5A (UNS J93404) | Castings | D256 | 1 |
| | ASTM A276/A276M/A479/A479M grade UNS S32550, S32750 and S32760<br>ASTM A182/A182M grade F53 (UNS S32750), grade F55 (UNS S32760), grade F61 (UNS S32550) | Bars | D257 | 1 |
| | ASTM A789/A789M grade UNS S32550, S32750, S32760 | Tubes | D258 | 1 |
| | ASTM A1082/A1082M grade UNS S32750, S32760 (strain hardened) | Studs, bolts and nuts | D259 | 1 |
| | ASTM A1082/A1082M grade UNS S32750, S32760 (solution annealed) | Studs, bolts and nuts | D260 | 1 |
| | ASTM A988/A988M grade UNS S32750, S32750, S32505 | HIP products | D269 | 1 |
| **Copper-nickel 90-10** | EEMUA 234 grade 7060X | Seamless pipes and tubes | K101 | 1 |
| | EEMUA 234 grade 7060X | Welded pipes | K102 | 1 |
| | EEMUA 234 grade 7060X | Wrought fittings | K103 | 1 |
| | EEMUA 234 grade 7060X | Flanges | K104 | 1 |
| | ASTM B171/B171M grade UNS C70600 | Plates and sheets | K105 | 1 |
| | ASTM B151/B151M grade C70600 | Bars and rods | K107 | 1 |
| **Aluminium bronze** | ASTM B124/B124M grade C63000 | Forgings | K114 | 1 |
| | ASTM B148 UNS grade C95800 | Castings | K116 | 1 |
| | ASTM B150/B150M grade UNS C63200 | Bars and rods | K117 | 1 |
| **Nickel alloyed steel, type 3,5 % Nickel** | ASTM A333/A333M grade 3 | Seamless pipes | L101 | 1 |
| | ASTM A671/A671M grade CFE 70 | Welded pipes | L102 | 1 |
| | ASTM A420/420M grade WLP3, WLP3W | Wrought fittings | L103 | 1 |
| | ASTM A350/A350M grade LF3 | Forgings | L104 | 1 |
| | ASTM A203/203M grade D, E | Plates | L105 | 1 |
| | ASTM A352/A352M grade LC3 (UNS J31550) | Castings | L106 | 1 |
| | ASTM A334/A334M grade 3 | Tubes | L108 | 1 |
| **Martensitic stainless steel** | ASTM A182/A182M grade F6A | Forgings | M104 | 1 |
| | ASTM A217/217M grade CA15 (UNS J91150) | Castings | M106 | 1 |

[a] The MDS number may also have a suffix with additional requirements for certain services as described in 5.2.

**Table A.1** *(continued)*

| Type of material | Material standard and grade(s) | Product form | MDS No. [a] | MDS Rev. |
|---|---|---|---|---|
| | ASTM A276/276M/ASTM A479/479M grade 410 (UNS S41000) | Bars | M107 | 1 |
| | ASTM A276/276M grade 420 (UNS S42000) | Bars | M127 | 1 |
| **Martensitic precipitation-hardened stainless steel** | ASTM A705/705M grade 630 (UNS S17400) | Forgings | M604 | 1 |
| | ASTM A564/564M grade 630 (UNS S17400) | Bars | M607 | 1 |
| **Nickel-based alloys** | ASTM F467/F467M / ASTM F468/F468M grade UNS N06625 | Studs, bolt and nuts | N100S | 1 |
| | ASTM B444 grade UNS N06625 | Seamless pipes and tubes | N101S | 1 |
| | ASTM B705 grade UNS N06625 (joint quality factor 0,8/0,85) | Welded pipes | N102S | 1 |
| | ASTM B366/B366M grade UNS N06625 | Wrought fittings | N103S | 1 |
| | ASTM B564 grade UNS N06625 | Forgings | N104S | 1 |
| | ASTM B443 grade UNS N06625 | Plates | N105S | 1 |
| | ASTM A494/494M grade CW6MC, CX2MW | Castings | N106S | 1 |
| | ASTM B446 grade UNS N06625 | Bars | N107S | 1 |
| | ASTM B834 grade UNS N06625 | HIP products | N109S | 1 |
| | ASTM B705 grade UNS N06625 (joint quality factor 1,0) | Welded pipes | N112S | 1 |
| | ASTM B423 grade UNS N08825 | Seamless pipes and tubes | N141S | 1 |
| | ASTM B705 grade UNS N08825 | Welded pipes | N142S | 1 |
| | ASTM B366/B366M grade UNS N08825 | Wrought fittings | N143S | 1 |
| | ASTM B564 grade UNS N08825 | Forgings | N144S | 1 |
| | ASTM B424 grade UNS N08825 | Plates | N145S | 1 |
| | ASTM A494/A494M grade CU5MCuC | Castings | N146S | 1 |
| | ASTM B425 grade UNS N08825 | Bars and rods | N147S | 1 |
| **Nickel-based alloys** | API Std 6ACRA UNS N07718 Gr. 120K | Studs, bolts and nuts | N210S | 1 |
| | API std 6ACRA grade UNS N07718 Gr. 120K, 140K, 150K | Bars | N217 | 1 |
| **Austenitic stainless steel type 6Mo** | ASTM A312/A312M grade UNS S31254, UNS N08367, N08926 | Seamless pipes | R111 | 1 |
| | ASTM A358/A358M grade UNS S31254, UNS N08367, N08926 | Welded pipes | R112 | 1 |
| | ASTM A403/A403M grade UNS S31254, N08367, N08926 | Wrought fittings | R113 | 1 |
| | ASTM A182/A182M grade F44 (UNS S31254), F62 (UNS N08367), UNS N08926<br>B462 Gr. UNS N08926 | Forgings | R114 | 1 |

[a] The MDS number may also have a suffix with additional requirements for certain services as described in 5.2.

**Table A.1** *(continued)*

| Type of material | Material standard and grade(s) | Product form | MDS No. [a] | MDS Rev. |
|---|---|---|---|---|
| | ASTM A240/A240M UNS S31254, N08367, N08926 | Plates | R115 | 1 |
| | ASTM A351/A351M grade CK-3MCuN, CN-3MN | Castings | R116 | 1 |
| | ASTM A276/A276M/A479/A479M UNS S31254, N08367, N08926<br>ASTM182, grade F44 (UNS S31254), grade F62 (UNS N08367) | Bars | R117 | 1 |
| | ASTM A269/A269M UNS S31254, N08367, N08926 | Tubes | R118 | 1 |
| | ASTM A988/A988M UNS S31254, N08367 | HIP products | R119 | 1 |
| **Austenitic stainless steel type UNS S34565** | ASTM A312/A312M UNS S34565 | Seamless pipes | R211 | 1 |
| | ASTM A358/A358M UNS S34565 | Welded pipes | R212 | 1 |
| | ASTM A403/A403M WP UNS S34565 | Wrought fittings | R213 | 1 |
| | ASTM A182/A182M grade F49 | Forgings | R214 | 1 |
| | ASTM A240/A240M UNS S34565 | Plates | R215 | 1 |
| | ASTM A276/A276M/A479/A479M UNS S34565 | Bars | R217 | 1 |
| | ASTM A988/A988M UNS S34565 | HIP parts | R219 | 1 |
| **Austenitic precipitation-hardened stainless steels** | ASTM A453/A453M grade 660 (UNS S66286) | Studs, bolts and nuts | S100 | 1 |
| **Austenitic stainless steel type 316** | ASTM A312/A312M grade TP316 | Seamless pipes | S101 | 1 |
| | ASTM A312/A312M grade TP316<br>ASTM A358/A358M grade 316 | Welded pipes | S102 | 1 |
| | ASTM A403/A403M grade WP316 | Wrought fittings | S103 | 1 |
| | ASTM A182/A182M grade F316 | Forgings | S104 | 1 |
| | ASTM A240/A240M grade 316 | Plates | S105 | 1 |
| | ASTM A351/A351M grade CF3M, CF8M | Castings | S106 | 1 |
| | ASTM A276/A276M/A479/A479M grade 316 | Bars | S107 | 1 |
| | ASTM A269/A269M grade 316 | Tubes | S108 | 1 |
| | ASTM A194/A194M grade 8M | Nuts | S109 | 1 |
| | ASTM A320/A320M grade B8M | Studs, bolts, screws | S109 | 1 |
| **Austenitic stainless steel type 304** | ASTM A312/A312M grade TP304 | Seamless pipes | S201 | 1 |
| | ASTM A312/A312M grade TP304<br>ASTM A358/A358M grade 304 | Welded pipes | S202 | 1 |
| | ASTM A403/A403M grade WP304 | Wrought fittings | S203 | 1 |
| | ASTM A182/A182M grade F304 | Forgings | S204 | 1 |
| | ASTM A240/A240M grade 304 | Plates | S205 | 1 |
| | ASTM A351/A351M grade CF3, CF8 | Castings | S206 | 1 |

[a] The MDS number may also have a suffix with additional requirements for certain services as described in 5.2.

**Table A.1** *(continued)*

| Type of material | Material standard and grade(s) | Product form | MDS No. [a] | MDS Rev. |
|---|---|---|---|---|
| | ASTM A276/A276M/A479/A479M grade 304 | Bars | S207 | 1 |
| | ASTM A269/A269M grade 304 | Tubes | S208 | 1 |
| **Austenitic stainless steel, stabilized grade** | ASTM A312/A312M grade TP321, TP347 | Seamless pipes | S301 | 1 |
| | ASTM A312/A312M / ASTM A358/ A358M grade TP321, TP347 | Welded pipes | S302 | 1 |
| | ASTM A403/A403M grade WP321, WP347 | Wrought fittings | S303 | 1 |
| | ASTM A182/A182M grade F321, F347 | Forgings | S304 | 1 |
| | ASTM A240/A240M grade 321, 347 | Plates | S305 | 1 |
| | ASTM A351/A351M grade CF8C | Castings | S306 | 1 |
| | ASTM A276/A276M / ASTM A479/ A479M grade 321, 347 | Bars | S307 | 1 |
| | ASTM A269/A269M grade TP321, TP347 | Tubes | S308 | 1 |
| | ASTM A312/A312M grade TP321H, TP347H | Seamless pipes | S321 | 1 |
| | ASTM A312/A312M / ASTM A358/ A358M grade TP321H, TP347H | Welded pipes | S322 | 1 |
| | ASTM A403/A403M grade WP321H, WP347H | Wrought fittings | S323 | 1 |
| | ASTM A182/A182M grade F347H, F321H | Forgings | S324 | 1 |
| | ASTM A240/A240M grade 321H, 347H | Plates | S325 | 1 |
| | ASTM A479/A479M grade 321H, 347H | Bars | S327 | 1 |
| Austenitic stainless steel, 200-series | ASTM A182/A182M grade F XM-19 (UNS S20910) | Forgings | S404 | 1 |
| | ASTM A276/A276M / ASTM A479/ A479M grade XM-19 (UNS S20910) | Bars | S407 | 1 |
| **Titanium grade 2** | ASTM B861 grade 2 | Seamless pipes | T101 | 1 |
| | ASTM B862 grade 2 | Welded pipes | T102 | 1 |
| | ASTM B363 grade WPT2/WPT2W | Wrought fittings | T103 | 1 |
| | ASTM B381 grade F2 | Forgings | T104 | 1 |
| | ASTM B265 grade 2 | Plates | T105 | 1 |
| | ASTM B367 grade C2 | Castings | T106 | 1 |
| | ASTM B348 grade 2 | Bars | T107 | 1 |
| | ASTM B338 grade 2 | Tubes | T108 | 1 |
| **1¼Cr ½Mo alloy steel** | ASTM A335/A335M grade P11 | Seamless pipes | V101 | 1 |
| | ASTM A691/A691M grade 1¼ Cr | Welded pipes | V102 | 1 |
| | ASTM A234/A234M grade WP11 | Wrought fittings | V103 | 1 |
| | ASTM A182/A182M grade F11 | Forgings | V104 | 1 |
| | ASTM A387/A387M grade 11 | Plate | V105 | 1 |
| | ASTM A217/A217M grade WC6 | Castings | V106 | 1 |
| | ASTM A739 grade B11 | Bars | V107 | 1 |

[a] The MDS number may also have a suffix with additional requirements for certain services as described in 5.2.

**Table A.1** *(continued)*

| Type of material | Material standard and grade(s) | Product form | MDS No. [a] | MDS Rev. |
|---|---|---|---|---|
| **2¼Cr 1Mo alloy steel** | ASTM A335/A335M grade P22 | Seamless pipes | V201 | 1 |
| | ASTM A691/A691M grade 2¼ Cr | Welded pipes | V202 | 1 |
| | ASTM A234/A234M grade WP22 | Wrought fittings | V203 | 1 |
| | ASTM A182/A182M grade F22 | Forgings | V204 | 1 |
| | ASTM A387/A387M grade 22 | Plate | V205 | 1 |
| | ASTM A217/A217M grade WC9 | Castings | V206 | 1 |
| | ASTM A739 grade B22 | Bars | V207 | 1 |
| **High strength low alloy steel** | ASTM A320/A320M grade L7, L7M, L43<br>ASTM A194/A194M grade 7, 7M | Studs, bolts and nuts (HDG) | X100 | 1 |
| | ASTM A320/A320M grade L7, L7M, L43<br>ASTM A194/A194M grade 7, 7M | Studs, bolts and nuts (black or uncoated) | X109 | 1 |
| | ASTM A193/A193M grade B7, B7M<br>ASTM A194/A194M grade 2H, 2HM | Studs, bolts and nuts (black or uncoated) | X110 | 1 |
| | ASTM A193/A193M grade B7, B7M<br>ASTM A194/A194M grade 2H, 2HM | Studs, bolts and nuts (HDG) | X120 | 1 |
| | ASTM A788/A788M grade AISI 4140 | Forged clamp | X124 | 1 |
| | ASTM A29/A29M grade 4140 | Bars | X127 | 1 |
| | ASTM A508/A508M grade 22 | Forged clamp | X134 | 1 |

[a] The MDS number may also have a suffix with additional requirements for certain services as described in 5.2.

**Table A.2 — List of material datasheets for high pressure service according to ASME B31.3**

| Type of material | Material standard and grade(s) | Product form | MDS No. [a] | MDS Rev. |
|---|---|---|---|---|
| **Impact tested (-46 °C) carbon steel type 42KSI, 52KSI, 60KSI and 65KSI** | API Spec 5L grade X42, X52 | Seamless pipes | C221 | 1 |
| | ASTM A860/A860M WPHY 42, WPHY 52 | Wrought fittings | C223 | 1 |
| | ASTM A694/A694M grade F42, F52 | Forgings | C224 | 1 |
| | API Spec 5L grade X60, X65 | Seamless pipes | C231 | 1 |
| | ASTM A860/A860M WPHY 60, WPHY 65 | Wrought fittings | C233 | 1 |
| | ASTM A694/A694M grade F60, F65 | Forgings | C234 | 1 |
| **Ferritic-austenitic stainless steel type 22Cr Duplex** | ASTM A790/A790M grade UNS S31803, UNS S32205 | Seamless pipes | D111 | 1 |
| | ASTM A928/A928M grade UNS S31803, UNS S32205 | Welded pipes | D112 | 1 |
| | ASTM A815/A815M grade UNS S31803, UNS S32205 | Wrought fittings | D113 | 1 |
| | ASTM A182/A182M grade F51 (S31803), F60 (S32205) | Forgings | D114 | 1 |
| | ASTM A995/A995M grade 4A (UNS J92205) | Castings | D116 | 1 |

[a] The MDS number may also have a suffix with additional requirements for certain services as described in 5.2.

**Table A.2** *(continued)*

| Type of material | Material standard and grade(s) | Product form | MDS No. [a] | MDS Rev. |
|---|---|---|---|---|
| | ASTM A276/A276M/A479/A479M grade UNS S31803, UNS S32205<br>ASTM A182/A182M grade F51 (S31803), F60 (S32205) | Bars | D117 | 1 |
| | ASTM A789/A789M grade UNS S31803, UNS S32205 | Tubes | D118 | 1 |
| | ASTM A988/A988M grade UNS S31803, S32205 | HIP products | D119 | 1 |
| **Ferritic-austenitic stainless steel type 25Cr Duplex** | ASTM A790/A790M grade UNS S32550, S32750, S32760 | Seamless pipes | D211 | 1 |
| | ASTM A928/A928M grade UNS S32550, S32750, S32760 | Welded pipes | D212 | 1 |
| | ASTM A815/A815M grade UNS S32550, S32750, S32760 | Wrought fittings | D213 | 1 |
| | ASTM A182/A182M grade F53 (UNS S32750), grade F55 (UNS S32760), grade F61 (UNS S32550) | Forgings | D214 | 1 |
| | ASTM A995/A995M grade 6A (UNS J93380), grade 5A (UNS J93404) | Castings | D216 | 1 |
| | ASTM A276/A276M/A479/A479M grade UNS S32550, S32750 and S32760<br>ASTM A182/A182M grade F53 (UNS S32750), grade F55 (UNS S32760), grade F61 (UNS S32550) | Bars | D217 | 1 |
| | ASTM A789/A789M grade UNS S32550, S32750, S32760 | Tubes | D218 | 1 |
| | ASTM A988/A988M grade UNS S32550, S32750, S32505 | HIP products | D219 | 1 |
| **Nickel-based alloys** | ASTM B444 grade UNS N06625 | Seamless pipes and tubes | N121 | 1 |
| | ASTM B705 grade UNS N06625 | Welded pipes | N122 | 1 |
| | ASTM B366/B366M grade UNS N06625 | Wrought fittings | N123 | 1 |
| | ASTM B564 grade UNS N06625 | Forgings | N124 | 1 |
| | ASTM A494/A494M grade CW-6MC, CX 2MW | Castings | N126 | 1 |
| | ASTM B446 grade UNS N06625 | Bars | N127 | 1 |
| | ASTM B834 grade UNS N06625 | HIP products | N129 | 1 |

[a] The MDS number may also have a suffix with additional requirements for certain services as described in 5.2.

## A.2 Material datasheets for normal pressure service

| Material Data Sheet | MDS No. C001 / C001S [a] | | | Rev. 1 |
|---|---|---|---|---|
| *TYPE OF MATERIAL: Non-impact tested carbon steel* | | | | |
| *PRODUCT FORM* | *STANDARD* | *GRADE* | *ACCEPTANCE CLASS* | *SUPPLEMENTARY REQUIREMENT* |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| | | | | |
|---|---|---|---|---|
| **Seamless pipes** | ASTM A106/A106M | B | - | ASTM A106/A106M S6 |
| | API Spec 5L | B | PSL1 | - |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Metal making*** | API Spec 5L Gr.B PSL1 pipe steel shall be killed and made according to fine grain practice. | | | |
| ***Manufacturing*** | Cold-drawn pipes shall be heat treated after cold forming. | | | |
| ***Chemical composition*** | For ASTM A106/A106M supplementary requirement S6 applies with the following restrictions:<br>C ≤ 0,23 %, S ≤ 0,020 %, P ≤ 0,025 %, CE ≤ 0,43 %<br>The following restrictions apply to API Spec 5L pipes:<br>C ≤ 0,23 %, CE ≤ 0,43 % | | | |
| ***Repair of defects*** | Weld repair of base material is not permitted. | | | |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: | | | |
| | *Chemical composition*<br>S ≤ 0,010 % | | | |
| | *Hardness testing*<br>Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on one length of pipe per lot. The maximum hardness shall be 22HRC from three readings taken in close proximity. | | | |
| | The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS. | | | |
| ***Marking*** | The pipes shall be marked to ensure full traceability to melt and heat treatment lot. | | | |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser. | | | |
| | The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition. For tempered condition, tempering temperature shall be stated. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. C002 / C002S [a] / C002SH [b]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Non-impact tested carbon steel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Welded pipes** | ASTM A672/A672M | C60, C65, C70 | Cl. 12, Cl. 22, CI.32 or CI.42 | - |
| | API Spec 5L | B | PSL1 | - |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Metal making*** | API Spec 5L Gr.B PSL1 pipe steel shall be killed and made according to fine grain practice. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service, but excluding HIC testing and UT examination.

[b] The supplementary suffix "SH" shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

| | |
|---|---|
| ***Manufacturing*** | — The longitudinal weld shall be straight and made using the SAW or HFW process.<br>— The weld metal for SAW shall be mild steel analysis A-No.1 per ASME BPVC IX, Table QW-442. |
| ***Chemical composition*** | C ≤ 0,23 %, S ≤ 0,020 %, P ≤ 0,025 %, CE ≤ 0,43 % |
| ***Heat treatment*** | For products delivered in the tempered condition, the minimum tempering temperature shall be 620 °C.<br>API Spec 5L pipe: Normalized, including weld and HAZ. |
| ***Non-destructive testing*** | Welded pipe to API Spec 5L: According to API Spec 5L, 46th Edition Annex E. OD and ID notches and radially drilled hole shall be used for electromagnetic or ultrasonic testing of weld seam. |
| ***Repair of defects*** | Weld repair of the base material is not permitted.<br>Repairs to weld metal are acceptable in accordance with the standard specification and shall meet the chemistry requirements of the original manufacturing weld. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a, b] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Chemical composition*<br>S ≤ 0,003 %<br>Ni < 1,0 % for the weld metal |
| | *Hardness testing*<br>— Welding procedure qualification testing for manufacturing and any repair welding shall meet the requirements of ISO 15156-2 / ANSI/NACE MR0175 using Vickers method, with a maximum hardness of 250HV.<br>— Production testing shall be performed on one length of pipe per lot as follows: Vickers hardness traverse shall be made across the base material, HAZ and weld metal at both ends of the pipe to include the centre of the pipe wall and 1,0 mm – 2,0 mm below the internal and external surfaces, with a maximum hardness of 250HV. |
| | *HIC testing and UT examination*<br>When suffix SH applies, one finished pipe per ASTM A672/A672M S14 (lot) shall be tested as follows:<br>— HIC testing:<br>— HIC testing in accordance with NACE TM0284, using Test Solution A.<br>— Acceptance criteria per specimen shall be CLR ≤ 15 %, CTR ≤ 5 %, CSR ≤ 2 %.<br>— Maximum individual crack length shall be reported for each section.<br>— UT examination:<br>— ASTM A672/A672M, S11 shall apply. |
| | The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS. |
| ***Marking*** | The pipes shall be marked to ensure full traceability to melt and heat treatment lot. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service, but excluding HIC testing and UT examination.

[b] The supplementary suffix "SH" shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

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| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser. |
| | The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition. For tempered condition, tempering temperature shall be stated. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service, but excluding HIC testing and UT examination.

[b] The supplementary suffix "SH" shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

| **Material Data Sheet** | **MDS No. C003 / C003S [a] / C003SH [b]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Non-impact tested carbon steel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Wrought fittings** | ASTM A234/A234M | WPB, WPBW | - | ASTM A234/A234M S3 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Chemical composition*** | Supplementary requirement ASTM A234/A234M S3 applies with the following restrictions:<br>C ≤ 0,23 %, S ≤ 0,020 %, P ≤ 0,025 %, CE ≤ 0,43 % | | | |
| ***Heat treatment*** | Normalized or normalized and tempered or quenched and tempered. For products delivered in the tempered condition, the minimum tempering temperature shall be 620 °C.<br>All hot formed or forged fittings, including those manufactured by locally heating a portion of the fitting stock, shall be heat treated after manufacture. | | | |
| ***Test sampling*** | Test sampling shall be made from an actual fitting, from a prolongation thereof, or if not possible, a length of starting material that has been heat treated in the same heat treatment load as the fittings it represents. | | | |
| ***Non-destructive testing*** | UT is not acceptable in-lieu of RT. | | | |
| ***Repair of defects*** | Weld repair of the base material is not permitted. | | | |
| | Repairs to weld metal are acceptable in accordance with the standard specification and shall meet the chemistry requirements of the original manufacturing weld. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service, but excluding HIC testing and UT examination.

[b] The supplementary suffix "SH" shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

| | |
|---|---|
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a, b] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Chemical composition*<br>— S ≤ 0,010 % for WPB fittings made from seamless pipe<br>— S ≤ 0,003 % for WPBW fitting made from flat-rolled products<br>— S ≤ 0,020 % for WPB fitting made from forging |
| | *Hardness testing*<br>WPB fittings: hardness testing shall be performed in accordance with the requirements in ASTM A234/A234M.<br>Hardness testing for WPBW fittings:<br>— Production testing shall be performed in accordance with the requirements in ASTM A234/A234M and shall include parent material, weld and HAZ. |
| | *HIC testing and UT examination*<br>When suffix SH applies, one finished WPBW fitting made from flat-rolled products per lot shall be tested as follows:<br>— HIC testing:<br>— HIC testing in accordance with NACE TM0284, using Test Solution A.<br>— Acceptance criteria per specimen shall be CLR ≤ 15 %, CTR ≤ 5 %, CSR ≤ 2 %.<br>— Maximum individual crack length shall be reported for each section.<br>— UT testing of flat-rolled product before manufacture:<br>— ASTM A578/A578M, S1, S2.1 shall apply. |
| | The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS. |
| ***Marking*** | The fittings shall be marked to ensure full traceability to melt and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser. |
| | The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition. For tempered condition, tempering temperature shall be stated. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service, but excluding HIC testing and UT examination.

[b] The supplementary suffix "SH" shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

| **Material Data Sheet** | **MDS No. C004 / C004S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Non-impact tested carbon steel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Forgings** | ASTM A105/105M | - | - | ASTM A105/A105M S2, S4 |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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|---|---|
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. |
| ***Metal making*** | Steel shall be made to fine grain practice according to ASTM A20/A20M. |
| ***Chemical composition*** | Supplementary requirement S4 applies with the following restrictions:<br>C ≤ 0,23 %, S ≤ 0,020 %, P ≤ 0,025 %, CE ≤ 0,43 % |
| ***Heat treatment*** | Normalized or normalized and tempered or quenched and tempered.<br>For products delivered in the tempered condition, the minimum tempering temperature shall be 620 °C. |
| ***Non-destructive testing*** | *Visual inspection*<br>VT shall be carried out on each forging or bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements:<br>The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS. |
| ***Marking*** | The forgings shall be marked to ensure full traceability to melt and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition. For tempered condition, tempering temperature shall be stated. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. C005 / C005S [a] / C005SH [b]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Non-impact tested carbon steel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Plates** | ASTM A516/A516M | 60, 65, 70 | - | - |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Chemical composition*** | C ≤ 0,23 %, S ≤ 0,020 %, P ≤ 0,025 %, CE ≤ 0,43 %<br>For Grade 60 plate 12,5 mm thick and thinner, C ≤ 0,21 % | | | |
| ***Non-destructive testing*** | *Visual inspection*<br>VT shall be carried out on each plate in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing. | | | |
| ***Repair of defects*** | Weld repair is not permitted. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service, but excluding HIC testing and UT examination.

[b] The supplementary suffix "SH" shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

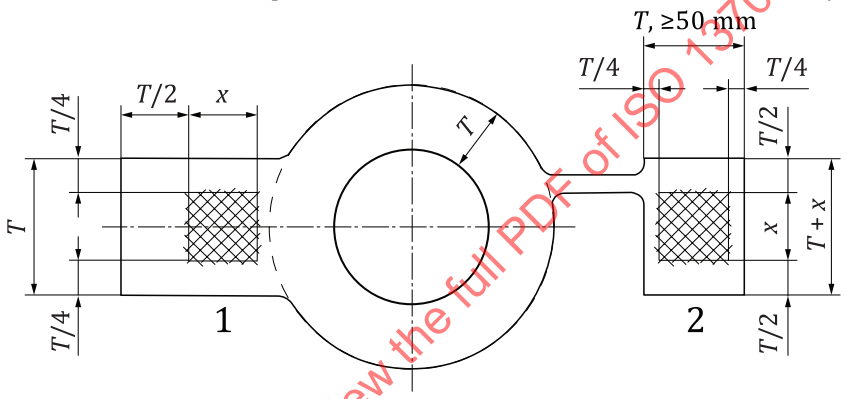
| | |
|---|---|
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a, b] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Chemical composition*<br>S ≤ 0,003 % |
| | *Hardness testing*<br>Production testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on one plate per lot. The maximum hardness shall be 22HRC from three readings taken in close proximity at each location. |
| | *HIC testing and UT examination*<br>When suffix SH applies, one plate per lot shall be tested as follows:<br>— HIC testing:<br>— HIC testing in accordance with NACE TM0284, using Test Solution A.<br>— Acceptance criteria per specimen shall be CLR ≤ 15 %, CTR ≤ 5 %, CSR ≤ 2 %.<br>— Maximum individual crack length shall be reported for each section.<br>— UT examination:<br>— ASTM A578/A578M S1, S2.1 shall apply. |
| | The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS. |
| ***Marking*** | The plates shall be marked to ensure full traceability to melt and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition. For tempered condition, tempering temperature shall be stated. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service, but excluding HIC testing and UT examination.

[b] The supplementary suffix "SH" shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

| **Material Data Sheet** | **MDS No. C006 / C006S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Non-impact tested carbon steel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Castings** | ASTM A216/A216M | WCB, WCC | - | ASTM A216/A216M S4, S5<br>ASTM A703/A703M S14, S20<br>ASTM A985/A985M S14, S20 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| | For steel castings produced by the investment casting process, the requirements of ASTM A985/A985M and this MDS shall apply. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| | |
|---|---|
| ***Metal making*** | Steel shall be made to fine grain practice according to ASTM A20/A20M. |
| ***Chemical composition*** | Supplementary requirements ASTM A216/A216M S11 and S52 apply with the following restrictions:<br>C ≤ 0,23 %, S ≤ 0,020 %, P ≤ 0,025 %, CE ≤ 0,43 % |
| ***Heat treatment*** | For products delivered in the tempered condition, the minimum tempering temperature shall be 620 °C. |
| ***Extent of testing*** | ASTM A703/A703M S14 or ASTM A985/A985M S14 shall apply. |
| ***Test sampling*** | 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 including any post weld stress relieving. 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 figure below for integral and gated test block. 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.<br>  <br><br>1 integrated test block<br>2 gated test block |
| | For investment casting, test sampling shall be according to ASTM A985/A985M.<br>Test blocks shall accompany the castings through all heat treatment operations including any post weld stress relieving. |
| ***Non-destructive testing*** | *General*<br>For definition and NDT of pilot castings reference is made to the general part of this document<br>Non-machined surfaces shall be cleaned prior to the testing.<br>*Visual inspection*<br>The testing shall be carried out after finished machining.<br>Each pilot and production casting shall be tested at all accessible surfaces, including weld ends. Surface testing and acceptance criteria shall be in accordance with ANSI/MSS SP-55.<br>*Magnetic particle testing*<br>ASTM A216/A216M / ASTM A985/A985M Supplementary requirement S4 shall apply as amended by this MDS:<br>Surface testing and acceptance criteria shall be in accordance with ASME BPVC VIII, Div. 1, Appendix 7.<br>Each pilot and production casting shall be tested after final machining at all accessible external and internal surfaces.<br>*Radiographic testing* |

[a] The supplementary suffix “S” shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

<table>
<tr><td></td><td>
— Supplementary requirement S5 shall apply as amended by this MDS. Method of radiography and acceptance criteria shall be in accordance with ASME BPVC VIII Div. 1 Appendix 7.<br>
— 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.<br>
— Sketches of the areas to be tested shall be established and agreed with the purchaser.<br>
— When random testing (5 %) is specified, minimum one casting of each pattern including feeder and riser system in any purchase order with the foundry shall be examined.<br>
— 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.<br>
— Pilot castings shall be radiographed to the extent described above.<br>
— Frequency of RT of valve castings shall be according to table below.
<table>
<tr><td colspan="6">Extent of RT based on pressure class and nominal outside diameter:</td></tr>
<tr><td colspan="2">Pressure class:</td><td>≤ 300</td><td>600</td><td>900</td><td>≥ 1 500</td></tr>
<tr><td rowspan="3">Frequency of RT</td><td>Not required</td><td>< 10”</td><td colspan="3">< 2”</td></tr>
<tr><td>5 %</td><td>≥ 10”</td><td colspan="3">≥ 2”</td></tr>
<tr><td>100 %</td><td>Not required</td><td>≥ 20”</td><td>≥ 16”</td><td>≥ 6”</td></tr>
</table>
— Non-valve 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.
</td></tr>
<tr><td>Repair of defects</td><td>
ASTM A703/A703M or ASTM A985/A985M, as applicable, supplementary requirement S20 shall apply with the following additional requirements:<br>
— Major repairs as defined in ASTM A216/A216M shall be documented in accordance with ASTM A703/A703M or ASTM A985/A985M S20.2.<br>
— The repair welding procedure shall be qualified in accordance with ASTM A488/A488M or ISO 11970 and this data sheet using a cast plate.<br>
— Weld repairs are not acceptable for castings that leak during pressure testing.<br>
— Examination of major repair welds on pressure containing parts shall also include RT.<br>
— The post-weld heat treatment temperature or stress relieving temperature for tempered parts shall maximum be equal to the final tempering temperature –15 °C.
</td></tr>
<tr><td rowspan="2">Sour service (additional metallurgical, manufacturing, testing and certification requirements) [a]</td><td>When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements:</td></tr>
<tr><td>
<u>Hardness testing</u><br>
— Production testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on the pilot casting and one casting per lot thereafter. The maximum hardness shall be 22HRC from three readings taken in close proximity.<br>
— Welding procedure qualification testing for all repair welding shall meet the requirements of ISO 15156-2 / ANSI/NACE MR0175 using Vickers method, with a maximum hardness of 250HV.<br>
The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS.
</td></tr>
<tr><td colspan="2">[a] The supplementary suffix “S” shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.</td></tr>
</table>

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| ***Marking*** | The castings shall be marked to ensure full traceability to melt and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition. For tempered condition, tempering temperature shall be stated. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. C007 / C007S [a]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Non-impact tested carbon steel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Bars** | ASTM A696 | B, C | - | |
| | ASTM A105/A105M | - | - | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.<br>This MDS includes additional requirements for valve parts DN 100 (NPS 4) and under manufactured from bars, when permitted by the valve specification. | | | |
| ***Manufacturing*** | Bars shall be manufactured to the following requirements:<br>— bar forgings as defined in ASTM A788/A788M and certified to ASTM A105; or<br>— hot rolled bars manufactured to ASTM A696 Grade B or C to a maximum outside diameter of 250 mm.<br>Cold finishing shall be restricted to turning, grinding or polishing (singly or in combination); cold drawing or cold forming is not permitted. | | | |
| ***Chemical composition*** | C ≤ 0,23 %, S ≤ 0,020 %, P ≤ 0,025 %, CE ≤ 0,43 % | | | |
| ***Heat treatment*** | Normalized or normalized and tempered or quenched and tempered. For products delivered in the tempered condition, the minimum tempering temperature shall be 620 °C. | | | |
| ***Test sampling*** | *Valve parts manufactured from bar*<br>Sampling of test specimens for bars intended for machining of valve parts shall conform with the following additional requirements:<br>— The mid-length of the axial tensile test specimen shall be located at a distance equal to the bar outside diameter or minimum of 100 mm, whichever is the greater, from the end of the bar, and the centreline of the specimen shall be located at a minimum distance of OD/4 from the surface.<br>— The centreline of the tangential tensile test specimen shall be located at a minimum distance of OD/4 from the surface and the mid-point of the specimens shall be located at a minimum of 100 mm from the end of the bar.<br>— For bar with outside diameter < 100 mm: tensile test in accordance with the standard.<br>— For bar with outside diameter ≥ 100 mm: in addition to the standard requirement, one tensile test specimen shall be taken in tangential direction of the bar. The specified minimum tensile strength properties of the referenced standard shall be met in both directions. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Non-destructive testing*** | *Visual Inspection*<br>VT shall be carried out on each bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing.<br>*NDT (MT) of valve parts manufactured from bar*<br>Inspection shall be according to the applicable valve specification or as specified below.<br>100 % magnetic particle testing of all accessible internal and external surfaces shall be carried out according to ASME BPVC V, article 7 or ASTM A961/A961M supplementary requirement S55. Acceptance criteria shall be according to ASME BPVC VIII, Div. 1, appendix 6. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements:<br>*Chemical composition*<br>S ≤ 0,020 %, Ni < 1,0 %<br>*Hardness testing*<br>Production testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on the end surface of one bar per lot. The maximum hardness shall be 22HRC from three readings taken in close proximity.<br>The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS. |
| ***Marking*** | The bars shall be marked to ensure full traceability to melt and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition. For tempered condition, tempering temperature shall be stated. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. C101 / C101S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Impact tested carbon steel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Seamless pipes** | ASTM A333/A333M | 6 | - | - |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Chemical composition*** | C ≤ 0,23 %, S ≤ 0,020 %, P ≤ 0,025 %, CE ≤ 0,43 % | | | |
| ***Heat treatment*** | During the heat treatment process, pipes shall be placed in such a way as to ensure free circulation around each pipe including any quenching operation.<br>For products delivered in the tempered condition, the minimum tempering temperature shall be 620 °C. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Impact testing/ Toughness testing*** | Impact testing is required for thickness ≥ 6 mm; for pipes with a weld end, the weld end thickness shall govern.<br>The test temperature shall be —46 °C.<br>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. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Chemical composition*<br>S ≤ 0,010 % |
| | *Hardness testing*<br>Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on one length of pipe per lot. The maximum hardness shall be 22HRC from three readings taken in close proximity. |
| | The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS. |
| ***Marking*** | The pipes shall be marked to ensure full traceability to melt and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser. |
| | The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition. For tempered condition, tempering temperature shall be stated. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. C102 / C102S [a] / C102SH [b]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Impact tested carbon steel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Welded pipes** | ASTM A671/A671M | CC60, CC65, CC70 | Cl. 12, Cl. 22, CI.32 or CI.42 | ASTM A671/A671M S2, S7, S11, S14 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Manufacturing*** | The longitudinal weld shall be straight and made using the SAW process.<br>The weld metal shall be mild steel analysis A-No.1 per ASME BPVC IX, Table QW-442. | | | |
| ***Chemical composition*** | C ≤ 0,23 %, S ≤ 0,020 %, P ≤ 0,025 %, CE ≤ 0,43 % | | | |
| ***Heat treatment*** | For pipes delivered in tempered condition, the minimum tempering temperature shall be 620 °C.<br>During the heat treatment process, pipes shall be placed in such a way as to ensure free circulation around each pipe including any quenching operation. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service, but excluding HIC testing and UT examination.

[b] The supplementary suffix "SH" shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

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| ***Impact testing/ Toughness testing*** | Impact testing is required for thickness ≥ 6 mm; for pipes with a weld end, the weld end thickness shall govern.<br>The test temperature shall be —46 °C.<br>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. |
| ***Extent of testing*** | For products delivered in the tempered condition, the minimum tempering temperature shall be 620 °C.<br>Impact testing per ASTM A671/A671M supplementary requirement S2, as modified by this MDS, shall also be carried out per lot (ASTM A671/A671M supplementary requirement S14 shall apply for lot definition). |
| ***Non-destructive testing*** | ASTM A671/A671M supplementary requirement S7 shall apply. |
| ***Repair of defects*** | Weld repair of the base material is not permitted.<br>Repairs to weld metal are acceptable in accordance with the standard specification and shall meet the chemistry requirements of the original manufacturing weld. |
| ***Sour Service (additional metallurgical, manufacturing, testing and certification requirements)*** [a, b] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Chemical composition*<br>S ≤ 0,003 %<br>Ni < 1,0 % for the weld metal |
| | *Hardness testing*<br>— Welding procedure qualification testing for manufacturing and any repair welding shall meet the requirements of ISO 15156-2 / ANSI/NACE MR0175 using Vickers method, with a maximum hardness of 250HV.<br>— Production testing shall be performed on one length of pipe per lot as follows:<br>— Vickers hardness traverse shall be made across the base material, HAZ and weld metal at both ends of the pipe to include the centre of the pipe wall and 1,0 mm – 2,0 mm below the internal and external surfaces, with a maximum hardness of 250HV. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a, b] | *HIC testing and UT examination*<br>When suffix SH applies, one finished pipe per ASTM A671/A671M S14 (lot) shall be tested as follows:<br>— HIC testing:<br>— HIC testing in accordance with NACE TM0284, using Test Solution A.<br>— Acceptance criteria per specimen shall be CLR ≤ 15 %, CTR ≤ 5 %, CSR ≤ 2 %.<br>— Maximum individual crack length shall be reported for each section.<br>— UT examination:<br>— ASTM A671/A671M, S11 shall apply. |
| | The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS. |
| ***Marking*** | The pipes shall be marked to ensure full traceability to melt and heat treatment lot. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service, but excluding HIC testing and UT examination.

[b] The supplementary suffix "SH" shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

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| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition. For tempered condition, tempering temperature shall be stated. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service, but excluding HIC testing and UT examination.

[b] The supplementary suffix "SH" shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

| **Material Data Sheet** | **MDS No. C103 / C103S [a] / C103SH [b]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Impact tested carbon steel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Wrought fittings** | ASTM A420/A420M | WPL6, WPL6W | - | ASTM A960/A960M S51, S53, S57, S69 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Chemical composition*** | C ≤ 0,23 %, S ≤ 0,020 %, P ≤ 0,025 %, CE ≤ 0,43 % | | | |
| ***Heat treatment*** | During the heat treatment process, fittings shall be placed in such a way as to ensure free circulation around each fitting including any quenching operation.<br>All hot formed or forged fittings, including those manufactured by locally heating a portion of the fitting stock, shall be heat treated after manufacture.<br>For products delivered in the tempered condition, the minimum tempering temperature shall be 620 °C. | | | |
| ***Test sampling*** | Test sampling shall be made from an actual fitting, from a prolongation thereof, or if not possible, a length of starting material that has been heat treated in the same heat treatment load as the fittings it represents. | | | |
| ***Tensile testing*** | ASTM A960/A960M supplementary requirement S51 shall apply as amended by this MDS. | | | |
| ***Impact testing/ Toughness testing*** | Impact testing is required for thickness ≥ 6 mm; for fittings with a weld end, the weld end thickness shall govern. The impact test specimens shall be taken from mid-thickness position.<br>The test temperature shall be −46 °C.<br>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. | | | |
| ***Hardness testing*** | ASTM A960/A960M supplementary requirement S57 shall apply with the following requirements: hardness testing shall be carried out on a minimum two fittings, including parent material, weld and HAZ, for each test lot, and shall not exceed 197HBW. | | | |
| ***Extent of testing*** | Tensile, hardness and impact test are required for each melt and heat treatment load. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service, but excluding HIC testing and UT examination.

[b] The supplementary suffix "SH" shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

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| ***Non-destructive testing*** | UT is not acceptable in-lieu of RT. |
| | *Magnetic particle testing*<br>ASTM A960/A960M supplementary requirement S53 and S69 shall apply as amended by this MDS:<br>Magnetic particle testing, in accordance with ASME BPVC V, Article 7 shall apply to 10 % of all fittings with wall thickness < 12,7 mm per lot or a minimum of one item per lot in any purchase order. All fittings with wall thickness ≥ 12,7 mm shall be 100 % tested. Testing shall be carried out as follows:<br>— Non-machined surfaces shall be cleaned prior to testing.<br>— The testing shall be carried out after final machining and cover 100 % of accessible surface of the test item.<br>— The acceptance criteria shall be to ASME BPVC VIII Div. 1, Appendix 6. |
| ***Repair of defects*** | Weld repair of the base material is not permitted.<br>Repairs to weld metal are acceptable in accordance with the standard specification and shall meet the chemistry requirements of the original manufacturing weld. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a, b] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Chemical composition*<br>— S ≤ 0,010 % for WPL6 fittings made from seamless pipe<br>— S ≤ 0,003 % for WPL6W fitting made from flat-rolled products<br>— S ≤ 0,020 % for WPL6 fitting made from forging or hot rolled/wrought bar<br>— Ni < 1,0 % for the weld metal of WPL6W fittings |
| | *Hardness testing*<br>For WPL6W fittings, in addition to the hardness testing requirement in the MDS, welding procedure qualification testing for manufacturing and any repair welding shall meet the requirements of ISO 15156-2 / ANSI/NACE MR0175 using Vickers method, with a maximum hardness of 250HV. |
| | *HIC testing and UT examination*<br>When suffix SH applies, one finished WPL6W fitting made from flat-rolled products per lot shall be tested as follows:<br>— HIC testing:<br>  — HIC testing in accordance with NACE TM0284, using Test Solution A.<br>  — Acceptance criteria per specimen shall be CLR ≤ 15 %, CTR ≤ 5 %, CSR ≤ 2 %.<br>  — Maximum individual crack length shall be reported for each section.<br>— UT examination of flat-rolled product before manufacture:<br>  — ASTM A578/A578M S1, S2.1 shall apply. |
| | The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS. |
| ***Marking*** | The fittings shall be marked to ensure full traceability to melt and heat treatment lot. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service, but excluding HIC testing and UT examination.

[b] The supplementary suffix "SH" shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

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| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition. For tempered condition, tempering temperature shall be stated. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service, but excluding HIC testing and UT examination.

[b] The supplementary suffix "SH" shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

| **Material Data Sheet** | **MDS No. C104 / C104S [a]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Impact tested carbon steel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Forgings** | ASTM A350/A350M | LF2 | Class 1 | ASTM A350/A350M S6<br>ASTM A961/A961M S55 |
| | ASTM A350/A350M | LF6 | Class 1 or 2 | ASTM A350/A350M S6<br>ASTM A961/A961M S55 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Chemical composition*** | Supplementary requirement ASTM A350/A350M S6 applies with the following restrictions:<br>C ≤ 0,23 %, S ≤ 0,020 %, P ≤ 0,025 %, CE ≤ 0,43 % | | | |
| ***Heat treatment*** | During the heat treatment process, forgings shall be placed in such a way as to ensure free circulation around each forging including any quenching operation.<br>For products delivered in the tempered condition, the minimum tempering temperature shall be 620 °C. | | | |
| ***Impact testing/ Toughness testing*** | Impact testing is required for thickness ≥ 6 mm; for forgings with a weld end, the weld end thickness shall govern.<br>The test temperature shall be −46 °C for grade LF2 and −51 °C for grade LF6.<br>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. | | | |
| ***Extent of testing*** | One set of tensile, impact and hardness testing shall be carried out for each heat and heat treatment load. A test lot shall not exceed 2 000 kg for forgings with as forged weight up to 50 kg, and 5 000 kg for forgings with as forged weight > 50 kg. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Non-destructive testing*** | *Visual inspection*<br>VT shall be carried out on each forging in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing.<br>*Magnetic particle testing*<br>10 % of all forgings per lot or a minimum of one item per lot in any purchase order shall be examined with magnetic particle testing. All accessible internal and external surfaces shall be examined according to ASME BPVC V, article 7 or ASTM A961/A961M supplementary requirement S55. Acceptance criteria shall be according to ASME BPVC VIII, Div. 1, appendix 6. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>Hardness testing shall be performed in accordance with the requirements in ASTM A350/A350M. |
| | The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS. |
| ***Marking*** | The forgings shall be marked to ensure full traceability to melt and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition. For tempered condition, tempering temperature shall be stated. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. C105 / C105S [a] / C105SH [b]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Impact tested carbon steel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Plates** | ASTM A516/A516M | 60, 65, 70 | - | ASTM A516/A516M S5 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Chemical composition*** | C ≤ 0,23 %, S ≤ 0,020 %, P ≤ 0,025 %, CE ≤ 0,43 %<br>For Grade 60 plate 12,5 mm ($^1/_2$ in) thick and thinner, C ≤ 0,21 % | | | |
| ***Heat treatment*** | During the heat treatment process, components shall be placed in such a way as to ensure free circulation around each plate including any quenching operation. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service, but excluding HIC testing and UT examination.

[b] The supplementary suffix "SH" shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

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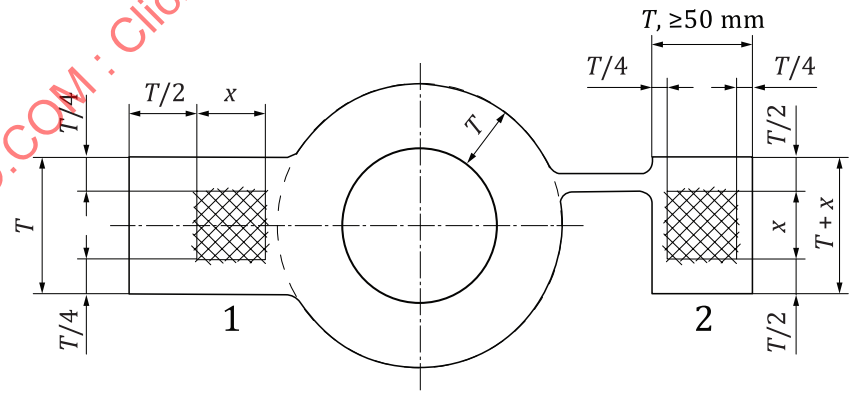
| ***Impact testing/ Toughness testing*** | Impact testing is required for thickness ≥ 6 mm. The test temperature shall be minus 46 °C.<br>The minimum absorbed energy for full size specimens shall be 27 J average and 20 J single. Reduction factors for sub-size specimens shall be: 7,5 mm – 5/6 and 5 mm – 2/3.<br>The test specimen shall be taken in the longitudinal orientation to the final direction of rolling. |
| ***Non-destructive testing*** | *Visual inspection*<br>VT shall be carried out on each plate in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a, b] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Chemical composition*<br>S ≤ 0,003 % |
| | *Hardness testing*<br>Production testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on one plate per lot. The maximum hardness shall be 22HRC from three readings taken in close proximity at each location. |
| | *HIC testing and UT examination*<br>When suffix SH applies, one plate per lot shall be tested as follows:<br>— HIC testing:<br>— HIC testing in accordance with NACE TM0284, using Test Solution A;<br>— Acceptance criteria per specimen shall be CLR ≤ 15 %, CTR ≤ 5 %, CSR ≤ 2 %.<br>— Maximum individual crack length shall be reported for each section.<br>— UT examination:<br>— ASTM A578/A578M S1; S2.1 shall apply. |
| | The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS. |
| ***Marking*** | The plates shall be marked to ensure full traceability to melt and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition. For tempered condition, tempering temperature shall be stated. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service, but excluding HIC testing and UT examination.

[b] The supplementary suffix "SH" shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

| **Material Data Sheet** | **MDS No. C106 / C106S** [a] | **Rev. 1** |
|---|---|---|
| ***TYPE OF MATERIAL: Impact tested carbon steel*** | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| *PRODUCT FORM* | *STANDARD* | *GRADE* | *ACCEPTANCE CLASS* | *SUPPLEMENTARY REQUIREMENT* |
|---|---|---|---|---|
| **Castings** | ASTM A352/A352M | LCC | - | ASTM A352/A352M S4, S5<br>ASTM A703/A703M S8, S14, S20 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Chemical composition*** | C ≤ 0,23 %, S ≤ 0,020 %, P ≤ 0,025 %, CE ≤ 0,43 % | | | |
| ***Heat treatment*** | During the heat treatment process, castings shall be placed in such a way as to ensure free circulation around each casting including possible quenching operation.<br>For products delivered in the tempered condition, the minimum tempering temperature shall be 620 °C. | | | |
| ***Impact testing/ Toughness testing*** | ASTM A703/A703M supplementary requirement S8 shall apply. Impact testing shall be performed at a minimum temperature of −46 ºC. Acceptance criteria shall be 27 J average, 20 J single. Reduction factors for sub-size specimens shall be: 7,5 mm – 5/6 and 5 mm – 2/3. | | | |
| ***Extent of testing*** | One set of tensile and impact test is required for each melt and heat treatment load.<br>A test lot shall not exceed 5 000 kg. | | | |
| ***Test sampling*** | Test blocks shall be integrally cast or gated onto the casting and shall accompany the castings through all heat treatment operations including any post weld stress relieving.<br>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.<br>Dimensions of test blocks and location of test specimens within the test blocks are shown in the figure below for integral and gated test block. 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.<br>  <br><br>1 intergrated test block<br>2 gated test block | | | |
| ***Non-destructive testing*** | *General*<br>For definition and NDT of pilot castings reference is made to the general part of this document.<br>Non-machined surfaces shall be cleaned prior to the testing.<br>*Visual inspection*<br>The testing shall be carried out after finished machining. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

Each pilot and production casting shall be tested at all accessible surfaces, including weld ends. Surface testing and acceptance criteria shall be in accordance with ANSI/MSS SP-55.

*Magnetic particle testing*

ASTM A352/352M supplementary requirement S4 shall apply as amended by this MDS:

Surface testing and acceptance criteria shall be in accordance with ASME BPVC VIII, Div. 1, Appendix 7.

Each pilot and production casting shall be tested after final machining at all accessible external and internal surfaces.

*Radiographic testing*

— Supplementary requirement S5 shall apply as amended by this MDS. Method of radiography and acceptance criteria shall be in accordance with ASME BPVC VIII Div. 1 Appendix 7.

— 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.

— Sketches of the areas to be tested shall be established and agreed with the purchaser.

— When random testing (5 %) 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.

— Pilot castings shall be radiographed to the extent described above.

— Frequency of RT of valve castings shall be according to table below.

| *Extent of RT based on pressure class and nominal outside diameter:* | | | | | |
|---|---|---|---|---|---|
| *Pressure class:* | | *≤ 300* | *600* | *900* | *≥ 1 500* |
| *Frequency of RT* | Not required | < 10” | < 2” | | |
| | 5 % | ≥ 10” | ≥ 2” | | |
| | 100 % | Not required | ≥ 20” | ≥ 16” | ≥ 6” |

— Non-valve 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.

***Repair of defects***

ASTM A703/A703M supplementary requirement S20 shall apply with the following additional requirements:

— Major repairs as defined in ASTM A352/A352M shall be documented in accordance with A703 S20.2.

— The repair welding procedure shall be qualified in accordance with ASTM A488/A488M or ISO 11970 and this data sheet using a cast plate.

— Weld repairs are not acceptable for castings that leak during pressure testing.

— Examination of major repair welds on pressure containing parts shall also include RT.

— The post-weld heat treatment temperature or stress relieving temperature for tempered parts shall maximum be equal to the final tempering temperature —15 °C.

[a] The supplementary suffix “S” shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a, b] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>— Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on the pilot casting and one casting per lot thereafter. The maximum hardness shall be 22HRC from three readings taken in close proximity.<br>— Welding procedure qualification testing for all repair welding shall meet the requirements of ISO 15156-2 / ANSI/NACE MR0175 using Vickers method, with a maximum hardness of 250HV. |
| | The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS. |
| ***Marking*** | The castings shall be marked to ensure full traceability to melt and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition. For tempered condition, tempering temperature shall be stated. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. C107 / C107S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Impact tested carbon steel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Bars** | ASTM A696 | B, C | - | ASTM A696 S5 |
| | ASTM A350/A350M | LF2 | Class 1 | |
| | ASTM A350/A350M | LF6 | Class 1 or 2 | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.<br>This MDS includes additional requirements for valve parts DN 100 (NPS 4) and under manufactured from bars, when permitted by the valve specification. | | | |
| ***Manufacturing*** | Bars shall be manufactured to the following requirements:<br>— bar forgings as defined in ASTM A788/A788M and certified to ASTM A350/A350M; or<br>— hot rolled bars manufactured to ASTM A696 Grade B or C to a maximum outside diameter of 250 mm.<br>Cold finishing shall be restricted to turning, grinding or polishing (singly or in combination); cold drawing or cold forming is not permitted. | | | |
| ***Chemical composition*** | C ≤ 0,23 %, S ≤ 0,020 %, P ≤ 0,025 %, CE ≤ 0,43 % | | | |
| ***Heat treatment*** | Normalized or normalized and tempered or quenched and tempered as a separate operation.<br>For products delivered in the tempered condition, the minimum tempering temperature shall be 620 °C.<br>During the heat treatment process, bars shall be placed in such a way as to ensure free circulation around each bar including any quenching operation. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Test sampling*** | *Valve parts manufactured from bar*<br>Sampling of test specimens for bars intended for machining of valve parts shall conform with the following requirements:<br>— The mid-length of the axial tensile and impact test specimens shall be located at a distance equal to the bar outside diameter or minimum of 100 mm, whichever is the greater, from the end of the bar, and the centreline of the specimen shall be located at a minimum distance of OD/4 from the surface.<br>— The centreline of the tangential tensile and impact test specimens shall be located at a minimum distance of OD/4 from the surface and the mid-point of the specimens shall be located at a minimum of 100 mm from the end of the bar.<br>— The notch of the impact test specimen shall be located perpendicular to the bar surface.<br>— For bar with outside diameter < 100 mm: one tensile and one set impact test specimens shall be taken.<br>— For bar with outside diameter ≥ 100 mm: one tensile and set impact test specimens shall be taken in axial direction of the bar. In addition, one tensile test specimen and one set impact test specimens shall be taken in tangential direction of the bar; the centreline of the tensile test specimen shall be located a minimum of 100 mm from the end of the bar.<br>— The specified minimum tensile strength of the referenced standard and impact energies specified in this data sheet shall be met in both directions. |
| ***Impact testing/ Toughness testing*** | Impact testing is required for thickness ≥ 6 mm; for bars with a weld end, the weld end thickness shall govern.<br>The test temperature shall be —46 °C.<br>The minimum absorbed energy for full size specimens shall be 27 J average and 21 J single. Reduction factors for sub-size specimens shall be: 7,5 mm – 5/6 and 5 mm – 2/3. |
| ***Hardness testing*** | Hardness testing shall be performed in accordance with the requirements in ASTM A370 on the end surface of one bar per lot. The maximum hardness shall be 197 HBW. |
| ***Non-destructive testing*** | *Visual inspection*<br>VT shall be carried out on each bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing. |
| | *NDT (MT) of valve parts manufactured from bar*<br>Inspection shall be according to the applicable valve specification or as specified below.<br>100 % magnetic particle testing of all accessible internal and external surfaces shall be carried out according to ASME BPVC V, article 7 or ASTM A961/A961M supplementary requirement S55. Acceptance criteria shall be according to ASME BPVC VIII, Div. 1, appendix 6. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Chemical composition*<br>Ni < 1,0 % |
| | The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS. |
| ***Marking*** | The bars shall be marked to ensure full traceability to melt and heat treatment lot. |

[a] The supplementary suffix “S” shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition. For tempered condition, tempering temperature shall be stated. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. C201 / C201S[a]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Impact tested carbon steel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Seamless pipes** | API Spec 5L | X42N, X42NO, X42Q, X42QO, X52N, X52NO, X52Q, X52QO (SMLS) | PSL2 | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Manufacturing*** | Seamless pipe (SMLS) according to the product standard | | | |
| ***Chemical composition*** | The chemical composition in API Spec 5L shall apply for all thicknesses with the addition of Ti+Nb+V ≤ 0,10. | | | |
| ***Heat treatment*** | For pipes delivered in quenched and tempered condition the minimum tempering temperature shall be 620 °C. | | | |
| ***Impact testing/ Toughness testing*** | Charpy V-notch testing according to ASTM A370 at —46 °C is required for nominal thickness ≥ 6 mm.<br>Where pipe dimension does not allow testing in the transverse direction, the specimen shall be oriented in longitudinal direction.<br>The minimum absorbed energy for full size specimens shall be 41J average of three specimens and 33J single value in the transverse direction and 60J average of three specimens and 48J single value in the longitudinal direction.<br>Reduction factors for sub-size specimens shall be: 7,5 mm – 5/6 and 5 mm – 2/3. | | | |
| ***Hardness testing*** | Hardness testing of pipe body shall be performed on one pipe per lot in accordance with API Spec 5L, 46th Edition Annex J.<br>The maximum hardness shall be 22 HRC or 250 HV10. | | | |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a,] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements:<br>The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS. | | | |
| ***Dimensional tolerances*** | For t > 25 mm the dimensional tolerances shall be the same as for t ≤ 25 mm. | | | |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The material certificate shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 confirm compliance with this specification, and include the following information: | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| | — melting and refining practice;<br>— heat treatment condition; for QT condition, austenitization and tempering temperature and quenching medium shall be stated;<br>— NDT standard and acceptance criteria. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. C202 /C202S[a] / C202SH[b]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Impact tested carbon steel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Welded pipes** | API Spec 5L | X42N, X42NO, X42Q, X42QO, X52N, X52NO, X52Q, X52QO | PSL2 | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Manufacturing*** | SAWL or HFW according to the product standard. | | | |
| ***Chemical composition*** | Chemical composition according to API Spec 5L shall apply for all thicknesses with the addition of:<br>— Ti+Nb+V ≤ 0,10 %<br>— S ≤ 0,003 % | | | |
| ***Heat treatment*** | For pipes delivered in quenched and tempered condition the minimum tempering temperature shall be 620 °C.<br>Heat treatment of weld | | | |
| ***Impact testing/ Toughness testing*** | Charpy V-notch testing according to ASTM A370 at −46 °C is required for nominal thickness ≥ 6 mm.<br>Impact testing shall be carried out in transverse direction. Where pipe dimension does not allow testing in the transverse direction, the specimen shall be oriented in longitudinal direction. One set of three samples shall be taken from each location: base material, weld metal and HAZ.<br>The minimum absorbed energy for full size specimens shall be 41J average of three specimens and 33J single value in the transverse direction and 60J average of three specimens and 48J single value in the longitudinal direction.<br>Reduction factors for sub-size specimens shall be: 7,5 mm – 5/6 and 5 mm – 2/3. | | | |
| ***Hardness testing*** | Hardness testing of pipe body, weld metal and HAZ shall be performed on one pipe per lot in accordance with API Spec 5L, 46th Edition Annex J.<br>The maximum hardness shall be 22 HRC in the base material and 250 HV10 in weld metal and HAZ. | | | |
| ***Non-destructive testing*** | NDT according to API Spec 5L, 46th Edition Annex K with the following additions<br>UT of longitudinal weld seam shall be carried out in accordance with ISO 10893-11 with acceptance criteria U2 for HFW and U2/U2H for SAWL.<br>UT of welds ends for t ≥ 5mm shall be carried out in accordance with API Spec 5L, 46th Edition K.2.1.3<br>MT shall be carried out according to API Spec 5L, 46th Edition K.2.1.4. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service, but excluding HIC testing and UT examination.

[b] The supplementary suffix "SH" shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

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| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a, b] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements:<br>The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS.<br>*HIC testing and UT examination*<br>When suffix SH applies the following additional requirements apply:<br>— HIC/SWC testing shall be carried out in accordance with API Spec 5L, 46th Edition H.4.3<br>— UT of strip/plate edges adjacent to the weld shall be carried out in accordance with API Spec 5L, 46th Edition K.4.3d |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The material certificate shall be issued in accordance with ISO 10474 / EN 10204 type 3.1, confirm compliance with this specification, and include the following information:<br>— melting and refining practice;<br>— heat treatment condition; for QT condition, austenitisation and tempering temperature and quenching medium shall be stated;<br>— NDT standard and acceptance criteria. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service, but excluding HIC testing and UT examination.

[b] The supplementary suffix "SH" shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

| **Material Data Sheet** | **MDS No. C203 /C203S[a] / C203SH[b]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Impact tested carbon steel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Wrought fittings** | ASTM A860/A860M | WPHY 42, WPHY 52 | Seamless or welded | ASTM A960/A960M S53, S57, S69 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Chemical composition*** | (V + Nb + Ti) ≤ 0,10 % | | | |
| ***Heat treatment*** | During the heat treatment process, fittings shall be placed in such a way as to ensure free circulation around each fitting including any quenching operation.<br>For products delivered in the tempered condition, the minimum tempering temperature shall be 620 °C. | | | |
| ***Test sampling*** | Samples for production testing shall realistically reflect the properties in the actual parts.<br>Test sampling shall be made from an actual fitting, from a prolongation thereof, or if not possible, a length of starting material that has been heat treated in the same heat treatment load as the fittings it represents. | | | |
| ***Extent of testing*** | Impact and hardness testing shall be carried out for each heat and heat treatment load. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service, but excluding HIC testing and UT examination.

[b] The supplementary suffix "SH" shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

| | |
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| ***Impact testing/ Toughness testing*** | Impact testing is required for thickness ≥ 6 mm; for fittings with a weld end, the weld end thickness shall govern.<br>Reduction factors for sub-size specimens shall be: 7,5 mm – 5/6 and 5 mm – 2/3.<br>The impact test specimens shall be taken from mid-thickness position. |
| ***Hardness testing*** | ASTM A960/A960M supplementary requirement S57 shall apply with the following requirements: hardness testing shall be carried out on a minimum two fittings, including parent material, weld and HAZ, for each test lot. |
| ***Non-destructive testing*** | *Ultrasonic testing*<br>For fittings with nominal wall thickness ≥ 30 mm: The entire length of the weld shall be ultrasonically examined for transverse and longitudinal defects in accordance with, and to the acceptance criteria of ASME BPVC VIII Div.1, Appendix 12.<br>*Magnetic particle testing*<br>ASTM A960/A960M supplementary requirement S53 and S69 shall apply as amended by this MDS:<br>Magnetic particle testing, in accordance with ASME BPVC V, Article 7 shall apply to 10 % of all fittings with wall thickness < 12,7 mm per lot or a minimum of one item per lot in any purchase order. All fittings with wall thickness ≥ 12,7 mm shall be 100 % tested. Testing shall be carried out as follows:<br>— Non-machined surfaces shall be cleaned prior to testing.<br>— The testing shall be carried out after final machining and cover 100 % of accessible surface of the test item.<br>— The acceptance criteria shall be to ASME BPVC VIII Div. 1, Appendix 6. |
| ***Repair of defects*** | Weld repair of the base material is not permitted.<br>Repairs to weld metal are acceptable in accordance with the standard specification and shall meet the chemistry requirements of the original manufacturing weld. |

[a] The supplementary suffix “S” shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service, but excluding HIC testing and UT examination.

[b] The supplementary suffix “SH” shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

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| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a, b] | When suffix S is specified is specified the following requirements shall apply:<br>— The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS.<br>— Chemical composition:<br>— S ≤ 0,010 % for fittings made from seamless pipe;<br>— S ≤ 0,003 % for welded fittings made from flat-rolled parts;<br>— S ≤ 0,020 % for fittings made from forging;<br>— Ni < 1,0 % for the weld metal.<br>— Hardness testing:<br>For fittings, in addition to the hardness testing requirement in the MDS, welding procedure qualification testing for manufacturing and any repair welding shall meet the requirements of ISO 15156-2 / ANSI/NACE MR0175 using Vickers method, with a maximum hardness of 250 HV.<br>When suffix SH is specified is specified the following requirements shall apply:<br>— HIC testing in accordance with NACE TM0284, using Test Solution A shall apply.<br>— Acceptance criteria per specimen shall be CLR ≤ 15 %, CTR ≤ 5 %, CSR ≤ 2 %.<br>— Maximum individual crack length shall be reported for each section.<br>— UT testing of flat-rolled product before manufacture:<br>— ASTM A578/A578M S1, S2.1 shall apply. |
| ***Marking*** | The fittings shall be marked to ensure full traceability to melt and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition. For tempered condition, tempering temperature shall be stated. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service, but excluding HIC testing and UT examination.

[b] The supplementary suffix "SH" shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

| **Material Data Sheet** | **MDS No. C204 /C204S[a]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Impact tested carbon steel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Forgings** | ASTM A694/A694M | F42, F52 | | ASTM A961/A961M S55 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Chemical composition*** | C ≤ 0,20 %, S ≤ 0,020 %, P ≤ 0,025 %, Ti ≤ 0,05 %, Nb ≤ 0,04 %, (V + Nb + Ti) ≤ 0,10 %, CE ≤ 0,43 % | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| | |
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| ***Heat treatment*** | For products delivered in the quenched and tempered condition the minimum tempering temperature shall be 620 °C.<br>Forgings shall be placed in such a way that free circulation around each forging is ensured during the heat treatment process, including quenching. |
| ***Test sampling*** | Test sampling shall be made from an actual forging or from a prolongation thereof.<br>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. |
| ***Extent of testing*** | Impact test, tensile test and hardness test shall be carried out for each heat, nominal thickness and heat treatment load.<br>The testing shall be carried out representing the part with heaviest wall thickness within the heat treatment load.<br>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. A test lot shall not exceed 2 000 kg for forgings with as forged weight ≤ 50 kg, and 5 000 kg for forgings with as forged weight > 50 kg. |
| ***Impact testing/ Toughness testing*** | Impact testing shall be carried out at −46 °C. One set of three samples shall be tested. Test samples shall be taken from the same location and shall have the same orientation as tensile test specimens.<br>The minimum absorbed energy for full size specimens shall be 41 J average and 33 J single. Reduction factors for sub-size specimens shall be: 7,5 mm – 5/6 and 5 mm – 2/3. |
| ***Hardness testing*** | Hardness testing shall be performed in accordance with the requirements in ASTM A370 on two forgings per lot. When only one part is produced, this part shall be hardness tested as required. The maximum hardness shall be 22 HRC from three readings per part. |
| ***Non-destructive testing*** | VT shall be carried out on each forging in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing.<br>Supplementary requirement ASTM A961/A961M S55, magnetic particle testing according to ASME BPVC V, Article 7 shall apply to 10 % of all forgings. All accessible internal and external surfaces shall be examined. The testing shall be carried out after final machining. Non-machined surfaces shall be cleaned prior to examination. The acceptance criteria shall be to ASME BPVC VIII Div. 1, Appendix 6. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements:<br>The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS.<br>$Ni \leq 1{,}0$ % |
| ***Marking*** | The forgings shall be marked to ensure full traceability to melt and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1, unless specified otherwise by the purchaser.<br>The inspection documents shall include the following information:<br>— Steel manufacturer, melting and refining practice;<br>— Heat treatment condition. For tempered condition, tempering temperature and holding time shall be stated. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| Material Data Sheet | MDS No. C211 / C211S[a] | | | Rev. 1 |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Impact tested carbon steel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Seamless pipes** | API Spec 5L | X60N, X60Q, X60QO, X65Q, X65QO (SMLS) | PSL2 | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Manufacturing*** | Seamless pipe (SMLS) according to the product standard | | | |
| ***Chemical composition*** | The chemical composition in API Spec 5L shall apply for all thicknesses. | | | |
| ***Heat treatment*** | For pipes delivered in quenched and tempered condition the minimum tempering temperature shall be 620 °C. | | | |
| ***Impact testing/ Toughness testing*** | Charpy V-notch testing according to ASTM A370 at —46 °C is required for nominal thickness ≥ 6 mm.<br>Where pipe dimension does not allow testing in the transverse direction, the specimen shall be oriented in longitudinal direction.<br>The minimum absorbed energy for full size specimens shall be 41J average of three specimens and 33J single value in the transverse direction and 60J average of three specimens and 48J single value in the longitudinal direction.<br>Reduction factors for sub-size specimens shall be: 7,5 mm – 5/6 and 5 mm – 2/3. | | | |
| ***Hardness testing*** | Hardness testing of pipe body shall be performed on one pipe per lot in accordance with API Spec 5L, 46th Edition Annex J.<br>The maximum hardness shall be 22 HRC or 250 HV10. | | | |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a,] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements:<br>The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS. | | | |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The material certificate shall be issued in accordance with ISO 10474 / EN 10204 type 3.1, confirm compliance with this specification, and include the following information:<br>— melting and refining practice;<br>— heat treatment condition; for QT condition, austenitisation and tempering temperature and quenching medium shall be stated;<br>— NDT standard and acceptance criteria. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| Material Data Sheet | MDS No. C212/C212S[a] / C212SH[b] | | | Rev. 1 |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Impact tested carbon steel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service, but excluding HIC testing and UT examination.

[b] The supplementary suffix "SH" shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

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| **Welded pipes** | API Spec 5L | X60N, X60Q, X60QO, X65Q, X65QO | PSL2 | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Manufacturing*** | SAWL or HFW according to the product standard. | | | |
| ***Chemical composition*** | Chemical composition according to API Spec 5L shall apply for all thicknesses with the addition of S ≤ 0,003 %. | | | |
| ***Heat treatment*** | For pipes delivered in quenched and tempered condition the minimum tempering temperature shall be 620 °C. | | | |
| ***Impact testing/ Toughness testing*** | Charpy V-notch testing according to ASTM A370 at —46 °C is required for nominal thickness ≥ 6 mm.<br>Impact testing shall be carried out in transverse direction. Where pipe dimension does not allow testing in the transverse direction, the specimen shall be oriented in longitudinal direction. One set of three samples shall be taken from each location: base material, weld metal and HAZ.<br>The minimum absorbed energy for full size specimens shall be 41J average of three specimens and 33J single value in the transverse direction and 60J average of three specimens and 48J single value in the longitudinal direction.<br>Reduction factors for sub-size specimens shall be; 7,5 mm – 5/6 and 5 mm – 2/3. | | | |
| ***Hardness testing*** | Hardness testing of pipe body, weld metal and HAZ shall be performed on one pipe per lot in accordance with API Spec 5L, 46th Edition Annex J.<br>The maximum hardness shall be 22 HRC in the base material and 250 HV10 in weld metal and HAZ. | | | |
| ***Non-destructive testing*** | NDT according to API Spec 5L, 46th Edition Annex K with the following additions<br>UT of longitudinal weld seam shall be carried out in accordance with ISO 10893-11 with acceptance criteria U2 for HFW and U2/U2H for SAWL.<br>UT of welds ends for t ≥ 5mm shall be carried out in accordance with API Spec 5L, 46th Edition K.2.1.3<br>MT shall be carried out in accordance with API Spec 5L, 46th Edition K.2.1.4. | | | |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a, b] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series /ANSI/NACE MR0175 and the following additional requirements:<br>The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS.<br>*HIC testing and UT examination*<br>When suffix SH applies the following additional requirements apply:<br>— HIC/SWC testing shall be carried out in accordance with API Spec 5L, 46th Edition H.4.3.<br>— UT of strip/plate edges adjacent to the weld shall be carried out in accordance with API Spec 5L, 46th Edition K.4.3d | | | |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The material certificate shall be issued in accordance with ISO 10474 / EN 10204 type 3.1, confirm compliance with this specification, and include the following information: | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service, but excluding HIC testing and UT examination.

[b] The supplementary suffix "SH" shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

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| | — melting and refining practice;<br>— heat treatment condition; for QT condition, austenitisation and tempering temperature and quenching medium shall be stated;<br>— NDT standard and acceptance criteria. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service, but excluding HIC testing and UT examination.

[b] The supplementary suffix "SH" shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

| **Material Data Sheet** | **MDS No. C213 /C213S[a] / C213SH[b]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Impact tested carbon steel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Wrought fittings** | ASTM A860/A860M | WHPHY 60, WPHY 65 | Seamless or welded | ASTM A960/A960M S53, S57, S69 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Chemical composition*** | A product chemical analysis shall be taken per melt of material.<br>The steel shall be made according to a fine grain and inclusion control practice.<br>The heat analysis shall be modified as follows:<br>C ≤ 0,16 %, P ≤ 0,020 %, (Nb+Ti+V) ≤ 0,10 %; | | | |
| ***Heat treatment*** | During the heat treatment process, fittings shall be placed in such a way as to ensure free circulation around each fitting, including any quenching operation.<br>For products delivered in the tempered condition, the minimum tempering temperature shall be 620 °C. | | | |
| ***Test sampling*** | Samples for production testing shall realistically reflect the properties in the actual parts.<br>Test sampling shall be made from an actual fitting, from a prolongation thereof, or if not possible, a length of starting material that has been heat treated in the same heat treatment load as the fittings it represents. | | | |
| ***Extent of testing*** | Impact and hardness testing shall be carried out for each heat and heat treatment load. | | | |
| ***Impact testing/ Toughness testing*** | Impact testing is required for thickness ≥ 6 mm; for fittings with a weld end, the weld end thickness shall govern.<br>Reduction factors for sub-size specimens shall be: 7,5 mm – 5/6 and 5 mm – 2/3.<br>The impact test specimens shall be taken from mid-thickness position. | | | |
| ***Hardness testing*** | ASTM A960/A960M supplementary requirement S57 shall apply with the following requirements: hardness testing shall be carried out on a minimum two fittings, including parent material, weld and HAZ, for each test lot. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service, but excluding HIC testing and UT examination.

[b] The supplementary suffix "SH" shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

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| ***Non-destructive testing*** | *Ultrasonic testing*<br>For fittings with nominal wall thickness ≥ 30 mm: The entire length of the weld shall be ultrasonically examined for transverse and longitudinal defects in accordance with, and to the acceptance criteria of ASME BPVC VIII Div.1, Appendix 12.<br>*Magnetic particle testing*<br>ASTM A960/A960M supplementary requirement S53 and S69 shall apply as amended by this MDS:<br>Magnetic particle testing, in accordance with ASME BPVC V, Article 7 shall apply to 10 % of all fittings with wall thickness < 12,7 mm per lot or a minimum of one item per lot in any purchase order. All fittings with wall thickness ≥ 12,7 mm shall be 100 % tested. Testing shall be carried out as follows:<br>— Non-machined surfaces shall be cleaned prior to testing.<br>— The testing shall be carried out after final machining and cover 100 % of accessible surface of the test item.<br>— The acceptance criteria shall be to ASME BPVC VIII Div. 1, Appendix 6. |
| ***Repair of defects*** | Weld repair of the base material is not permitted.<br>Repairs to weld metal are acceptable in accordance with the standard specification and shall meet the chemistry requirements of the original manufacturing weld. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When suffix S is specified is specified the following requirements shall apply:<br>— The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS.<br>— Chemical composition:<br>— S ≤ 0,010 % for fittings made from seamless pipe;<br>— S ≤ 0,003 % for welded fittings made from flat-rolled parts;<br>— S ≤ 0,020 % for fittings made from forging;<br>— Ni < 1,0 % for the weld metal.<br>— Hardness testing:<br>For fittings, in addition to the hardness testing requirement in the MDS, welding procedure qualification testing for manufacturing and any repair welding shall meet the requirements of ISO 15156-2 / ANSI/NACE MR0175 using Vickers method, with a maximum hardness of 250 HV.<br>When suffix SH is specified is specified the following requirements shall apply:<br>— HIC testing in accordance with NACE TM0284, using Test Solution A shall apply.<br>— Acceptance criteria per specimen shall be CLR ≤ 15 %, CTR ≤ 5 %, CSR ≤ 2 %.<br>— Maximum individual crack length shall be reported for each section.<br>— UT testing of flat-rolled product before manufacture:<br>ASTM A578/A578M S1, S2.1 shall apply. |
| ***Marking*** | The fittings shall be marked to ensure full traceability to melt and heat treatment lot. |

[a] The supplementary suffix “S” shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service, but excluding HIC testing and UT examination.

[b] The supplementary suffix “SH” shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

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| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition. For tempered condition, tempering temperature shall be stated. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service, but excluding HIC testing and UT examination.

[b] The supplementary suffix "SH" shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

| **Material Data Sheet** | **MDS No. C214 / C214S[a]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Impact tested carbon steel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Forgings** | ASTM A694/A694M | F60, F65 | | ASTM A961/A961M S55 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Chemical composition*** | The steel shall be made according to a fine grain and inclusion control practice.<br>C ≤ 0,20 %, S ≤0,020 %, P ≤ 0,025 %, Ti ≤ 0,05 %, Nb ≤ 0,04 %, (V+Nb+Ti) ≤ 0,10 %, CE ≤ 0,43 % | | | |
| ***Heat treatment*** | For products delivered in the quenched and tempered condition the minimum tempering temperature shall be 620 °C.<br>Forgings shall be placed in such a way that free circulation around each forging is ensured during the heat treatment process, including quenching. | | | |
| ***Test sampling*** | Test sampling shall be made from an actual forging or from a prolongation thereof.<br>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. | | | |
| ***Extent of testing*** | Impact test, tensile test and hardness test shall be carried out for each heat, nominal thickness and heat treatment load.<br>The testing shall be carried out representing the part with heaviest wall thickness within the heat treatment load.<br>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. A test lot shall not exceed 2 000 kg for forgings with as forged weight ≤ 50 kg , and 5 000 kg for forgings with as forged weight > 50 kg. | | | |
| ***Impact testing/ Toughness testing*** | Impact testing shall be carried out at −46 °C. One set of three samples shall be tested. Test samples shall be taken from the same location and have the same orientation as tensile test specimens.<br>The minimum absorbed energy for full size specimens shall be 41 J average and 33 J single.<br>Reduction factors for sub-size specimens shall be: 7,5 mm – 5/6 and 5 mm – 2/3. | | | |
| ***Hardness testing*** | Hardness testing shall be performed in accordance with the requirements in ASTM A370 on two forgings per lot. When only one part is produced, this part shall be hardness tested as required. The maximum hardness shall be 22 HRC from three readings per part. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Non-destructive testing*** | VT shall be carried out on each forging in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing.<br>Supplementary requirement ASTM A961/A961M S55, magnetic particle testing according to ASME BPVC V, Article 7 shall apply to 10 % of all forgings. All accessible internal and external surfaces shall be examined. The testing shall be carried out after final machining. Non-machined surfaces shall be cleaned prior to examination. The acceptance criteria shall be to ASME BPVC VIII Div. 1, Appendix 6. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements:<br>The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS.<br>Ni < 1,0 % |
| ***Marking*** | The forgings shall be marked to ensure full traceability to melt and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1, unless specified otherwise by the purchaser.<br>The inspection documents shall include the following information:<br>— Steel manufacturer, melting and refining practice;<br>— Heat treatment condition. For tempered condition, tempering temperature and holding time shall be stated. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. D101** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL:*** **Ferritic-Austenitic stainless steel type lean duplex** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Seamless pipes** | ASTM A790/ A790M | UNS S32003, S32304, S82441 | - | - |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Metal making*** | The melt shall be refined by AOD or equivalent method. | | | |
| ***Chemical composition*** | PREN ≥ 28,0 | | | |
| ***Heat treatment*** | The pipes shall be solution annealed followed by rapid cooling.<br>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 rapid cooling. | | | |
| ***Test sampling*** | Where pipe dimension does not allow taking test specimens in transverse direction specimens shall be taken in longitudinal direction. | | | |
| ***Extent of testing*** | One tensile, one set of impact tests and one micrographic examination including ferrite measurements shall be carried out for each heat and heat treatment lot. | | | |
| ***Impact testing/ Toughness testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall conform with ISO 17781 QL II.<br>NOTE Impact testing is only applicable for wall thickness ≥ 6 mm and when the pipe dimension allows extraction of a test sample. | | | |

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| ***Corrosion testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781. |
| ***Micrographic examination*** | The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Surface treatment and finish*** | Finished pipes shall be white pickled or bright annealed. Machined surfaces do not require pickling. |
| ***Marking*** | The pipes shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Steel manufacturer;<br>— Solution annealing temperature, holding time and cooling medium shall be stated (holding time is not applicable for pipes produced hot finished and direct quenched). |

| **Material Data Sheet** | **MDS No. D102** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Ferritic-Austenitic stainless steel type* lean duplex** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Welded pipes** | ASTM A928/ A928M | UNS S32003, S32304, S82441 | Class 1, 3, 4 and 5 | ASTM A928/A928M S3, S4 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Metal making*** | The melt shall be refined by AOD or equivalent method. | | | |
| ***Chemical composition*** | PREN ≥ 28,0 | | | |
| ***Welding*** | The WPS shall be qualified in accordance with ISO 15614-1 or ASME BPVC IX and shall include the same examinations as for the production testing and shall fulfil the acceptance criteria of ISO 17781. 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. | | | |
| ***Heat treatment*** | The pipes shall be solution annealed followed by rapid cooling.<br>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 rapid cooling. | | | |
| ***Impact testing/ Toughness testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall conform with ISO 17781 QL II. | | | |
| ***Corrosion testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781. | | | |

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| ***Micrographic Examination*** | Supplementary requirement S4 shall apply as modified by this MDS.<br>The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781. |
| ***Extent of testing*** | One tensile, one set of impact tests and one micrographic examination including ferrite measurement shall be carried out for each heat and heat treatment lot.<br>A lot of pipe is defined as the quantity of product not exceeding the lot definition in the standard and from the same heat, same processing conditions including weld procedure and same heat treatment load. For continuous furnaces, the lot definition shall conform with the product standards. |
| ***Non-destructive testing*** | Supplementary requirement S3, penetrant testing, according to ASME BPVC V Article 6 shall apply to 100 % of the weld area of 10 % of the pipes (same test lot as defined for mechanical testing) delivered.<br>The testing shall be carried out after calibration and pickling/bright annealing.<br>Acceptance criteria shall be to ASME BPVC VIII, Div. 1 Appendix 8. |
| ***Repair of defects*** | Weld repair of base material is not permitted.<br>For repair of welds, the requirements for production welding above shall apply to the repair WPS. Repair welds shall be heat treated as per the original production weld. |
| ***Surface treatment and finish*** | Finished pipes shall be white pickled or bright annealed. Machined surfaces do not require pickling. |
| ***Marking*** | The pipes shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Manufacturer of the starting material;<br>— Solution annealing temperature, holding time and quench medium shall be stated. |

| **Material Data Sheet** | **MDS No. D103** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Ferritic-Austenitic stainless steel type lean duplex*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Wrought fittings** | ASTM A815/ A815M | UNS S32003, S32304, S82441 | WP-W, WP-S or WP-WX | ASTM A815/A815M S2, S7 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Metal making*** | The melt shall be refined by AOD or equivalent method. | | | |
| ***Chemical composition*** | PREN ≥ 28,0 | | | |

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| ***Welding*** | The WPS shall be qualified in accordance with ISO 15614-1 or ASME BPVC IX and shall include the same examinations as for the base material and shall meet the acceptance criteria of ISO 17781. 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. |
| ***Heat treatment*** | The fittings shall be solution annealed followed by water/liquid quenching.<br>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. |
| ***Test sampling*** | Test sampling shall be made from an actual fitting, from a prolongation thereof, or if not possible, a length of starting material that has been heat treated in the same heat treatment load as the fittings it represents. |
| ***Tensile testing*** | Supplementary requirement S2 shall apply. |
| ***Impact testing/ Toughness testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall conform with ISO 17781 QL II. |
| ***Corrosion testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781. |
| ***Micrographic Examination*** | The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781. |
| ***Extent of testing*** | One tensile, impact tests and one micrographic examination including ferrite measurement shall be carried out for each lot as defined below.<br>A test lot shall include all fittings from the same heat and heat treatment load, with a wall thickness range of ±5 mm and, where applicable, welded with the same WPS. |
| ***Non-destructive testing*** | Ultrasonic testing is not acceptable as replacement for RT of fittings.<br>Supplementary requirements S7, penetrant testing, shall apply to:<br>— 10 % of seamless or minimum one item per lot in any purchase order;<br>— 100 % of welded fittings above NPS 2.<br>The testing shall be carried out after calibration.<br>For welded fittings the testing shall cover the weld only. |
| ***Repair of defects*** | Weld repair of base material is not permitted.<br>For repair of welds, the requirements for production welding shall apply to the repair WPS. Repair welds shall be heat treated as per the original production weld. |
| ***Surface treatment and finish*** | Finished fittings shall be white pickled. Machined surfaces do not require pickling. |
| ***Marking*** | The fittings shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Steel manufacturer of the starting material for the finished product;<br>— Solution annealing temperature, holding time and quench medium shall be stated. |

| Material Data Sheet | MDS No. D104 | | | Rev. 1 |
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| ***TYPE OF MATERIAL: Ferritic-Austenitic stainless steel type lean duplex*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Forgings** | ASTM A182/A182M | F68 (S32304) | | ASTM A961/A961M S56 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.<br>Product covered by this MDS is limited to a maximum thickness of 300 mm. For thickness exceeding 300 mm, qualification and specification requirements shall be subject to agreement. | | | |
| ***Metal making*** | The melt shall be refined by AOD or equivalent method. | | | |
| ***Chemical composition*** | PREN ≥ 28,0 | | | |
| ***Heat treatment*** | The forgings shall be solution annealed followed by water/liquid quenching.<br>Forgings 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. | | | |
| ***Test sampling*** | For forgings as discs, balls and closed die parts without weld ends, sampling shall be as per ISO 17781 for bars and long solid forgings without weld end.<br>The tensile test specimen shall be taken from the same location as the impact test sample and shall be oriented tangentially when size permits.<br>For all products, the mid-length of the test specimens shall be located one T or 100 mm, whichever is less, to any second surface.<br>For parts forged in closed die and flanges exceeding 80 kg, it is recognized that alternative test may be used. This alternative test sampling shall be qualified and shall comprise comparative testing of sacrificial forgings and the proposed alternative test sample. | | | |
| ***Extent of testing*** | One tensile, impact tests and one micrographic examination including ferrite measurement shall be carried out for each heat and heat treatment load.<br>The testing shall be carried out on the forgings with heaviest wall thickness within the heat treatment load.<br>A test lot shall not exceed 2 000 kg for forgings with as forged weight up to 50 kg, and 5 000 kg for forgings with as forged weight > 50 kg. | | | |
| ***Impact testing/ Toughness testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall conform with ISO 17781 QL II. | | | |
| ***Corrosion testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781. | | | |
| ***Micrographic examination*** | The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781 for forging with weld ends. Test specimens shall be taken from the surface and the centre of the forging with no weld ends and shall sample an area of 10 mm by 10 mm minimum. | | | |

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| ***Non-destructive testing*** | VT shall be carried out on each forging in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be white pickled prior to the testing.<br>ASTM A961/A961M supplementary requirement S56 or ASME BPVC V Article 6, penetrant testing, shall apply to 10 % of forgings above NPS 2.<br>The testing shall be carried out after final machining. Non-machined surfaces shall be pickled prior to the testing. All accessible internal and external surfaces shall be examined.<br>The acceptance criteria shall be ASME BPVC VIII, Div. 1, Appendix 8. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Surface treatment and finish*** | Finished forgings shall be white pickled. Machined surfaces do not require pickling. |
| ***Marking*** | The forgings shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Steel manufacturer;<br>— Solution annealing temperature, holding time and quenching medium shall be stated. |

| **Material Data Sheet** | **MDS No. D105 / D105S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Ferritic-Austenitic stainless steel type lean duplex*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Plates, sheets, strips** | ASTM A240/ A240M | UNS S32003, S32304, S82441 | - | ASTM A240/A240M S1 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Metal making*** | The melt shall be refined by AOD or equivalent method. | | | |
| ***Chemical composition*** | PREN ≥ 28,0 | | | |
| ***Heat treatment*** | The plates shall be solution annealed followed by water/liquid quenching.<br>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. | | | |
| ***Tensile testing*** | Tensile test specimens shall be sampled in the transverse orientation to the direction of final rolling and shall be located in mid-thickness for thickness (t) ≤ 40 mm and in location t/4 for thicknesses (t) > 40 mm, in accordance with ASTM E8/E8M. | | | |
| ***Impact testing/ Toughness testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall conform with ISO 17781 QL II. | | | |
| ***Corrosion testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781. | | | |

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| ***Micrographic Examination*** | The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781. |
| ***Extent of testing*** | One tensile, one set of impact tests and one micrographic examination including ferrite measurement shall be carried out for each heat of steel and heat treatment lot. |
| ***Non-destructive testing*** | *Visual Inspection*<br>VT shall be carried out on each plate in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Surface treatment and finish*** | Finished plates, sheets or strips shall be white pickled. |
| ***Marking*** | The plates, sheets or strips shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Steel manufacturer;<br>— Solution annealing temperature, holding time and quench medium shall be stated. |

| **Material Data Sheet** | **MDS No. D107** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Ferritic -Austenitic stainless steel type lean duplex*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Bars** | ASTM A276/ A276M | UNS S32003, S32304, S82441 | | |
| | ASTM A479/ A479M | UNS S32003, S32304, S82441 | | |
| | ASTM A182/ A182M | F68 (UNS S32304) | | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.<br>This MDS includes additional requirements for valve parts DN 100 (NPS 4) and under manufactured from bars, when permitted by the valve specification.<br>Product covered by this MDS is limited to a maximum thickness of 300 mm. For thickness exceeding 300 mm, qualification and specification requirements shall be subject to agreement. | | | |
| ***Metal making*** | The melt shall be refined by AOD or equivalent method. | | | |
| ***Manufacturing*** | Bars shall be manufactured to the following requirements:<br>— bar forgings as defined in ASTM A788/A788M and certified to ASTM A182/ A182M, or;<br>— hot or cold finished cylindrical shaped bar manufactured according to ASTM A276/A276M or ASTM A479/A479M with maximum diameter of 300 mm. | | | |

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| | Cold finishing shall be restricted to turning, grinding or polishing (singly or in combination); cold drawing or cold forming is not permitted. |
| ***Chemical composition*** | PREN ≥ 28,0 |
| ***Heat treatment*** | Bars shall be solution annealed followed by water/liquid quenching.<br>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. |
| ***Tensile testing*** | Where tensile testing in both directions is required by this MDS, all tensile tests shall meet the specified properties of the referenced standard specification in both directions. The centreline of tensile specimen shall be located at a distance from the bar OD in accordance with ASTM A370. |
| ***Impact testing/ Toughness testing*** | Except as modified in the MDS, sampling and acceptance criteria shall conform with ISO 17781 QL II.<br>Where impact testing in the tangential direction is required by this MDS, the acceptance criteria shall be 45 J average, 35 J minimum single. |
| ***Corrosion testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781. |
| ***Micrographic examination*** | The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781. Test specimens shall be taken from the surface and the centre of the bar and shall sample an area of 10 mm by 10 mm minimum. |
| ***Extent of testing*** | Tensile, impact tests and one micrographic examination including ferrite measurements shall be carried out for each lot as defined in ASTM A484/A484M. |
| ***Test sampling*** | The mid-length of axial (longitudinal) and tangential (transverse) specimens shall be located at a distance equal to the bar outside diameter or 100 mm, whichever is the lesser, from the end of the bar.<br>*Valve parts manufactured from bar*<br>For bars with outside diameter ≥ 100 mm intended for machining of valve parts, in addition to tensile testing and impact testing in the longitudinal direction, one tensile test specimen and one set of three impact test specimens shall be taken in the tangential direction. Acceptance criteria shall conform with this MDS. |
| ***Non-destructive testing*** | *Visual inspection*<br>VT shall be carried out on each bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing. |
| | *NDT (PT) of valve parts manufactured from bar*<br>Inspection of valve parts manufactured from bar shall be according to the applicable valve specification or as specified below.<br>100 % penetrant testing of all accessible internal and external surfaces shall be carried out in accordance with ASME BPVC V, article 6 or ASTM A961/A961M supplementary requirement S56. Acceptance criteria shall be according to ASME BPVC VIII, Div. 1, appendix 8. The testing shall be carried out after machining. Non machined surfaces shall be white pickled prior to testing. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Surface treatment and finish*** | Finished parts shall be white pickled. Machined or peeled surfaces do not require pickling. |
| ***Marking*** | The bars shall be marked to ensure full traceability to heat and heat treatment lot. |

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| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Steel manufacturer of starting material;<br>— Solution annealing temperature, holding time and quenching medium shall be stated. |

| **Material Data Sheet** | **MDS No. D108** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Ferritic-Austenitic stainless steel type lean duplex*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Tubes** | ASTM A789/ A789M | UNS S32003, S32304, S82441 | | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Metal making*** | The melt shall be refined by AOD or equivalent method. | | | |
| ***Chemical composition*** | PREN ≥ 28,0 | | | |
| ***Heat treatment*** | The tubes shall be solution annealed followed by rapid cooling.<br>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 rapid cooling. | | | |
| ***Test sampling*** | Where tube dimension does not allow taking test specimens in transverse direction specimens shall be taken in longitudinal direction. | | | |
| ***Impact testing/ Toughness testing*** | The sampling of test specimens, testing methodology and the acceptance criteria shall conform with ISO 17781 QL II.<br>NOTE Impact testing is only applicable for wall thickness ≥ 6 mm and when the pipe dimension allows extraction of a test sample. | | | |
| ***Corrosion testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781. | | | |
| ***Micrographic examination*** | The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781. | | | |
| ***Extent of testing*** | Tensile testing, one set of impact tests and one micrographic examination including ferrite measurement shall be carried out for each lot as defined in the standard for mechanical tests. | | | |
| ***Repair of defects*** | Weld repair is not permitted. | | | |
| ***Surface treatment and finish*** | Finished tubes shall be white pickled or bright annealed. Machined surfaces do not require pickling. | | | |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information: | | | |

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| | — Steel manufacturer of the starting material;<br>— Solution annealing temperature, holding time and cooling medium shall be stated (holding time is not applicable for tubes produced hot finished and direct quenched). |

| **Material Data Sheet** | **MDS No. D141 / D141S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL:* Ferritic-Austenitic stainless steel type 22Cr duplex** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Seamless pipes** | ASTM A790/A790M | UNS S31803, UNS S32205 | - | - |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Qualification*** | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| ***Metal making*** | The melt shall be refined by AOD or equivalent method. | | | |
| ***Chemical composition*** | UNS S31803: N = 0,14 % - 0,20 % | | | |
| ***Heat treatment*** | The pipes shall be solution annealed followed by rapid cooling.<br>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 rapid cooling. | | | |
| ***Test sampling*** | Where pipe dimension does not allow taking test specimens in transverse direction specimens shall be taken in longitudinal direction. | | | |
| ***Extent of testing*** | One tensile, one set of impact tests, corrosion test and one micrographic examination including ferrite measurements shall be carried out for each heat and heat treatment lot. | | | |
| ***Impact testing/ Toughness testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall conform with ISO 17781 QL II.<br>NOTE Impact testing is only applicable for wall thickness ≥ 6 mm and when the pipe dimension allows extraction of a test sample. | | | |
| ***Hardness testing*** | Hardness testing shall be performed by the Rockwell C method. | | | |
| ***Corrosion testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781. | | | |
| ***Micrographic Examination*** | The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781. | | | |
| ***Repair of defects*** | Weld repair is not permitted. | | | |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: | | | |
| | <u>*Hardness testing*</u><br>Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on one length of pipe per lot. The maximum hardness shall be 28HRC from three readings taken in close proximity. | | | |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. | | | |
| ***Surface treatment and finish*** | Finished pipes shall be white pickled or bright annealed. Machined surfaces do not require pickling. | | | |
| ***Marking*** | The pipes shall be marked to ensure full traceability to heat and heat treatment lot. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— The MPS identification or the MPCR/QTR number used;<br>— Steel manufacturer;<br>— Solution annealing temperature, holding time and cooling medium shall be stated (holding time is not applicable for pipes produced hot finished and direct quenched). |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. D142 / D142S [a]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Ferritic-Austenitic stainless steel type 22Cr duplex*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Welded pipes** | ASTM A928/A928M | UNS S31803, UNS S32205 | Class 1, 3, 4 and 5 | ASTM A928/A928M S3, S4 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Qualification*** | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| ***Metal making*** | The melt shall be refined by AOD or equivalent method. | | | |
| ***Chemical composition*** | UNS S31803: N = 0,14 % - 0,20 % | | | |
| ***Welding*** | The WPS shall be qualified in accordance with ISO 15614-1 or ASME BPVC IX and shall include the same examinations as for the production testing and shall fulfil the acceptance criteria of ISO 17781. 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. | | | |
| ***Heat treatment*** | The pipes shall be solution annealed followed by rapid cooling.<br>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 rapid cooling. | | | |
| ***Impact testing/ Toughness testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall conform with ISO 17781 QL II.<br>CVN test specimens may be oriented in longitudinal direction when combination of OD, ID and wall thickness does not allow orienting the test specimen in transverse direction. | | | |
| ***Corrosion testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781. | | | |
| ***Micrographic Examination*** | Supplementary requirement S4 shall apply as modified by this MDS.<br>The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Extent of testing*** | One tensile, one set of impact tests, corrosion test, and one micrographic examination including ferrite measurement shall be carried out for each heat and heat treatment lot.<br>A lot of pipe is defined as the quantity of product not exceeding the lot definition in the standard and from the same heat, same processing conditions including weld procedure and same heat treatment load. For continuous furnaces, the lot definition shall conform with the product standards. |
| ***Non-destructive testing*** | Supplementary requirement S3, penetrant testing, according to ASME BPVC V Article 6 shall apply to 100 % of the weld area of 10 % of the pipes (same test lot as defined for mechanical testing) delivered.<br>The testing shall be carried out after calibration and pickling/bright annealing.<br>Acceptance criteria shall be to ASME BPVC VIII, Div. 1 Appendix 8. |
| ***Repair of defects*** | Weld repair of base material is not permitted.<br>For repair of welds, the requirements for production welding above shall apply to the repair WPS. Repair welds shall be heat treated as per the original production weld. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished pipes shall be white pickled or bright annealed. Machined surfaces do not require pickling. |
| ***Marking*** | The pipes shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— MPS identification or MPCR/QTR number used;<br>— Manufacturer of the starting material;<br>— Solution annealing temperature, holding time and quench medium shall be stated. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. D143 / D143S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Ferritic-Austenitic stainless steel type 22Cr duplex*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Wrought fittings** | ASTM A815/A815M | UNS S31803, UNS S32205 | WP-W, WP-S or WP-WX | ASTM A815/A815M S2, S7 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Qualification*** | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| ***Metal making*** | The melt shall be refined by AOD or equivalent method. | | | |
| ***Chemical composition*** | UNS S31803: N = 0,14 % - 0,20 % | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Welding*** | The WPS shall be qualified in accordance with ISO 15614-1 or ASME BPVC IX and shall include the same examinations as for the base material and shall meet the acceptance criteria of ISO 17781. 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. |
| ***Heat treatment*** | The fittings shall be solution annealed followed by water/liquid quenching.<br>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. |
| ***Test sampling*** | Test sampling shall be made from an actual fitting, from a prolongation thereof, or if not possible, a length of starting material that has been heat treated in the same heat treatment load as the fittings it represents. |
| ***Tensile testing*** | Supplementary requirement S2 shall apply. |
| ***Impact testing/ Toughness testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall conform with ISO 17781 QL II.<br>CVN test specimens may be oriented in longitudinal direction when combination of OD, ID and wall thickness does not allow orienting the test specimen in transverse direction. |
| ***Corrosion testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781. |
| ***Micrographic Examination*** | The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781. |
| ***Extent of testing*** | One tensile, impact tests and corrosion test, and one micrographic examination including ferrite measurement shall be carried out for each lot as defined below.<br>A test lot shall include all fittings from the same heat and heat treatment load, with a wall thickness range of ±5 mm and, where applicable, welded with the same WPS. |
| ***Non-destructive testing*** | Ultrasonic testing is not acceptable as replacement for RT of fittings.<br>Supplementary requirements S7, penetrant testing, shall apply to:<br>— 10 % of seamless or minimum one item per lot in any purchase order;<br>— 100 % of welded fittings above NPS 2.<br>The testing shall be carried out after calibration.<br>For welded fittings the testing shall cover the weld only.<br>The acceptance criteria shall be ASME BPVC VIII, Div. 1, Appendix 8. |
| ***Repair of defects*** | Weld repair of base material is not permitted.<br>For repair of welds, the requirements for production welding shall apply to the repair WPS. Repair welds shall be heat treated as per the original production weld. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished fittings shall be white pickled. Machined surfaces do not require pickling. |
| ***Marking*** | The fittings shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information: |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| | — MPS identification or MPCR/QTR number used;<br>— Steel manufacturer of the starting material for the finished product;<br>— Solution annealing temperature, holding time and quench medium shall be stated. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. D144 / D144S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Ferritic-Austenitic stainless steel type 22Cr duplex*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Forgings** | ASTM A182/A182M | F51 (UNS S31803), F60 (UNS S32205) | | ASTM A961/A961M S56 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.<br>Product covered by this MDS is limited to a maximum thickness of 300 mm. For thickness exceeding 300 mm, qualification and specification requirements shall be subject to agreement. | | | |
| ***Qualification*** | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| ***Metal making*** | The melt shall be refined by AOD or equivalent method. | | | |
| ***Chemical composition*** | UNS S31803: N = 0,14 % - 0,20 % | | | |
| ***Heat treatment*** | The forgings shall be solution annealed followed by water/liquid quenching.<br>Forgings 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. | | | |
| ***Test sampling*** | For forgings as discs, balls and closed die parts without weld ends, sampling shall be as per ISO 17781 for bars and long solid forgings without weld end.<br>The tensile test specimen shall be taken from the same location as the impact test sample and shall be oriented tangentially when size permits.<br>For all products, the mid-length of the test specimens shall be located one T or 100 mm, whichever is less, to any second surface.<br>For parts forged in closed die and flanges exceeding 80 kg, it is recognized that alternative test may be used. This alternative test sampling shall be qualified and shall comprise comparative testing of sacrificial forgings and the proposed alternative test sample. | | | |
| ***Extent of testing*** | One tensile, impact tests, corrosion test, and one micrographic examination including ferrite measurement shall be carried out for each heat and heat treatment load.<br>The testing shall be carried out on the forgings with heaviest wall thickness within the heat treatment load.<br>A test lot shall not exceed 2 000 kg for forgings with as forged weight up to 50 kg, and 5 000 kg for forgings with as forged weight > 50 kg. | | | |
| ***Impact testing/ Toughness testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall conform with ISO 17781 QL II. | | | |
| ***Corrosion testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781 for forging with weld ends. Test specimens shall be taken from the surface and the centre of the forging with no weld ends. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Micrographic examination*** | The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781 for forging with weld ends. Test specimens shall be taken from the surface and the centre of the forging with no weld ends and shall sample an area of 10 mm by 10 mm minimum. |
| ***Non-destructive testing*** | VT shall be carried out on each forging in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be white pickled prior to the testing.<br>ASTM A961/A961M supplementary requirement S56 or ASME BPVC V Article 6, penetrant testing, shall apply to 10 % of forgings above NPS 2.<br>The testing shall be carried out after final machining. Non-machined surfaces shall be pickled prior to the testing. All accessible internal and external surfaces shall be examined.<br>The acceptance criteria shall be ASME BPVC VIII, Div. 1, Appendix 8. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on two forgings per lot. When only one part is produced, it shall be hardness tested as required. The maximum hardness shall be 28HRC from three readings taken in close proximity. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished forgings shall be white pickled. Machined surfaces do not require pickling. |
| ***Marking*** | The forgings shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— The MPS identification or the MPCR/QTR number used;<br>— Steel manufacturer;<br>— Solution annealing temperature, holding time and quenching medium shall be stated. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. D145 / D145S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Ferritic-Austenitic stainless steel type 22Cr duplex*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Plates, sheets, strips** | ASTM A240/A240M | UNS S31803, UNS S32205 | - | ASTM A240/A240M S1 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Qualification*** | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. |
| ***Metal making*** | The melt shall be refined by AOD or equivalent method. |
| ***Chemical composition*** | UNS S31803: N = 0,14 % - 0,20 % |
| ***Heat treatment*** | The plates shall be solution annealed followed by water/liquid quenching.<br>Plates shall be placed in such a way as to ensure free circulation of heating and cooling media around<br>each plate during the heat treatment process including quenching. |
| ***Tensile testing*** | Tensile test specimens shall be sampled in the transverse orientation to the direction of final rolling and shall be located in mid-thickness for thickness (t) ≤ 40 mm and in location t/4 for thicknesses (t) > 40 mm, in accordance with ASTM E8/E8M. |
| ***Impact testing/ Toughness testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall conform with ISO 17781 QL II. |
| ***Corrosion testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781. |
| ***Micrographic Examination*** | The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781. |
| ***Extent of testing*** | One tensile, one set of impact tests and corrosion test, and one micrographic examination including ferrite measurement shall be carried out for each heat of steel and heat treatment lot. |
| ***Non-destructive testing*** | *Visual inspection*<br>VT shall be carried out on each plate in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series /ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>Production testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on one plate per lot. For coil, tests shall be carried out at both ends of the coil. The maximum hardness shall be 28HRC from three readings taken in close proximity at each location. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished plates, sheets or strips shall be white pickled. |
| ***Marking*** | The plates, sheets or strips shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— MPS identification or MPCR/QTR number used;<br>— Steel manufacturer;<br>— Solution annealing temperature, holding time and quench medium shall be stated. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| Material Data Sheet | MDS No. D146 / D146S [a] | | | Rev. 1 |
|---|---|---|---|---|
| *TYPE OF MATERIAL: Ferritic -Austenitic stainless steel type 22Cr duplex* | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Castings** | ASTM A995/A995M | 4A (UNS J92205) | - | ASTM A995/A995M S5, S6, S11, ASTM A703/A703M S20.2 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Qualification*** | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| ***Metal making*** | The melt shall be refined by AOD or equivalent method. Induction melting of AOD refined ingot or equally refined scrap as permitted by ISO 17782 is regarded to be equivalent to AOD refined materials. | | | |
| ***Chemical composition*** | N = 0,14 % - 0,30 % | | | |
| ***Heat treatment*** | The castings shall be solution annealed followed by water/liquid quenching.<br>Castings shall be placed in such a way as to ensure free circulation of heating and cooling media around each casting during the heat treatment process including quenching. | | | |
| ***Impact testing/ Toughness testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall conform with ISO 17781 QL II. | | | |
| ***Corrosion testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781. | | | |
| ***Micrographic Examination*** | The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781. | | | |
| ***Extent of testing*** | One tensile, one set of impact tests and corrosion test, and one micrographic examination including ferrite measurement shall be carried out for each heat of steel and heat treatment load (including any PWHT).<br>A test lot shall not exceed 5 000 kg in weight. | | | |
| ***Test sampling*** | The test blocks shall be in accordance with ISO 17781. | | | |
| ***Non-destructive testing*** | *General*<br>For definition and NDT of pilot castings reference is made to the general part of this document.<br>Non-machined surfaces shall be cleaned prior to the testing.<br>*Visual inspection*<br>The testing shall be carried out after finished machining.<br>Each pilot and production casting shall be tested at all accessible surfaces, including weld ends. Surface testing and acceptance criteria shall be in accordance with ANSI/MSS SP-55.<br>*Penetrant testing*<br>ASTM A995/A995M supplementary requirement S6 shall apply as amended by this MDS:<br>— Surface testing and acceptance criteria shall be in accordance with ASME BPVC VIII, Div. 1, Appendix 7.<br>— Each pilot and production casting shall be tested after final machining at all accessible external and internal surfaces.<br>— Non-machined surfaces shall be white pickled prior to the testing. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

<table>
<tr><td></td><td>
<u>Radiographic testing</u><br>
ASTM A995/A995M supplementary requirement S5 shall apply as amended by this MDS:<br>
— Method of radiography and acceptance criteria shall be in accordance with ASME BPVC VIII Div. 1 Appendix 7.<br>
— 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.<br>
— Sketches of the areas to be tested shall be established and agreed with the purchaser.<br>
— When random testing (5 %) is specified, minimum one casting of each pattern including feeder and riser system in any purchase order with the foundry shall be examined.<br>
— 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.<br>
— Pilot castings shall be radiographed to the extent described above.<br>
— Frequency of RT of valve castings shall be according to table below.
<table>
<tr><td colspan="6">Frequency of RT based on pressure class and nominal outside diameter:</td></tr>
<tr><td colspan="2">Pressure class:</td><td>≤ 300</td><td>600</td><td>900</td><td>≥ 1 500</td></tr>
<tr><td rowspan="3">Frequency of RT</td><td>Not required</td><td>< 10”</td><td colspan="3">< 2”</td></tr>
<tr><td>5 %</td><td>≥ 10”</td><td colspan="3">≥ 2”</td></tr>
<tr><td>100 %</td><td>Not applicable</td><td>≥ 20”</td><td>≥ 16”</td><td>≥ 6”</td></tr>
</table>
— Non-valve 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.
</td></tr>
<tr><td>Repair of defects</td><td>
Weld repair of castings that leak during pressure testing is not permitted.<br>
All major repairs as defined by ASTM A995/A995M shall be documented in accordance with ASTM A703/A703M S20.2.<br>
Post weld heat treatment (PWHT) is required after all weld repairs. For minor weld repairs, as defined by ASTM A995/A995M, the PWHT may be excluded provided the welding procedure qualification fulfils all specified tests as specified below.<br>
The repair welding procedure shall be qualified in accordance with ISO 11970 or ASTM A488/A488M and the following requirements:<br>
— qualified on a casting of the same grade (UNS-number) which shall be welded;<br>
— change of specific make of filler metal (brand names) requires requalification for SMAW and FCAW processes;<br>
— micrographic testing, ferrite measurement, Charpy V-notch and corrosion test shall be carried out in accordance with ISO 17781 section for welds in the as welded condition;<br>
— Charpy V-notch test specimens in FL+2 may be omitted for welds with PWHT;<br>
— Test methods and conditions shall be in accordance with ISO 17781. Acceptance criteria shall be accordingly, except for corrosion testing, the weight loss shall be < 4,0 g/m$^2$;
</td></tr>
<tr><td colspan="2">[a] The supplementary suffix “S” shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.</td></tr>
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| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished castings shall be white pickled. Machined surfaces do not require pickling. |
| ***Marking*** | The castings shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— The MPS identification or the MPCR/QTR number used;<br>— Steel melting and refining practice;<br>— Solution annealing temperature, holding time and quenching medium shall be stated. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. D147 / D147S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Ferritic -Austenitic stainless steel type 22Cr duplex*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Bars** | ASTM A276/A276M<br>ASTM A479/A479M | UNS S31803, UNS S32205 | | |
| | ASTM A182/A182M | F51 (UNS S31803), F60 (UNS S32205) | | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.<br>This MDS includes additional requirements for valve parts DN 100 (NPS 4) and under manufactured from bars, when permitted by the valve specification.<br>Product covered by this MDS is limited to a maximum thickness of 300 mm. For thickness exceeding 300 mm, qualification and specification requirements shall be subject to agreement. | | | |
| ***Qualification*** | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| ***Metal making*** | The melt shall be refined by AOD or equivalent method. | | | |
| ***Manufacturing*** | Bars shall be manufactured to the following requirements:<br>— bar forgings as defined in ASTM A788/A788M and certified to ASTM A182/A182M, or;<br>— hot or cold finished cylindrical shaped bar manufactured to ASTM A276/A276M or ASTM A479/A479M with maximum diameter of 300 mm.<br>Cold finishing shall be restricted to turning, grinding or polishing (singly or in combination); cold drawing or cold forming is not permitted. | | | |
| ***Chemical composition*** | UNS S31803: N = 0,14 % - 0,20 % | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Heat treatment*** | Bars shall be solution annealed followed by water/liquid quenching.<br>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. |
| ***Tensile testing*** | Where tensile testing in both directions is required by this MDS, all tensile tests shall meet the specified properties of the referenced standard specification in both directions. The centreline of tensile specimen shall be located at a distance from the bar OD in accordance with ASTM A370. |
| ***Impact testing/ Toughness testing*** | Except as modified in the MDS, sampling and acceptance criteria shall conform with ISO 17781 QL II.<br>Where impact testing in the tangential direction is required by this MDS, the acceptance criteria shall be 45 J average, 35 J minimum single. |
| ***Corrosion testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781. Test specimens shall be taken from the surface and the centre of the bar. |
| ***Micrographic Examination*** | The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781. Test specimens shall be taken from the surface and the centre of the bar and shall sample an area of 10 mm by 10 mm minimum. |
| ***Extent of testing*** | Tensile, impact tests and corrosion tests, and one micrographic examination including ferrite measurements shall be carried out for each lot as defined in ASTM A484/A484M. |
| ***Test sampling*** | The mid-length of axial (longitudinal) and tangential (transverse) specimens shall be located at a distance equal to the bar outside diameter or 100 mm, whichever is the lesser, from the end of the bar.<br>*Valve parts manufactured from bar*<br>For bars with outside diameter ≥ 100 mm intended for machining of valve parts, in addition to tensile testing and impact testing in the longitudinal direction, one tensile test specimen and one set of three impact test specimens shall be taken in the tangential direction. Acceptance criteria shall conform with this MDS. |
| ***Non-destructive testing*** | *Visual inspection*<br>VT shall be carried out on each bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing. |
| | *NDT (PT) of valve parts manufactured from bar*<br>Inspection of valve parts manufactured from bar shall be according to the applicable valve specification or as specified below.<br>100 % penetrant testing of all accessible internal and external surfaces shall be carried out in accordance with ASME BPVC V, article 6 or ASTM A961/A961M supplementary requirement S56. Acceptance criteria shall be according to ASME BPVC VIII, Div. 1, appendix 8. The testing shall be carried out after machining. Non machined surfaces shall be white pickled prior to testing. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on the end surface of one bar per lot. The maximum hardness shall be 28HRC from three readings taken in close proximity. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished parts shall be white pickled. Machined or peeled surfaces do not require pickling. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Marking*** | The bars shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— The MPS identification or the MPCR/QTR number used;<br>— Steel manufacturer of starting material;<br>— Solution annealing temperature, holding time and quenching medium shall be stated. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. D148 / D148S [a]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Ferritic-Austenitic stainless steel type 22Cr duplex*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Tubes** | ASTM A789/A789M | UNS S31803, UNS S32205 | | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Qualification*** | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| ***Metal making*** | The melt shall be refined by AOD or equivalent method. | | | |
| ***Chemical composition*** | UNS S31803: N = 0,14 % - 0,20 % | | | |
| ***Heat treatment*** | The tubes shall be solution annealed followed by rapid cooling.<br>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 rapid cooling. | | | |
| ***Test sampling*** | Where tube dimension does not allow taking test specimens in transverse direction specimens shall be taken in longitudinal direction. | | | |
| ***Impact testing/ Toughness testing*** | The sampling of test specimens, testing methodology and the acceptance criteria shall conform with ISO 17781 QL II.<br>NOTE Impact testing is only applicable for wall thickness ≥ 6 mm and when the tube dimension allows extraction of a test sample. | | | |
| ***Corrosion testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781. | | | |
| ***Micrographic examination*** | The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781. | | | |
| ***Extent of testing*** | Tensile testing, one set of impact tests and corrosion test, and one micrographic examination including ferrite measurement shall be carried out for each lot as defined in the standard for mechanical tests. | | | |
| ***Repair of defects*** | Weld repair is not permitted. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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|---|---|
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on one tube per lot. The maximum hardness shall be 28HRC from three readings taken in close proximity. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished tubes shall be white pickled or bright annealed. Machined surfaces do not require pickling. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— MPS identification or MPCR/QTR number used;<br>— Steel manufacturer of the starting material;<br>— Solution annealing temperature, holding time and cooling medium shall be stated (holding time is not applicable for tubes produced hot finished and direct quenched). |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. D149 / D149S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Ferritic-Austenitic stainless steel type 22Cr duplex*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **HIP products** | ASTM A988/A988M | UNS S31803, UNS S32205 | | ASTM A988/A988M S5 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced ASTM standard specification.<br>Product covered by this MDS is limited to a maximum thickness of 300 mm. For thickness exceeding 300 mm, requirements shall be subject to agreement. | | | |
| ***Qualification*** | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| ***Metal making*** | Gas atomized powder made from AOD-refined metal. Powder blends shall be a homogenous mixture of powder heats in terms of composition, particle size and other properties. | | | |
| ***Chemical composition*** | UNS S31803: N = 0,14 % - 0,20 % | | | |
| ***Heat treatment*** | The HIP product shall be solution annealed followed by water/liquid quenching.<br>Products 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. | | | |
| ***Test sampling*** | For all products, the mid-length of the test specimens shall be located one T or 100 mm, whichever is less, to any second surface. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Extent of testing*** | One tensile test, one set of impact tests, corrosion test and one microstructure examination including ferrite measurement shall be carried out for each lot. A lot shall include all products from a single powder blend, same manufacturing procedure and same heat treatment load. |
| ***Impact testing/ Toughness testing*** | The sampling of test specimens, testing methodology and the acceptance criteria shall conform with ISO 17781 QL II. |
| ***Corrosion testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781 for HIP product with weld ends. Test specimens shall be taken from the surface and the centre of the product with no weld ends. |
| ***Micrographic Examination*** | The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781 for HIP product with weld ends. Test specimens shall be taken from the surface and the centre of the product with no weld ends and shall sample an area of 10 mm by 10 mm minimum. |
| ***Non-destructive testing*** | VT shall be carried out on each item in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be white pickled prior to the testing.<br>ASTM A 988 supplementary requirement S5, penetrant testing, shall apply to 10 % of parts from each melt lot and heat treatment load.<br>The testing shall be carried out after final machining on all accessible internal and external surfaces. Non-machined surfaces shall be pickled prior to the testing.<br>The acceptance criteria shall be ASME BPVC VIII, Div. 1, Appendix 8. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on two parts per lot. When only one part is produced, it shall be hardness tested as required. The maximum hardness shall be 25HRC from three readings taken in close proximity. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished components shall be white pickled. Machined surfaces do not require pickling. |
| ***Marking*** | The powder blend shall have a unique identity marked on the powder container and this identity shall be recorded and maintained throughout production of the product. The components shall be marked to ensure full traceability to lot as defined in this MDS. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— MPS identification or MPCR/QTR number used;<br>— Steel manufacturer of the starting material (powder) for the finished product;<br>— Solution annealing temperature, holding time and quench medium shall be stated. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| Material Data Sheet | MDS No. D251 / D251S [a] | | | Rev. 1 |
|---|---|---|---|---|
| *TYPE OF MATERIAL: Ferritic-Austenitic stainless steel type 25Cr duplex* | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Seamless pipes** | ASTM A790/A790M | UNS S32550, UNS S32750, UNS S32760 | | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced ASTM standard specification. | | | |
| ***Qualification*** | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| ***Metal making*** | The melt shall be refined by AOD or equivalent method. | | | |
| ***Chemical composition*** | PREN ≥ 40,0 | | | |
| ***Heat treatment*** | The pipes shall be solution annealed followed by rapid cooling.<br>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 rapid cooling. | | | |
| ***Test sampling*** | Where pipe dimension does not allow taking test specimens in transverse direction specimens shall be taken in longitudinal direction. | | | |
| ***Extent of testing*** | One tensile test, one set of impact tests, corrosion test and one microstructure examination including ferrite measurement shall be carried out for each heat and heat treatment lot. | | | |
| ***Tensile testing*** | A ≥ 25 % | | | |
| ***Impact testing/ Toughness testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall conform with ISO 17781 QL II.<br>NOTE Impact testing is only applicable for wall thickness ≥ 6 mm and when the pipe dimension allows extraction of a test sample. | | | |
| ***Hardness testing*** | Hardness testing shall be performed by the Rockwell C method. | | | |
| ***Corrosion testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781. | | | |
| ***Micrographic examination*** | The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781. | | | |
| ***Repair of defects*** | Weld repair is not permitted. | | | |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: | | | |
| | *Hardness testing*<br>Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on one length of pipe per lot. The maximum hardness shall be 32HRC from three readings taken in close proximity. | | | |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. | | | |
| ***Surface treatment and finish*** | Finished pipes shall be white pickled or bright annealed. Machined surfaces do not require pickling. | | | |
| ***Marking*** | The pipes shall be marked to ensure full traceability to heat and heat treatment lot. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— MPS identification or MPCR/QTR number used;<br>— Steel manufacturer;<br>— Solution annealing temperature, holding time and cooling medium shall be stated (holding time is not applicable for pipes produced hot finished and direct quenched). |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. D252 / D252S [a]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Ferritic-Austenitic stainless steel type 25Cr duplex*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Welded pipes** | ASTM A928/A928M | UNS S32550, UNS S32750, UNS S32760 | Class 1, 3, 4 and 5 | ASTM A928/A928M S3, S4 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Qualification*** | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| ***Metal making*** | The melt shall be refined by AOD or equivalent method. | | | |
| ***Chemical composition*** | PREN ≥ 40,0 | | | |
| ***Welding*** | The WPS shall be qualified in accordance with ISO 15614-1 or ASME BPVC IX, shall include the same examinations as for the production testing and shall fulfil the acceptance criteria of ISO 17781. 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. | | | |
| ***Heat treatment*** | The pipes shall be solution annealed followed by rapid cooling.<br>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 rapid cooling. | | | |
| ***Tensile testing*** | A ≥ 25 % | | | |
| ***Impact testing/ Toughness testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall conform with ISO 17781 QL II.<br>CVN test specimens may be oriented in longitudinal direction when combination of OD, ID and wall thickness does not allow orienting the test specimen in transverse direction. | | | |
| ***Corrosion testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781. | | | |
| ***Micrographic examination*** | Supplementary requirement S4 shall apply as modified by this MDS.<br>The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Extent of testing*** | One tensile test, one set of impact tests and corrosion test and one microstructure examination including ferrite measurement shall be carried out for each heat and heat treatment lot.<br>A lot of pipe is defined as the quantity of product not exceeding the lot definition in the standard and from the same heat, same processing conditions including weld procedure and same heat treatment load.<br>For continuous furnaces, the lot definition shall conform with the product standards. |
| ***Non-destructive testing*** | Supplementary requirement S3, penetrant testing, according to ASME BPVC V Article 6 shall apply to 100 % of the weld area of 10 % of the pipes (same test lot as defined for mechanical testing) delivered.<br>The testing shall be carried out after calibration and pickling/bright annealing.<br>Acceptance criteria shall be to ASME BPVC VIII, Div. 1 Appendix 8. |
| ***Repair of defects*** | Weld repair of base material is not permitted.<br>For repair of welds, the requirements for production welding above shall apply to the repair WPS. Repair welds shall be heat treated as per original production weld. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished pipes shall be white pickled or bright annealed. Machined surfaces do not require pickling. |
| ***Marking*** | The pipes shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— MPS identification or MPCR/QTR number used;<br>— Manufacturer of the starting material;<br>— Solution annealing temperature, holding time and quench medium shall be stated. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. D253 / D253S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Ferritic-Austenitic stainless steel type 25Cr duplex*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Wrought fittings** | ASTM A815/A815M | UNS S32550, UNS S32750, UNS S32760 | WP-W, WP-S or WP-WX | ASTM A815/A815M S2, S7 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Qualification*** | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| ***Metal making*** | The melt shall be refined by AOD or equivalent method. | | | |
| ***Chemical composition*** | PREN ≥ 40,0 | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Welding*** | The WPS shall be qualified in accordance with ISO 15614-1 or ASME BPVC IX, shall include the same examinations as for the production testing and shall fulfil the acceptance criteria of ISO 17781. 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. |
| ***Heat treatment*** | The fittings shall be solution annealed followed by water/liquid quenching.<br>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. |
| ***Test sampling*** | Test sampling shall be made from an actual fitting, from a prolongation thereof, or if not possible, a length of starting material that has been heat treated in the same heat treatment load as the fittings it represents. |
| ***Tensile testing*** | Supplementary requirement S2 shall apply.<br>A ≥ 25 % |
| ***Impact testing/ Toughness testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall conform with ISO 17781 QL II.<br>CVN test specimens may be oriented in longitudinal direction when combination of OD, ID and wall thickness does not allow orienting the test specimen in transverse direction. |
| ***Corrosion testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781. |
| ***Micrographic Examination*** | The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781. |
| ***Extent of testing*** | One tensile test, impact tests and corrosion test and one micrographic examination including ferrite measurement shall be carried out for each lot as defined below.<br>A test lot shall include all fittings from the same heat and heat treatment load, with a wall thickness range of ±5 mm and, where applicable, welded with the same WPS. |
| ***Non-destructive testing*** | Ultrasonic testing is not acceptable as replacement for RT of fittings.<br>Supplementary requirements S7, penetrant testing, shall apply to:<br>— 10 % of seamless or minimum one item per lot in any purchase order;<br>— 100 % of welded fittings above NPS 2.<br>The testing shall be carried out after calibration.<br>For welded fittings the testing shall cover the weld only.<br>The acceptance criteria shall be ASME BPVC VIII, Div. 1, Appendix 8. |
| ***Repair of defects*** | Weld repair of base material is not permitted.<br>For repair of welds, the requirements for production welding shall apply to the repair WPS. Repair welds shall be heat treated as per the original production weld. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished fittings shall be white pickled. Machined surfaces do not require pickling. |
| ***Marking*** | The fittings shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 /EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information: |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| | — MPS identification or MPCR/QTR number used;<br>— Steel manufacturer of the starting material for the finished product;<br>— Solution annealing temperature, holding time and quench medium shall be stated. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. D254 / D254S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Ferritic -Austenitic stainless steel, type 25Cr duplex*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Forgings** | ASTM A182/ A182M | F53 (UNS S32750), F55 (UNS S32760), F61 (UNS S32550) | | ASTM A961/A961M S56 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced ASTM standard specification.<br>Product covered by this MDS is limited to a maximum thickness of 200 mm. For thickness exceeding 200 mm, qualification and specification requirements shall be subject to agreement. | | | |
| ***Qualification*** | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| ***Metal making*** | The melt shall be refined by AOD or equivalent method. | | | |
| ***Chemical composition*** | PREN ≥ 40,0 | | | |
| ***Heat treatment*** | The forgings shall be solution annealed followed by water/liquid quenching.<br>Forgings shall be placed in such a way as to ensure free circulation of heating and cooling media around each forging during the heat treatment process including quenching. | | | |
| ***Test sampling*** | For forgings as discs, balls and closed die parts without weld ends, sampling shall be as per ISO 17781 for bars and long solid forgings without weld end.<br>The tensile test specimen shall be taken from the same location as the impact test sample and shall be oriented tangentially when size permits.<br>For all products, the mid-length of the test specimens shall be located one T or 100 mm, whichever is less, to any second surface.<br>For parts forged in closed die and flanges exceeding 80 kg, it is recognized that alternative test may be used. This alternative test sampling shall be qualified and shall comprise comparative testing of sacrificial forgings and the proposed alternative test sample. | | | |
| ***Extent of testing*** | One tensile test, impact tests, corrosion test and one micrographic examination including ferrite measurement shall be carried out for each heat and heat treatment load.<br>The testing shall be carried out on the forging with heaviest wall thickness within the heat treatment load.<br>A test lot shall not exceed 2 000 kg for forgings with as forged weight up to 50 kg, and 5 000 kg for forgings with as forged weight > 50 kg. | | | |
| ***Tensile testing*** | A ≥ 25 % | | | |
| ***Impact testing/ Toughness testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall conform with ISO 17781 QLII. | | | |
| ***Corrosion testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781 for forging with weld ends. Test specimens shall be taken from the surface and the centre of the forging with no weld ends. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Micrographic Examination*** | The sampling of test specimens, testing methodology and acceptance criteria for micro-structural examination including ferrite measurements shall be in accordance with ISO 17781 for forging with weld ends. Test specimens shall be taken from the surface and the centre of the forging with no weld ends and shall sample an area of 10 mm by 10 mm minimum. |
| ***Non-destructive testing*** | VT shall be carried out on each forging in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be white pickled prior to the testing.<br>ASTM A961/A961M supplementary requirement S56 or ASME BPVC V Article 6, penetrant testing, shall apply to 10 % of forgings above NPS 2.<br>The testing shall be carried out after final machining. Non-machined surfaces shall be pickled prior to the testing. All accessible internal and external surfaces shall be examined.<br>The acceptance criteria shall be ASME BPVC VIII, Div. 1, Appendix 8. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When conformance with sour service requirements is specified by the purchaser, the material shall conform to the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on two forgings per lot. When only one part is produced, it shall be hardness tested as required. The maximum hardness shall be 32HRC from three readings taken in close proximity. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished forgings shall be white pickled. Machined surfaces do not require pickling. |
| ***Marking*** | The forgings shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— The MPS identification or the MPCR/QTR number used;<br>— Steel manufacturer of starting material for the finished product;<br>— Solution annealing temperature, holding time and quenching medium shall be stated. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. D255 / D255S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Ferritic-Austenitic stainless steel type 25Cr duplex*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Plates, sheets, strips** | ASTM A240/A240M | UNS S32550, UNS S32750, UNS S32760 | | ASTM A240/A240M S1 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Qualification*** | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. |
| ***Metal making*** | The melt shall be refined by AOD or equivalent method. |
| ***Chemical composition*** | PREN ≥ 40,0 |
| ***Heat treatment*** | The plates shall be solution annealed followed by water/liquid quenching.<br>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. |
| ***Tensile testing*** | Tensile test specimens shall be sampled in the transverse orientation to the direction of final rolling and shall be located in mid-thickness for thickness (t) ≤ 40 mm and in location t/4 for thicknesses (t) > 40 mm, in accordance with ASTM E8/E8M.<br>Elongation, A ≥ 25 %. |
| ***Impact testing/ Toughness testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall conform with ISO 17781 QL II. |
| ***Corrosion testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781. |
| ***Micrographic Examination*** | The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781. |
| ***Extent of testing*** | One tensile, one set of impact tests and corrosion test, and one micrographic examination including ferrite measurement shall be carried out for each heat and heat treatment lot. |
| ***Non-destructive testing*** | *Visual inspection*<br>VT shall be carried out on each plate in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>Production testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on one plate per lot. For coil, tests shall be carried out at both ends of the coil. The maximum hardness shall be 32HRC from three readings taken in close proximity at each location. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished plates, sheets and strips shall be white pickled. |
| ***Marking*** | The plates, sheets and strips shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— MPS identification or MPCR/QTR number used;<br>— Steel manufacturer of the starting material for the finished product;<br>— Solution annealing temperature, holding time and quench medium shall be stated. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| Material Data Sheet | MDS No. D256 / D256S [a] | | | Rev. 1 |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Ferritic -Austenitic stainless steel, type 25Cr duplex*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Castings** | ASTM A995/A995M | 5A (UNS J93404), 6A (UNS J93380) | | ASTM A995/A995M S5, S6, S11<br>ASTM A703/A703M S20 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Qualification*** | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| ***Metal making*** | The melt shall be refined by AOD or equivalent method. Induction melting of AOD refined ingot or equally refined scrap as permitted by ISO 17782 is regarded to be equivalent to AOD refined materials. | | | |
| ***Chemical composition*** | PREN ≥ 40,0 | | | |
| ***Heat treatment*** | The castings shall be solution annealed followed by water/liquid quenching.<br>Castings shall be placed in such a way as to ensure free circulation of heating and cooling media around each casting during the heat treatment process including quenching. | | | |
| ***Impact testing/ Toughness testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall conform with ISO 17781 QL II. | | | |
| ***Corrosion testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781. | | | |
| ***Micrographic Examination*** | The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781. | | | |
| ***Extent of testing*** | One tensile, one set of impact tests and corrosion test, and one micrographic examination including ferrite measurement shall be carried out for each heat of steel and heat treatment load (including any PWHT).<br>A test lot shall not exceed 5 000 kg in weight. | | | |
| ***Test sampling*** | The test blocks shall be in accordance with ISO 17781. | | | |
| ***Non-destructive testing*** | *General*<br>For definition and NDT of pilot castings reference is made to the general part of this document.<br>Non-machined surfaces shall be cleaned prior to the testing.<br>*Visual inspection*<br>The testing shall be carried out after finished machining.<br>Each pilot and production casting shall be tested at all accessible surfaces, including weld ends. Surface testing and acceptance criteria shall be in accordance with ANSI/MSS SP-55.<br>*Penetrant testing*<br>ASTM A995/A995M supplementary requirement S6 shall apply as amended by this MDS: | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

— Surface testing and acceptance criteria shall be in accordance with ASME BPVC VIII, Div. 1, Appendix 7.

— Each pilot and production casting shall be tested after final machining at all accessible external and internal surfaces.

— Non-machined surfaces shall be white pickled prior to the testing.

*Radiographic testing*

ASTM A995/A995M supplementary requirement S5 shall apply as amended by this MDS:

— Method of radiography and acceptance criteria shall be in accordance with ASME BPVC VIII Div. 1 Appendix 7.

— 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.

— Sketches of the areas to be tested shall be established and agreed with the purchaser.

— When random testing (5 %) 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.

— Pilot castings shall be radiographed to the extent described above.

— Frequency of RT of valve castings shall be according to table below.

| *Frequency of RT based on pressure class and nominal outside diameter:* | | | | | |
|---|---|---|---|---|---|
| *Pressure class:* | | ≤ 300 | 600 | 900 | ≥ 1 500 |
| *Frequency of RT* | Not required | < 10” | < 2” | | |
| | 5 % | ≥ 10” | ≥ 2” | | |
| | 100 % | Not applicable | ≥ 20” | ≥ 16” | ≥ 6” |

— Non-valve 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.

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| ***Repair of defects*** | Weld repair of castings that leak during pressure testing is not permitted.<br>All major repairs as defined by A995 shall be documented in accordance with ASTM A703/A703M S20.2.<br>Post weld heat treatment (PWHT) is required after all weld repairs. For minor weld repairs, as defined by ASTM A995/A995M, the PWHT may be excluded provided the welding procedure qualification fulfils all specified tests as specified below.<br>The repair welding procedure shall be qualified in accordance with ISO 11970 or ASTM A488/A488M and the following requirements: |

[a] The supplementary suffix “S” shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| | — qualified on a casting of the same grade (UNS-number) which shall be welded;<br>— change of specific make of filler metal (brand names) requires requalification for SMAW and FCAW processes;<br>— micrographic testing, ferrite measurement, Charpy V-notch and corrosion test shall be carried out in accordance with ISO 17781 section for welds in the as welded condition;<br>— Charpy V-notch test specimens in FL+2 may be omitted for welds with PWHT;<br>— Test methods and conditions shall be in accordance with ISO 17781. Acceptance criteria shall be accordingly, except for corrosion testing, the weight loss shall be < 4,0 g/m$^2$; |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished castings shall be white pickled. Machined surfaces do not require pickling. |
| ***Marking*** | The castings shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— The MPS identification or the MPCR/QTR number used;<br>— Steel melting and refining practice;<br>— Solution annealing temperature, holding time and quenching medium shall be stated. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. D257 / D257S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Ferritic -Austenitic stainless steel, type 25Cr duplex*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Bars** | ASTM A276/A276M | UNS S32550 (A/S), UNS S32750 (A), UNS S32760 (A/S) | | |
| | ASTM A479/A479M | UNS S32550, UNS S32750, UNS S32760 | | |
| | ASTM A182/A182M | F53 (UNS S32750), F55 (UNS S32760), F61 (UNS S32550) | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced ASTM standard specification.<br>This MDS includes additional requirements for valve parts DN 100 (NPS 4) and under manufactured from bars, when permitted by the valve specification.<br>Product covered by this MDS is limited to a maximum thickness of 200 mm. For thickness exceeding 200 mm, qualification and specification requirements shall be subject to agreement. |
| ***Qualification*** | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS.<br>Bars in condition S shall be qualified to ISO 17782 or NORSOK M-650, with test acceptance criteria to ASTM A276/A276M Condition S and this MDS.<br>When NORSOK M-650 is used as qualification standard, the qualification testing shall be to ISO 17782. The qualification testing shall meet the requirements of this MDS. |
| ***Metal making*** | The melt shall be refined by AOD or equivalent method. |
| ***Manufacturing*** | Bars shall be manufactured to the following requirements:<br>— bar forgings as defined in ASTM A788/A788M and certified to ASTM A182/A182M; or<br>— hot or cold finished cylindrical shaped bar manufactured to ASTM A276/A276M or ASTM A479/A479M with maximum diameter of 200 mm.<br>For bar in condition A: Cold finishing shall be restricted to turning, grinding or polishing (singly or in combination); cold drawing or cold forming is not permitted. |
| ***Chemical composition*** | PREN ≥ 40,0 |
| ***Heat treatment*** | The bars shall be solution annealed followed by water/liquid quenching<br>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. |
| ***Tensile testing*** | Elongation, A ≥ 25 %.<br>Where tensile testing in both directions is required by this MDS, all tensile tests shall meet the specified properties of the referenced standard specification in both directions. The centreline of tensile specimen shall be located at a distance from the bar OD in accordance with ASTM A370. |
| ***Impact testing/ Toughness testing*** | Except as modified in the this MDS, sampling and acceptance criteria shall conform with ISO 17781 QL II. Where impact testing in the tangential direction is required by this MDS, the acceptance criteria shall be 45 J average, 35 J minimum single. |
| ***Corrosion testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781. Test specimens shall be taken from the surface and the centre of the bar. |
| ***Micrographic Examination*** | The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781. Test specimens shall be taken from the surface and the centre of the bar and shall sample an area of 10 mm by 10 mm minimum. |
| ***Extent of testing*** | Tensile, impact tests and corrosion tests and one micrographic examination including ferrite measurements shall be carried out for each lot as defined in ASTM A484/A484M. |
| ***Test sampling*** | The mid-length of axial (longitudinal) and tangential (transverse) specimens shall be located at a distance equal to the bar outside diameter or 100 mm, whichever is the lesser, from the end of the bar.<br>*Valve parts manufactured from bar*<br>For bars with outside diameter ≥ 100 mm intended for machining of valve parts, in addition to tensile testing and impact testing in the longitudinal direction, one tensile test specimen and one set of three impact test specimens shall be taken in the tangential direction. Acceptance criteria shall conform with this MDS. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Non-destructive testing*** | *Visual inspection*<br>VT shall be carried out on each bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing. |
| | *NDT (PT) of valve parts manufactured from bar*<br>Inspection of valve parts manufactured from bar shall be according to the applicable valve specification or as specified below.<br>100 % penetrant testing of all accessible internal and external surfaces shall be carried out in accordance with ASME BPVC V, article 6 or ASTM A961/A961M supplementary requirement S56. Acceptance criteria shall be according to ASME BPVC VIII, Div. 1, appendix 8. The testing shall be carried out after machining. Non machined surfaces shall be white pickled prior to testing. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on the end surface of one bar per lot. The maximum hardness shall be 32HRC from three readings taken in close proximity. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished parts shall be white pickled. Machined or peeled surfaces do not require pickling. |
| ***Marking*** | The bars shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— The MPS identification or the MPCR/QTR number used;<br>— Steel melting and refining practice;<br>— Solution annealing temperature, holding time and quenching medium shall be stated. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. D258 / D258S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Ferritic-Austenitic stainless steel type 25Cr duplex*** | | | | |
| ***Product Form*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Tubes** | ASTM A789/A789M | UNS S32550, UNS S32750, UNS S32760 | | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced ASTM standard specification. | | | |
| ***Qualification*** | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| ***Metal making*** | The melt shall be refined by AOD or equivalent method. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Chemical composition*** | PREN ≥ 40,0 |
| ***Heat treatment*** | The tubes shall be solution annealed followed by rapid cooling.<br>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 rapid cooling. |
| ***Test sampling*** | Where tube dimension does not allow taking test specimens in transverse direction specimens shall be taken in longitudinal direction. |
| ***Tensile testing*** | A ≥ 25 % |
| ***Impact testing/ Toughness testing*** | The sampling of test specimens, testing methodology and the acceptance criteria shall conform with ISO 17781 QL II.<br>NOTE Impact testing is only applicable for wall thickness ≥ 6 mm and when the tube dimension allows extraction of a test sample. |
| ***Corrosion testing*** | The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781. |
| ***Micrographic Examination*** | The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781. |
| ***Extent of testing*** | Tensile testing, one set of impact tests and corrosion test and one micrographic examination including ferrite measurement shall be carried out for each lot as defined in the standard for mechanical tests. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on one tube per lot. The maximum hardness shall be 32HRC from three readings taken in close proximity. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished tubes shall be white pickled or bright annealed. Machined surfaces do not require pickling. |
| ***Marking*** | The tubes shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— MPS identification or MPCR/QTR number used;<br>— Steel heat and refining practice;<br>— Solution annealing temperature, holding time and cooling medium shall be stated (holding time is not applicable for tubes produced hot finished and direct quenched). |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. D259 / D259L** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Ferritic -Austenitic stainless steel, type 25Cr duplex*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |

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| **Studs and bolts** | ASTM A1082/ A1082M (strain hardened) | UNS S32550, UNS S32750, UNS S32760 | S | ASTM A1082/ A1082MS5,<br>ASTM A962/A962M S64, S66 |
| **Nuts** | | | A | ASTM A1082/ A1082M S6 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced ASTM standard specification.<br>NOTE The supplementary suffix "L" is used to designate products impact tested at low temperature —101 °C. | | | |
| ***Qualification*** | Manufacturers and the manufacturing process for bars as start material for bolting to this MDS shall be qualified in accordance with ISO 17782 or NORSOK M-650.<br>Manufacturers and the manufacturing process for production of studs, bolts and nuts that involves any further hot/cold working (except for cold rolling of threads) and/or heat treatment of bar start material shall be separately qualified in accordance with ISO 17782 or NORSOK M-650 and this MDS.<br>When NORSOK M-650 is used as qualification standard, the qualification testing shall be to ISO 17782.<br>The maximum stud/bolt size shall be limited to M64 (2.5 inch). | | | |
| ***Metal making*** | The steel melt shall be refined with AOD or equivalent method. | | | |
| ***Chemical composition*** | PREN ≥ 40,0 | | | |
| ***Manufacturing process*** | Headed bolts shall be manufactured by machining from ASTM A276/A276M Condition S strain hardened bar. No further working of the cold strained bar is allowed except for thread rolling.<br>Nuts shall be machined from solution annealed and water quenched bar or forgings.<br>Threads on studs and bolts may be made by cold rolling or machining. For machined threads, the thread dimensions shall conform with UNR profile.<br>Threads in nuts shall be machined. | | | |
| ***Heat treatment*** | Heat treatment of the strain hardened material is prohibited. | | | |
| ***Extent of testing*** | One tensile and corrosion test, one set of impact tests, and one micrographic test including ferrite measurement shall be carried out for each test lot. Where a test lot is as specified in ASTM A962/A962M for non-heat treated, strain hardened bolting including the same lot for the bar material. | | | |
| ***Tensile testing*** | Testing shall be in accordance with ASTM A962.<br>The minimum tensile test properties shall conform with the following requirements for all sizes and grades:<br>Stud and headed bolts: $R_{p0,2}$ ≥ 725 Mpa; $R_m$ ≥ 860 Mpa; A ≥ 16 %.<br>Nuts: $R_{p0,2}$ ≥ 550 Mpa; $R_m$ ≥ 750 Mpa; A ≥ 25 %. | | | |
| ***Micrographic testing*** | The sampling of test specimens, testing methodology and acceptance criteria for microstructural testing including ferrite measurements shall be in accordance with ISO 17781. Test specimens shall be sampled from surface to mid-thickness.<br>Forged nuts: Testing shall be carried out on a sacrificial part. | | | |

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| ***Impact testing*** | Impact testing of studs, bolts and nuts shall be carried out in accordance with the requirements in ASTM A962.<br>Forged nuts: A sacrificial part shall be used as far as size permits.<br>Test temperature shall be as follows:<br>MDS D259: —46 °C<br>MDS D259L: —101 °C<br>The acceptance criteria shall be minimum 45 J average and 35 J single. |
| ***Corrosion test*** | The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with the principles in ISO 17781. Test specimens shall at least sample from surface to mid-thickness.<br>Forged nuts: Testing shall be carried out on a sacrificial part. |
| ***Hardness test*** | Maximum hardness of the strain hardened bar shall not exceed the values in ASTM A276/A276M for the specified grades supplied in Condition S measured at mid-radius location. Hardness may be measured at bar outer surface before threading or in area not affected by the thread rolling operation. |
| ***Proof load testing of nuts*** | Supplementary requirement to ASTM A1082/A1082M S5 shall apply to at least one nut per test lot. Testing shall be in accordance with ASTM A962. The load shall conform with ASTM A194/A194M Grade 7. Alternatively, tensile strength properties shall be documented and shall conform with the following requirements:<br>$R_{p0,2} \geq 550$ Mpa; $R_m \geq 750$ Mpa; A ≥ 25 %. |
| ***Dimensional tolerance*** | Supplementary requirement S64: Product dimensions shall be checked or controlled to an extent as specified by ASME B18.18 Category 2. |
| ***Non-destructive testing*** | All parts shall be 100 % visually examined in all areas of threads, shanks, and heads. Discontinuities shall conform with requirements specified in ASTM F788/F788M for bolts/studs and ASTM F812 for nuts. |
| ***Surface treatment and finish*** | Finished parts shall be white pickled or grit blasted. Machined or rolled surfaces do not require pickling. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Marking*** | The part shall in addition to material grade and manufactures logo be hard marked with a traceability code to ensure full traceability to melt and heat treatment lot, supplementary requirement S66 shall apply.<br>The marking shall contain the following information:<br>— manufacturer's identification symbol or name (ID);<br>— alloy designation[1] with underscore or the letter "S", e.g. S32760 = 760 or 760S;<br>— impact test temperature or MDS No. (add letter "L") e.g. 760L or 760SL;<br>— lot number or traceability code (LOT).<br>EXAMPLES<br>— Stud and bolts MDS D259: Manufacturers' ID – 760 – LOT or ID – 760S – LOT<br>— Stud and bolts MDS D59L: ID – 760L – LOT or ID – 760SL – LOT<br>— Nuts: ID – 32760 – LOT or ID 32760L-LOT<br>Due to limited space the alloy designation may be shortened to include only the three last digits of the UNS No. |

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| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The material certificate shall be issued in accordance with ISO 10474 / EN 10204 type 3.1, shall confirm compliance with this specification, and shall include the following information:<br>— ISO 17782 / NORSOK M-650 manufacturing summary identification or MPCR/QTR no. used;<br>— steel producer of starting material;<br>— steel melting practice and refining method;<br>— solution annealing temperature and holding time. |

| **Material Data Sheet** | **MDS No. D260 / D260L / D260S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Ferritic-Austenitic stainless steel, type 25Cr duplex*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Stud and bolts** | ASTM A1082/ A1082M | UNS S32550, UNS S32750, UNS S32760 | | ASTM A962/A962M S64, S66 |
| **Nuts** | | | | A1082 S5 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced ASTM standard specification.<br>NOTE The supplementary suffix "L" is used to designate products impact tested at low temperature —101 °C. | | | |
| ***Qualification*** | Manufacturers and the manufacturing process for bars as start material for bolting to this MDS shall be qualified in accordance with ISO 17782 or NORSOK M-650.<br>Manufacturers and the manufacturing process for production of studs, bolts and nuts that involves any further hot/cold working (except for cold rolling of threads) and/or heat treatment of bar start material shall be separately qualified in accordance with ISO 17782 or NORSOK M-650 and this MDS.<br>When NORSOK M-650 is used as qualification standard, the qualification testing shall be to ISO 17782. | | | |
| ***Metal making*** | The steel melt shall be refined with AOD or equivalent method. | | | |
| ***Chemical composition*** | PREN ≥ 40,0 | | | |
| ***Manufacturing process*** | The studs, bolts and nuts shall be made from solution annealed bars manufactured to ASTM A276/A276M / ASTM 479.<br>Any hot forging operation shall be followed by solution annealing.<br>Threads on studs and bolts shall be made by cold rolling. Machined threads shall have UNR profile. Threads in nuts shall be machined. | | | |
| ***Extent of testing*** | A test lot shall be limited to each cast of material, same heat treatment batch, size of start material and same type of product and size.<br>Charpy V-notch impact, microstructure, corrosion and tensile testing shall be carried out for each lot. | | | |
| ***Tensile testing*** | Testing in accordance with ASTM A962/A962M shall apply.<br>The minimum wedge tensile strength ($T_s$) shall be $T_s \geq R_m$ x stress area. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Proof load of testing of nuts*** | Supplementary requirement to ASTM A1082/A1082M S5 shall apply to at least one nut per test lot. Testing shall be in accordance with ASTM A962. The load shall conform with ASTM A194/A194M Grade 7. Alternatively, tensile strength properties shall be documented as described under tensile testing in this MDS. |
| ***Micrographic testing*** | The sampling of test specimens, testing methodology and acceptance criteria for microstructural testing shall be in accordance with the principles in ISO 17781. Test specimens shall be from surface to mid-thickness.<br>*Forged headed bolts and nuts:* Testing shall be carried out on a sacrificial part. |
| ***Impact testing*** | Impact testing of studs, bolts and nuts shall be carried out in accordance with the requirements in ASTM A962.<br>*Forged nuts:* A sacrificial part shall be used as far as size permits.<br>Forged headed bolts: The notch shall be located as close to the head as possible.<br>Test temperature shall be as follows:<br>*MDS D260:* —46 °C<br>*MDS D260L:* —101 °C<br>The acceptance criteria shall be minimum 45 J average and 35 J single. |
| ***Corrosion test*** | The sampling of test specimens, testing methodology and acceptance criteria shall be as specified for bars in accordance with ISO 17781. Test specimens shall at least sample surface to mid-thickness.<br>Forged headed bolts and nuts: Testing shall be carried out on a sacrificial part. |
| ***Dimensional tolerance*** | Supplementary requirement S64: Product dimensions shall be checked or controlled to an extent as specified by ASME B18.18 Category 2. |
| ***Non-destructive testing*** | All parts shall be 100 % visually examined in all areas of threads, shanks, and heads. Discontinuities shall conform with requirements specified in ASTM F788/F788M for bolts/studs and ASTM F812 for nuts. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Surface treatment and finish*** | Finished parts shall be white pickled or grit blasted. Machined or rolled surfaces do not require pickling. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements:<br>*Hardness testing*<br>Hardness testing shall be performed in accordance with the requirements in ASTM A1082/A1082M.<br>Hardness may be measured at bar outer surface before threading or in area not affected by the thread rolling operation. The maximum hardness for UNS S32750 and UNS S32760 shall be 32HRC from three readings taken in close proximity. The maximum hardness for grade UNS S32550 shall not exceed 31HRC.<br>The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Marking*** | All parts shall in addition to material grade and manufactures logo be hard marked with a traceability code to ensure full traceability to melt and heat treatment lot, supplementary requirement S66 shall apply.<br>The marking shall contain the following information:<br>— manufacturer's identification symbol or name (ID);<br>— alloy designation[1], (e.g. UNS S32760 = 760);<br>— impact test temperature or MDS No. (add letter "L");<br>— lot number or traceability code (LOT). |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| | EXAMPLES<br>— Stud and bolts MDS D60: Manufacturers' ID –760 – LOT<br>— Stud and bolts MDS D60L: ID –760L – LOT<br>— Nuts: ID – 32760 – LOT<br>Due to limited space the alloy designation may be shortened to include only the three last digits of the UNS No. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The material certificate shall be issued in accordance with ISO 10474 / EN 10204 type 3.1, shall confirm compliance with this specification, and shall include the following information:<br>— ISO 17782 / NORSOK M-650 manufacturing summary identification or MPCR/QTR no. used;<br>— steel producer;<br>— steel melting practice and refining method;<br>— solution annealing temperature and holding time. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. D269 / D269S [a]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Ferritic-Austenitic stainless steel type 25Cr duplex*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **HIP products** | ASTM A988/A988M | UNS S32750, UNS S32760, UNS S32505 | | ASTM A988/A988M S5 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.<br>Product covered by this MDS is limited to a maximum thickness of 200 mm. For thickness exceeding 200 mm, qualification and specification requirements shall be subject to agreement. | | | |
| ***Qualification*** | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| ***Metal making*** | Gas atomized powder made from AOD-refined metal. Powder blends shall be a homogenous mixture of powder heats in terms of composition, particle size and other properties. | | | |
| ***Chemical composition*** | PREN ≥ 40,0 | | | |
| ***Heat treatment*** | The HIP product shall be solution annealed followed by water/liquid quenching.<br>Products 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. | | | |
| ***Test sampling*** | For all products, the mid-length of the test specimens shall be located one T or 100 mm, whichever is less, to any second surface. | | | |
| ***Extent of testing*** | One tensile test, one set of impact tests, corrosion test and one microstructure examination including ferrite measurement shall be carried out for each lot. A lot shall include all products from a single powder blend, same manufacturing procedure and same heat treatment load. | | | |
| ***Tensile testing*** | A ≥ 25 % | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Impact testing/ Toughness testing*** | The sampling of test specimens, testing methodology and the acceptance criteria shall conform with ISO 17781 QL II. |
| ***Corrosion testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781 for HIP product with weld ends. Test specimens shall be taken from the surface and the centre of the product with no weld ends. |
| ***Micrographic Examination*** | The sampling of test specimens, testing methodology and acceptance criteria for micro-structural examination including ferrite measurements shall be in accordance with ISO 17781 for HIP product with weld ends. Test specimens shall be taken from the surface and the centre of the product with no weld ends and shall sample an area of 10 mm by 10 mm minimum. |
| ***Non-destructive testing*** | VT shall be carried out on each item in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be white pickled prior to the testing.<br>ASTM A988/A988M supplementary requirement S5, penetrant testing, shall apply to 10 % of parts from each melt lot and heat treatment load.<br>The testing shall be carried out after final machining on all accessible internal and external surfaces. Non-machined surfaces shall be pickled prior to the testing.<br>The acceptance criteria shall be ASME BPVC VIII, Div. 1, Appendix 8. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on two parts per lot. When only one part is produced, it shall be hardness tested as required. The maximum hardness shall be 32HRC from three readings taken in close proximity. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished components shall be white pickled. Machined surfaces do not require pickling. |
| ***Marking*** | The powder blend shall have a unique identity marked on the powder container and this identity shall be recorded and maintained throughout production of the product. The components shall be marked to ensure full traceability to lot as defined in this MDS. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— MPS identification or MPCR/QTR number used;<br>— Steel manufacturer of the starting material (powder) for the finished product;<br>— Solution annealing temperature, holding time and quench medium shall be stated. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. K101** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Copper-Nickel 90-10*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |

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| **Seamless pipes and tubes** | EEMUA 234 | 7060X | - | - |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Heat treatment*** | Hot formed pipe and tube: products hot formed in the temperature range of 760 °C to 800 °C do not need annealing after forming.<br>Cold formed pipe and tube: annealed. | | | |
| ***Test sampling*** | Test samples shall be cut from the products themselves, from prolongations or from sacrificial pipe and tube. | | | |
| ***Tensile testing*** | Tensile test specimens shall be taken from each lot where a lot is defined as all products of the same type and nominal size, which are produced from the same heat of material and subject to the same finishing operation. | | | |
| ***Repair of defects*** | Weld repair is not permitted. | | | |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification. | | | |

| **Material Data Sheet** | **MDS No. K102** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Copper-Nickel 90-10*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Welded pipes** | EEMUA 234 | 7060X | | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Welding*** | An electric fusion welding process shall be used.<br>Welding procedures shall be established and qualified in accordance with ASME BPVC IX. | | | |
| ***Heat treatment*** | Hot formed pipes: pipes hot formed in the temperature range of 760 °C to 800 °C do not need annealing after forming.<br>Cold formed pipes: annealed.<br>Welded pipes: annealed or as welded from annealed materials. | | | |
| ***Test sampling*** | Test samples shall be cut from the products themselves, from prolongations or from sacrificial pipes. | | | |
| ***Tensile testing*** | Tensile test specimens shall be taken from each lot where a lot is defined as all products of the same type and nominal size, which are produced from the same heat of material and subject to the same finishing operation. | | | |
| ***Non-destructive testing*** | *Radiographic testing*<br>— SCH 10S: Welds shall be spot radiographed in accordance with the requirements of the ASME BPVC VIII, Div. 1, Paragraph UW-52.;<br>— Other schedules: Welds shall be 100 % radiographed in accordance with the requirements of the ASME BPVC VIII, Div. 1, Paragraph UW-51. | | | |
| ***Repair of defects*** | Weld repair of base material is not permitted.<br>For repair of welds, the requirements for production welding shall apply to the repair WPS. | | | |

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| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification. |

| **Material Data Sheet** | **MDS No. K103** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Copper-Nickel 90-10*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Fittings** | EEMUA 234 | 7060X | - | - |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Welding*** | An electric fusion welding process shall be used.<br>Welding procedures shall be established and qualified in accordance with ASME BPVC IX. | | | |
| ***Heat treatment*** | Hot formed fittings: fittings hot formed in the temperature range of 760 °C to 800 °C do not need annealing after forming.<br>Cold formed fittings: annealed.<br>Welded fittings: annealed or as welded from annealed materials. | | | |
| ***Test sampling*** | Test samples may be cut from the products themselves, from prolongations or from sacrificial fittings. | | | |
| ***Tensile testing*** | Tensile test specimens shall be taken from each lot where a lot is defined as all products of the same type and nominal size, which are produced from the same heat of material and subject to the same finishing operation. | | | |
| ***Non-destructive testing*** | *Radiographic testing*<br>— SCH 10S: Welds shall be spot radiographed in accordance with the requirements of the ASME BPVC VIII, Div. 1, Paragraph UW-52.;<br>— Other schedules: Welds shall be 100 % radiographed in accordance with the requirements of the ASME BPVC VIII, Div. 1, Paragraph UW-51. | | | |
| ***Repair of defects*** | Weld repair of base material is not permitted.<br>For repair of welds, the requirements for production welding shall apply to the repair WPS. | | | |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification. | | | |

| **Material Data Sheet** | **MDS No. K104** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Copper-Nickel 90-10*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Flanges** | EEMUA 234 | 7060X | | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |

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| ***Heat treatment*** | Hot formed flanges: flanges hot formed in the temperature range of 760 °C to 800 °C do not need annealing after forming.<br>Cold formed flanges: annealed. |
| ***Test sampling*** | Test samples may be cut from the products themselves, from prolongations or from sacrificial flanges. |
| ***Tensile testing*** | Tensile test specimens shall be taken from each lot where a lot is defined as all products of the same type and nominal size, which are produced from the same heat of material and subject to the same finishing operation. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification. |

| **Material Data Sheet** | **MDS No. K105** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Copper-Nickel 90-10*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Plate and sheet** | ASTM B171/B171M | UNS C70600 | | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Design and dimensional standards*** | The EEMUA standard No. 234: “Copper Nickel alloy piping for offshore applications specification” shall apply. | | | |
| ***Chemical composition*** | According to EEMUA 234 grade 7060X | | | |
| ***Heat treatment*** | Plate shall be annealed. Hot rolled/forged plate in the temperature range of 760 °C to 800 °C do not need annealing after forming. | | | |
| ***Test sampling*** | Test samples may be cut from the products themselves, from prolongations or from sacrificial plates. | | | |
| ***Tensile testing*** | Tensile test specimens shall be taken from each lot where a lot is defined as all products of the same type and nominal size, which are produced from the same heat of material and subject to the same finishing operation. | | | |
| ***Repair of defects*** | Weld repair is not permitted. | | | |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification. | | | |

| **Material Data Sheet** | **MDS No. K107** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Copper-Nickel 90-10*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Rods and bars** | ASTM B151/B151M | UNS C70600 | | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |

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| ***Design and dimensional standards*** | The EEMUA standard No. 234: "Copper Nickel alloy piping for offshore applications specification" shall apply. |
| ***Chemical composition*** | According to EEMUA 234 grade 7060X |
| ***Heat treatment*** | Rods and bars hot formed in the temperature range of 760 °C to 800 °C do not need annealing after forming.<br>Cold formed rods and bars: annealed. |
| ***Test sampling*** | Test samples may be cut from the products themselves, from prolongations or from sacrificial rods and bars. |
| ***Tensile testing*** | Tensile test specimens shall be taken from each lot where a lot is defined as all products of the same type and nominal size, which are produced from the same heat of material and subject to the same finishing operation. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification. |

| **Material Data Sheet** | **MDS No. K114** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Aluminium bronze*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Forgings** | ASTM B124/ B124M | UNS C63000 | | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Manufacturing*** | Hot working shall be used. | | | |
| ***Heat treatment*** | Forgings shall be hot worked and supplied in O61- Annealed condition. | | | |
| ***Tensile testing*** | Tensile test specimens shall be taken from each lot where a lot is defined as all products of the same type and nominal size, which are produced from the same material heat and heat treatment load. | | | |
| ***Test sampling*** | Test samples may be cut from the products themselves, from prolongations or from sacrificial forging. | | | |
| ***Non-destructive testing*** | Valve forgings NDT:<br>Inspection shall be according to the applicable valve specification. | | | |
| ***Repair of defects*** | Weld repair is not permitted. | | | |
| ***Marking*** | The forging shall be marked to ensure full traceability to heat and heat treatment lot. | | | |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification. | | | |

| Material Data Sheet | MDS No. K116 | | | Rev. 1 |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Aluminium bronze*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Castings** | ASTM B148 | UNS C95800 | | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Heat treatment*** | Heat treatment may be carried out at the discretion of the manufacturer. | | | |
| ***Extent of testing*** | One tensile test shall be carried out for each lot as defined by the in ASTM B148. | | | |
| ***Non-destructive testing*** | *General*<br>Testing shall be carried out after machining, if applicable.<br>*Visual inspection*<br>VT shall be carried out on each casting in accordance with the product standard.<br>*Liquid penetrant testing*<br>Liquid penetrant testing shall be carried out in accordance with ASME BPVC V, Article 6. All accessible internal and external surfaces shall be examined on pilot castings and production castings. Acceptance criteria shall be to ASME BPVC VIII, Div. 1, Appendix 7.<br>*Radiographic testing*<br>Method of radiography shall be to ASME V, Article 2 and acceptance criteria shall be in accordance with ASME BPVC VIII Div. 1 Appendix 7.<br>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.<br>Sketches of the areas to be tested shall be established and agreed with the purchaser.<br>When random testing (5 %) is specified, minimum one casting of each pattern including feeder and riser system in any purchase order with the foundry shall be examined.<br>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.<br>Pilot castings shall be radiographed to the extent described above<br>Frequency of RT of valve castings with pressure class ≤ 300 shall be 5 % for NPS 10 and above and 0 % below NPS 10. For higher pressure classes the extent shall be agreed. Non-valve 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. | | | |
| ***Repair of defects*** | Repairs that exceed the limit in ASTM B148 shall be considered major repairs.<br>All major repairs shall be documented with a sketch showing location and size of excavations.<br>Weld repairs are not acceptable for castings that leak during the final pressure testing.<br>Repairs by peening and impregnation are prohibited.<br>The repair welding procedure shall be qualified in accordance with ASME BPVC IX; a change of filler metal brand names requires requalification. | | | |

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| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition (annealing temperature). |

| **Material Data Sheet** | **MDS No. K117** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Aluminium bronze*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Rods and bars** | ASTM B150/150M | UNS C63200 | | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Manufacturing*** | Hot rolling or hot forging may be used. | | | |
| ***Heat treatment*** | Temper annealed for all diameters or thickness to condition O20 or O25. | | | |
| ***Tensile testing*** | Tensile test specimens shall be taken from each lot where a lot is defined as all products of the same type and nominal size, which are produced from the same material heat and heat treatment load. | | | |
| ***Test sampling*** | Test samples may be cut from the products themselves, from prolongations or from sacrificial rods or bars. | | | |
| ***Repair of defects*** | Weld repair is not permitted. | | | |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification. | | | |

| **Material Data Sheet** | **MDS No. L101** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Nickel alloyed steel, type 3,5 % Nickel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Seamless pipes** | ASTM A333/A333M | 3 | - | - |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Heat treatment*** | Products shall be delivered in the normalized or normalized and tempered condition.<br>During the heat treatment process, pipes shall be placed in such a way as to ensure free circulation around each pipe including any quenching operation.<br>For products delivered in the tempered condition, the minimum tempering temperature shall be 615 °C. | | | |

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| ***Impact testing / toughness testing*** | Impact testing is required for thickness ≥ 6 mm. For pipes with a weld end, the weld end thickness shall govern.<br>The test temperature shall be –101 °C.<br>The minimum absorbed energy for full size specimens shall be 27 J average and 20 J single.<br>Reduction factors for sub-size specimens shall be: 7,5 mm – 5/6 and 5 mm – 2/3. |
| ***Test sampling*** | Test specimens shall be prepared and tested after simulated PWHT in accordance with the product standard. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Marking*** | The pipes shall be marked to ensure full traceability to heat and heat treatment load. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition. For tempered condition, tempering temperature shall be stated. |

| **Material Data Sheet** | **MDS No. L102** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Nickel alloyed steel, type 3,5 % Nickel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Welded pipes** | ASTM A671/671M | CFE 70 | Cl. 22, Cl. 32, Cl. 42 | ASTM A671/671M S2, S7, S14 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Manufacturing process*** | The longitudinal weld shall be straight. Welds shall be made using the SAW process. | | | |
| ***Heat treatment*** | During the heat treatment process, pipes shall be placed in such a way as to ensure free circulation around each pipe including any quenching operation.<br>For products delivered in the tempered condition, the minimum tempering temperature shall be 615 °C. | | | |
| ***Impact testing / toughness testing*** | Impact testing is required for thickness ≥ 6 mm. For pipes with a weld end, the weld end thickness shall govern.<br>The test temperature shall be –101 °C.<br>The minimum absorbed energy for full size specimens shall be 27 J average and 20 J single.<br>Reduction factors for sub-size specimens shall be: 7,5 mm – 5/6 and 5 mm – 2/3. | | | |
| ***Extent of testing*** | Impact testing per ASTM A671/A671M supplementary requirement S2, as modified by this MDS, shall be carried out per lot.<br>ASTM A671/A671M supplementary requirement S14 shall apply for lot definition.<br>Impact test samples for base metal shall be taken from mid-thickness. | | | |
| ***Test sampling*** | Test specimens shall be prepared and tested after simulated PWHT at 600 °C with minimum holding time of 2,5 min/mm, and then furnace cooled to a temperature not exceeding 315 °C. | | | |

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| ***Non-destructive testing*** | ASTM A671/A671M supplementary requirement S7 shall apply. |
| ***Repair of defects*** | Weld repair of the base material is not permitted.<br>Repairs to weld metal are acceptable in accordance with the standard specification and shall meet the requirements of the original manufacturing weld. |
| ***Marking*** | The pipes shall be marked to ensure full traceability to heat and heat treatment load. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition. For stress relieved condition or tempered conditions, the stress relieving temperature or tempering temperature shall be stated. |

| **Material Data Sheet** | **MDS No. L103** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Nickel alloyed steel, type 3,5 % Nickel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Wrought fittings** | ASTM A420/420M | WLP3, WLP3W | - | ASTM A960/960M S51, S53, S59, S69 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Manufacturing process*** | Fittings shall be made from seamless pipe, welded pipe, forging or plate (for end caps only) compliant with the MDSs of this specification.<br>End caps shall be seamless. | | | |
| ***Welding*** | An electric fusion welding process shall be used with the addition of filler metal. Autogenous welding is not permitted. | | | |
| ***Heat treatment*** | Products shall be delivered in the normalized or normalized and tempered condition.<br>During the heat treatment process, parts shall be placed in such a way as to ensure free circulation around each part including any quenching operation.<br>All hot formed or forged fittings, including those manufactured by locally heating a portion of the fitting stock, shall be heat treated after manufacturing. ASTM A960/A960M supplementary requirement S69 shall apply.<br>For products delivered in the tempered condition, the minimum tempering temperature shall be 615 °C. | | | |
| ***Tensile testing*** | ASTM A960/A960M supplementary requirement S51 shall apply as amended by this MDS.<br>Test sampling shall be made from an actual fitting, from a prolongation thereof, or if not possible, a length of starting material that has been heat treated in the same heat treatment load as the fittings it represents. | | | |
| ***Impact testing / toughness testing*** | Impact testing is required for thickness ≥ 6 mm. For fittings with a weld end, the weld end thickness shall govern. The test temperature shall be –101 °C. 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. | | | |

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| ***Extent of testing*** | Impact testing and tensile testing shall be carried out for each heat and heat treatment load. |
| ***Non-destructive testing*** | UT is not acceptable in-lieu of RT.<br>*Magnetic particle testing*<br>ASTM A960/A960M supplementary requirement S53 and S69 shall apply as amended by this MDS:<br>Magnetic particle testing, in accordance with ASME BPVC V, Article 7 shall apply to 10 % of all fittings, minimum one per test lot. Testing shall be carried out as follows:<br>— Non-machined surfaces shall be cleaned prior to testing.<br>— The testing shall be carried out after final machining and cover 100 % of accessible surface of the test item.<br>— The acceptance criteria shall be to ASME BPVC VIII Div. 1, Appendix 6. |
| ***Repair of defects*** | Weld repair of the base material is not permitted.<br>Repairs to weld metal are acceptable in accordance with the standard specification and shall meet the requirements of the original manufacturing weld. |
| ***Marking*** | The fittings shall be marked to ensure full traceability to heat and heat treatment load. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition. For tempered condition, the tempering temperature shall be stated. |

| **Material Data Sheet** | **MDS No. L104** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Nickel alloyed steel, type 3,5 % Nickel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Forgings** | ASTM A350/ A350M | LF3 | Class 2 | ASTM A961/961M S55 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Heat treatment*** | Products shall be delivered in the normalized or normalized and tempered condition.<br>During the heat treatment process, parts shall be placed in such a way as to ensure free circulation around each part including any quenching operation.<br>For products delivered in the tempered condition, the minimum tempering temperature shall be 615 °C. | | | |
| ***Impact testing / toughness testing*** | Impact testing is required for thickness ≥ 6 mm. For forgings with a weld end, the weld end thickness shall govern.<br>Reduction factors for sub-size specimens shall be: 7,5 mm – 5/6 and 5 mm – 2/3. | | | |

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| ***Extent of testing*** | One set of tensile, impact and hardness testing shall be carried out for each heat and heat treatment load.<br>A test lot shall not exceed 2 000 kg for forgings with as forged weight up to 50 kg, and 5 000 kg for forgings with as forged weight > 50 kg. |
| ***Non-destructive testing*** | *Visual inspection*<br>VT shall be carried out on each forging in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing.<br>*Magnetic particle testing*<br>10 % of all forgings per lot or a minimum of one item per lot in any purchase order shall be examined with magnetic particle testing. All accessible internal and external surfaces shall be examined according to ASME BPVC V, article 7 or ASTM A961/A961M supplementary requirement S55. Acceptance criteria shall be according to ASME BPVC VIII, Div. 1, appendix 6. The testing shall be carried out after machining, if applicable. Non-machined surfaces shall be cleaned prior to the testing. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Marking*** | The parts shall be marked to ensure full traceability to heat and heat treatment load. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition, including tempering temperature. |

| **Material Data Sheet** | **MDS No. L105** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Nickel alloyed steel, type 3,5 % Nickel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Plates** | ASTM A203/ A203M | D, E | - | ASTM A20/A20M S5 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Impact testing / toughness testing*** | ASTM A20/A20M supplementary requirement S5 shall apply as amended by this MDS.<br>Impact testing is required for thickness ≥ 6 mm after final heat treatment. The test temperature shall be –101 °C. The minimum absorbed energy for full size specimens shall be 27 J average and 20 J single. The test specimen shall be taken at mid-thickness in the longitudinal orientation to the final direction of rolling.<br>Reduction factors for sub-size specimens shall be: 7,5 mm – 5/6 and 5 mm – 2/3. | | | |
| ***Non-destructive testing*** | *Visual inspection*<br>VT shall be carried out on each plate in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing. | | | |
| ***Repair of defects*** | Weld repair is not permitted. | | | |
| ***Marking*** | The parts shall be marked to ensure full traceability to heat and heat treatment load. | | | |

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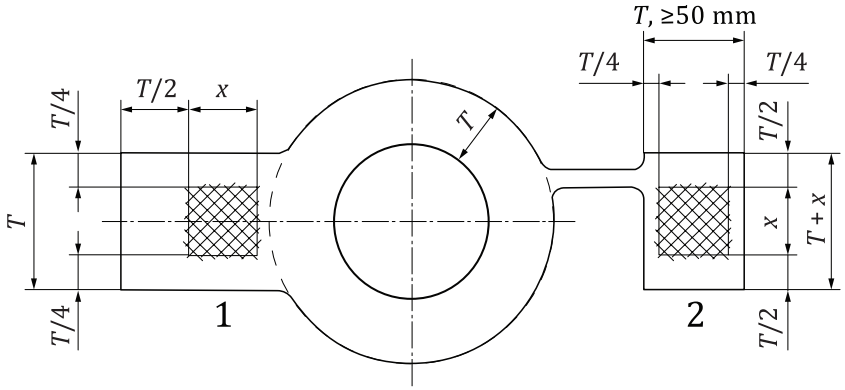
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition. |

| **Material Data Sheet** | **MDS No. L106** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Nickel alloyed steel, type 3,5 % Nickel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Castings** | ASTM A352/ A352M | LC3 (UNS J31550) | - | ASTM A352/A352M S4, S5<br>ASTM A703/A703M S8, S14, S20 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Heat treatment*** | During the heat treatment process, castings shall be placed in such a way as to ensure free circulation around each casting including possible quenching operation.<br>For products delivered in the tempered condition, the minimum tempering temperature shall be 615 °C. | | | |
| ***Impact testing / toughness testing*** | ASTM A703/703M supplementary requirement S8 shall apply.<br>The test temperature shall be –101 °C. The minimum absorbed energy for full size specimens shall be 27 J average and 20 J single. The test specimen shall be taken at mid-thickness.<br>Reduction factors for sub-size specimens shall be: 7,5 mm – 5/6 and 5 mm – 2/3. | | | |
| ***Extent of testing*** | ASTM A703/703M supplementary requirement S14 shall apply. | | | |
| ***Test sampling*** | Test blocks shall be integrally cast or gated onto the casting and shall accompany the castings through all heat treatment operations including any post weld stress relieving.<br>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.<br>Dimensions of test blocks and location of test specimens within the test blocks are shown in the figure below for integral and gated test block. 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.<br>  <br> | | | |

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|---|---|
| | 1 integrated test block<br>2 gated test block |
| ***Non-destructive testing*** | *General*<br>For definition and NDT of pilot castings reference is made to the general part of this document.<br>Non-machined surfaces shall be cleaned prior to the testing.<br>*Visual inspection*<br>The testing shall be carried out after finished machining.<br>Each pilot and production casting shall be tested at all accessible surfaces, including weld ends. Surface testing and acceptance criteria shall be in accordance with ANSI/MSS SP-55.<br>*Magnetic particle testing*<br>ASTM A352/352M supplementary requirement S4 shall apply as amended by this MDS:<br>Surface testing and acceptance criteria shall be in accordance with ASME BPVC VIII, Div. 1, Appendix 7.<br>Each pilot and production casting shall be tested after final machining at all accessible external and internal surfaces.<br>*Radiographic testing*<br>— Supplementary requirement S5 shall apply as amended by this MDS. Method of radiography and acceptance criteria shall be in accordance with ASME BPVC VIII Div. 1 Appendix 7.<br>— 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.<br>— Sketches of the areas to be tested shall be established and agreed with the purchaser.<br>— When random testing (5 %) is specified, minimum one casting of each pattern including feeder and riser system in any purchase order with the foundry shall be examined.<br>— 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.<br>— Pilot castings shall be radiographed to the extent described above.<br>— Frequency of RT of valve castings shall be according to table below. |

| *Extent of RT based on pressure class and nominal outside diameter:* | | | | | |
|---|---|---|---|---|---|
| *Pressure class:* | | *≤ 300* | *600* | *900* | *≥ 1 500* |
| *Frequency of RT* | Not required | < 10” | < 2” | | |
| | 5 % | ≥ 10” | ≥ 2” | | |
| | 100 % | Not required | ≥ 20” | ≥ 16” | ≥ 6” |

Non-valve 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.

| | |
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| ***Repair of defects*** | ASTM A703/A703M supplementary requirement S20 shall apply with the following additional requirements:<br>— Major repairs as defined in ASTM A352/A352M shall be documented in accordance with ASTM A703/A703M S20.2.<br>— The repair welding procedure shall be qualified in accordance with ASTM A488/A488M or ISO 11970 and this data sheet using a cast plate.<br>— Weld repairs are not acceptable for castings that leak during pressure testing.<br>— Examination of major repair welds on pressure containing parts shall also include RT. |
| ***Marking*** | The parts shall be marked to ensure full traceability to heat and heat treatment load. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition, including tempering temperature. |

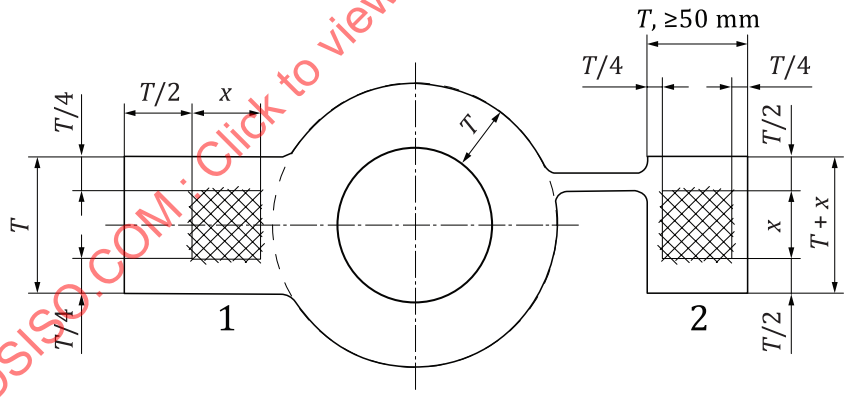
| **Material Data Sheet** | **MDS No. L108** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Nickel alloyed steel, type 3,5 % Nickel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Tubes** | A334/A334M | 3 | - | - |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Heat treatment*** | Products shall be delivered in the normalized or normalized and tempered condition.<br>During the heat treatment process, tubes shall be placed in such a way as to ensure free circulation around each tube including any quenching operation.<br>For products delivered in the tempered condition, the minimum tempering temperature shall be 615 °C. | | | |
| ***Impact testing / toughness testing*** | Impact testing is required for thickness ≥ 6 mm. The test temperature shall be –101 °C. The minimum absorbed energy for full size specimens shall be 27 J average and 20 J single.<br>Reduction factors for sub-size specimens shall be: 7,5 mm – 5/6 and 5 mm – 2/3. | | | |
| ***Repair of defects*** | Weld repair is not permitted. | | | |
| ***Marking*** | The tubes shall be marked to ensure full traceability to heat and heat treatment load. | | | |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition. For tempered condition, tempering temperature shall be stated. | | | |

| Material Data Sheet | MDS No. M104 / M104S [a] | | | Rev. 1 |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Martensitic stainless steel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Forgings** | ASTM A182/A182M | F6A (UNS S41000) | Class 1, Class 2 | ASTM A961/A961M S56 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Heat treatment*** | Forgings shall be supplied in the normalized and double-temper condition with the final temper at a lower temperature than the intermediate temper, but not lower than the minimum tempering temperature stated in the standard.<br>Forgings shall be placed in such a way as to ensure free circulation around each forging during the heat treatment process including possible quenching operation. | | | |
| ***Non-destructive testing*** | VT shall be carried out on each forging in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be white pickled prior to the testing.<br>ASTM A961/A961M supplementary requirement S56 or ASME BPVC V Article 6, penetrant testing, shall apply to 10 % of forgings above NPS 2.<br>The testing shall be carried out after final machining. Non-machined surfaces shall be pickled prior to the testing. All accessible internal and external surfaces shall be examined.<br>The acceptance criteria shall be ASME BPVC VIII, Div. 1, Appendix 8. | | | |
| ***Repair of defects*** | Weld repair is not permitted. | | | |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: | | | |
| | *Hardness testing*<br>Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on one forging per lot. The maximum hardness shall be 22HRC from three readings taken in close proximity. | | | |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. | | | |
| ***Surface treatment and finish*** | Finished forgings shall be white pickled or bright annealed. Machined surfaces do not require pickling. | | | |
| ***Marking*** | The forgings shall be marked to ensure full traceability to heat and heat treatment lot. | | | |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition including tempering temperature; | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| Material Data Sheet | MDS No. M106 / M106S [a] | | | Rev. 1 |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Martensitic stainless steel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| | | | | |
|---|---|---|---|---|
| **Castings** | ASTM A217/A217M | CA15 (J91150) | | ASTM A217/217M S4, S5, S21, S52.6<br>ASTM A703/A703M S14, S20 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Chemical composition*** | Supplementary requirement ASTM A217/A217M S52.6 shall apply. | | | |
| ***Heat treatment*** | Supplementary requirement ASTM A217/A217M S21 shall apply.<br>Castings shall be supplied in the normalized and double-temper condition with the final temper at a lower temperature than the intermediate temper. The minimum tempering temperature shall be 621 °C.<br>During the heat treatment process, castings shall be placed in such a way as to ensure free circulation around each casting. | | | |
| ***Extent of testing*** | ASTM A703/A703M supplementary requirement S14 shall apply for each heat and heat treatment charge including any PWHT. | | | |
| ***Test sampling*** | For castings with weight 250kg or more, the test blocks shall be integral or gated with the casting(s) they represent and shall accompany the castings through all heat treatment operations.<br>Thickness of the test block shall be equal to the thickest part of the casting represented. For flanged castings, the largest flange thickness is the ruling section.<br>Dimensions of test blocks and location of test specimens within the test blocks are shown in the figure below. The test specimens shall be taken within the cross hatched area and in a distance of T/4 from the ends.<br>During any PWHT the test block shall be tack welded onto the casting.<br>  <br><br>1 integrated test block<br>2 gated test block<br>For investment casting, test sampling shall be according to ASTM A985/A985M. Test blocks shall accompany the castings through all heat treatment operations including any post weld stress relieving. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

<table>
<tr>
<td>Non-destructive testing</td>
<td>
<u>General</u><br>
For definition and NDT of pilot castings reference is made the general part of this document.<br>
Non-machined surfaces shall be cleaned prior to testing.<br>
<u>Visual inspection</u><br>
Visual testing shall be carried out on each casting in accordance with ANSI/MSS SP-55. The testing shall be performed after final machining.<br>
<u>Radiographic testing</u><br>
ASTM A217/A217M supplementary requirement S5 shall apply as amended by this MDS:<br>
— Method of radiography of radiography shall be according to ASME BPVC V, Article 2 and acceptance criteria shall be in accordance with ASME BPVC VIII, Div. 1, Appendix 7.<br>
— 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.<br>
— Sketches of the areas to be tested shall be established and agreed with the purchaser.<br>
— When random testing (5 %) is specified, minimum one casting of each pattern including feeder and riser system in any purchase order with the foundry shall be examined.<br>
— 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.<br>
— Pilot castings shall be radiographed to the extent described above.<br>
— Frequency of RT of valve castings shall be according to table below.
<table>
<tr><td colspan="6">Frequency of RT based on pressure class and nominal outside diameter:</td></tr>
<tr><td colspan="2">Pressure class:</td><td>≤ 300</td><td>600</td><td>900</td><td>≥ 1 500</td></tr>
<tr><td rowspan="3">Frequency of RT</td><td>Not required</td><td>< 10”</td><td colspan="3">< 2”</td></tr>
<tr><td>5 %</td><td>≥ 10”</td><td colspan="3">≥ 2”</td></tr>
<tr><td>100 %</td><td>Not applicable</td><td>≥ 20”</td><td>≥ 16”</td><td>≥ 6”</td></tr>
</table>
— Non-valve 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.<br>
<u>Liquid penetrant testing</u><br>
ASTM A217/217M supplementary requirement S4 shall apply as amended by this MDS:<br>
Testing shall be carried out in accordance with ASME BPVC V, Article 7. Each pilot and production casting shall be tested after final machining at all accessible surfaces, including all accessible internal surfaces. Non-machined surfaces shall be cleaned prior to the testing.<br>
Acceptance criteria shall be according to ASME BPVC VIII, Div. 1, Appendix 7.
</td>
</tr>
<tr>
<td>Repair of defects</td>
<td>Repairs as described in ASTM A217/217M shall be considered major. All major repairs shall be documented in accordance with ASTM A703/A703M S20.2.<br>
The repair welding procedure shall be qualified in accordance with ISO 11970 or ASTM A488/A488M and this MDS:</td>
</tr>
<tr>
<td colspan="2">[a] The supplementary suffix “S” shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.</td>
</tr>
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| | — Welding procedure shall be qualified on casting or plate of the same cast material grade as used in production;<br>— Testing methodology and acceptance criteria shall be in accordance with the requirements of this MDS for the parent material.<br>Weld repairs are not acceptable for castings that leak during pressure testing.<br>Stress relieving PWHT shall be required after all major weld repairs at a minimum temperature of 621 °C<br>If a minor cosmetic repair is required to a semi-finished or finished cast component, heat treatment may be omitted provided the welding procedure meets all the test requirements of this data sheet in the as-welded condition. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>Supplementary requirement ASTM A217/217M S13 shall apply with the following additions:<br>Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on the pilot casting and one casting per lot thereafter. The maximum hardness shall be 22HRC from three readings taken in close proximity. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished castings shall be white pickled. Machined surfaces do not require pickling. |
| ***Marking*** | The castings shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition, including final tempering temperature. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. M107 / M107S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Martensitic stainless steel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Bars** | ASTM A276/A276M | 410 (UNS S41000) | | |
| | ASTM A479/A479M | 410 (UNS S41000) | | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.<br>This MDS includes additional requirements for valve parts DN 100 (NPS 4) and under manufactured from bars, when permitted by the valve specification. | | | |
| ***Manufacturing*** | Bars shall be hot finished cylindrical shaped with maximum diameter of 300 mm. Cold finishing shall be restricted to turning, grinding or polishing (singly or in combination). | | | |
| ***Heat treatment*** | 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. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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|---|---|
| ***Test sampling*** | The mid-length of axial (longitudinal) and tangential (transverse) tensile specimens shall be located at a distance equal to the bar outside diameter or 100 mm, whichever is the lesser, from the end of the bar.<br>The centreline of tensile specimen shall be located at a distance from the bar OD in accordance with ASTM A370.<br>*Valve parts manufactured from bar*<br>For bars with outside diameter ≥ 100 mm intended for machining of valve parts, tensile testing shall be taken in both the longitudinal and transverse direction. |
| ***Tensile testing*** | Where tensile testing in both directions is required by this MDS, all tensile tests shall meet the specified properties of the referenced standard specification in both directions. |
| ***Hardness testing*** | Hardness of the finished bar shall be in the range 200-275 HBW.<br>Production hardness testing shall be performed in accordance with the requirements in ASTM A370/A1058 on the end surface of one bar per lot. |
| ***Non-destructive testing*** | *Visual inspection*<br>VT shall be carried out on each bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing. |
| | *NDT (PT) of valve parts manufactured from bar*<br>Inspection of valve parts manufactured from bar shall be according to the applicable valve specification or as described below.<br>100 % penetrant testing according to ASTM A961/A961M supplementary requirement S56 or ASME BPVC V Article 6.<br>The testing shall be carried out after final machining. Non-machined surfaces shall be pickled prior to the testing. All accessible internal and external surfaces shall be examined.<br>The acceptance criteria shall be ASME BPVC VIII, Div. 1, Appendix 8. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Heat treatment*<br>Austenitized and quenched followed by a double tempering at minimum 621 °C. The part shall be cooled to ambient temperature in between tempering cycles and the second tempering shall be carried at a lower temperature than the first.<br>*Hardness testing*<br>Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on the end surface of one bar per lot. The maximum hardness shall be 22HRC from three readings taken in close proximity. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Marking*** | The bars shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition including tempering temperature. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| Material Data Sheet | MDS No. M127 / M127S [a] | | | Rev. 1 |
|---|---|---|---|---|
| *TYPE OF MATERIAL: Martensitic stainless steel* | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Bars** | ASTM A276/A276M | 420 (UNS S42000) | | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.<br>This MDS includes additional requirements for valve parts DN 100 (NPS 4) and under manufactured from bars, when permitted by the valve specification. | | | |
| ***Manufacturing*** | Bars shall be hot finished cylindrical shaped with maximum diameter of 300 mm. | | | |
| ***Heat treatment*** | 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. | | | |
| ***Test sampling*** | The mid-length of axial (longitudinal) and tangential (transverse) tensile specimens shall be located at a distance equal to the bar outside diameter or 100 mm, whichever is the lesser, from the end of the bar.<br>The centreline of tensile specimen shall be located at a distance from the bar OD in accordance with ASTM A370.<br>*Valve parts manufactured from bar*<br>For bars with outside diameter ≥ 100 mm intended for machining of valve parts, tensile testing shall be taken in both the longitudinal and transverse direction. | | | |
| ***Tensile testing*** | Where tensile testing in both directions is required by this MDS, all tensile tests shall meet the specified properties of the referenced standard specification in both directions. | | | |
| ***Non-destructive testing*** | *Visual inspection*<br>VT shall be carried out on each bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing. | | | |
| | *NDT (PT) of valve parts manufactured from bar*<br>Inspection of valve parts manufactured from bar shall be according to the applicable valve specification or as described below.<br>100 % penetrant testing according to ASTM A961/A961M supplementary requirement S56 or ASME BPVC V Article 6.<br>The testing shall be carried out after final machining. Non-machined surfaces shall be pickled prior to the testing. All accessible internal and external surfaces shall be examined.<br>The acceptance criteria shall be ASME BPVC VIII, Div. 1, Appendix 8. | | | |
| ***Repair of defects*** | Weld repair is not permitted. | | | |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: | | | |
| | *Heat treatment*<br>Solution annealed, quenched and tempered.<br>*Hardness testing*<br>Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on the end surface of one bar per lot. The maximum hardness shall be 22HRC from three readings taken in close proximity. | | | |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. | | | |
| ***Marking*** | The bars shall be marked to ensure full traceability to heat and heat treatment lot. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition including tempering temperature. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. M604 / M604S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Martensitic precipitation-hardened stainless steel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Forgings** | ASTM A705/705M | 630 (UNS S17400) | | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Metal making*** | Electric furnace (EF) melt shall be refined by AOD or VOD followed by electro slag remelting (ESR) or vacuum arc remelting (VAR) or equivalent multiple refining methods. | | | |
| ***Heat treatment*** | Forgings shall be supplied in condition H1150D or H1150M.<br>Forgings shall be placed in such a way as to ensure free circulation around each forging during the heat treatment process including possible quenching operation. | | | |
| ***Hardness testing*** | The maximum hardness shall be 33HRC from three readings taken in close proximity.<br>Production hardness testing shall be performed in accordance with the requirements in ASTM A370/A1058 on one forging per lot. | | | |
| ***Impact testing/ Toughness testing*** | Impact testing is required for thickness ≥ 6 mm.<br>The test temperature shall be −29 °C.<br>The minimum absorbed energy for full size specimens shall be 27 J average and 20 J single.<br>Reduction factors for sub-size specimens shall be: 7,5 mm – 5/6 and 5 mm – 2/3. | | | |
| ***Non-destructive testing*** | VT shall be carried out on each forging in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be white pickled prior to the testing.<br>Penetrant testing according to ASME BPVC V Article 6 shall apply to 10 % of forgings above NPS 2.<br>The testing shall be carried out after final machining. Non-machined surfaces shall be pickled prior to the testing. All accessible internal and external surfaces shall be examined.<br>The acceptance criteria shall be ASME BPVC VIII, Div. 1, Appendix 8. | | | |
| ***Repair of defects*** | Weld repair is not permitted. | | | |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements:<br>The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. | | | |
| ***Surface treatment and finish*** | Finished forgings shall be white pickled or bright annealed. Machined surfaces do not require pickling. | | | |
| ***Marking*** | The forgings shall be marked to ensure full traceability to heat and heat treatment lot. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. M607 / M607S [a]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Martensitic precipitation-hardened stainless steel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Bars** | ASTM A564/564M | 630 (UNS S17400) | | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Metal making*** | Electric furnace (EF) melt shall be refined by AOD or VOD followed by electro slag remelting (ESR) or vacuum arc remelting (VAR) or equivalent multiple refining methods. | | | |
| ***Manufacturing*** | Maximum diameter of 125 mm. | | | |
| ***Heat treatment*** | Forgings shall be supplied in condition H1150D or H1150M.<br>Forgings shall be placed in such a way as to ensure free circulation around each forging during the heat treatment process including possible quenching operation. | | | |
| ***Test sampling*** | The mid-length of axial (longitudinal) and tangential (transverse) tensile specimens shall be located at a distance equal to the bar outside diameter or 100 mm, whichever is the lesser, from the end of the bar.<br>The centreline of tensile specimen shall be located at a distance from the bar OD in accordance with ASTM A370.<br>*Valve parts manufactured from bar*<br>For bars with outside diameter ≥ 100 mm intended for machining of valve parts, tensile testing shall be taken in both the longitudinal and transverse direction. | | | |
| ***Tensile testing*** | Where tensile testing in both directions is required by this MDS, all tensile tests shall meet the specified properties of the referenced standard specification in both directions. | | | |
| ***Hardness testing*** | The maximum hardness shall be 33HRC from three readings taken in close proximity.<br>Production hardness testing shall be performed in accordance with the requirements in ASTM A370/A1058 on one forging per lot. | | | |
| ***Impact testing/ Toughness testing*** | Impact testing is required for thickness ≥ 6 mm. The test temperature shall be —29 °C. 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. | | | |
| ***Non-destructive testing*** | *NDT (PT) of valve parts manufactured from bar*<br>Inspection of valve parts manufactured from bar shall be according to the applicable valve specification or as described below.<br>100 % penetrant testing according to ASTM A961/A961M supplementary requirement S56 or ASME BPVC V Article 6.<br>The testing shall be carried out after final machining. Non-machined surfaces shall be pickled prior to the testing. All accessible internal and external surfaces shall be examined.<br>The acceptance criteria shall be ASME BPVC VIII, Div. 1, Appendix 8. | | | |
| ***Repair of defects*** | Weld repair is not permitted. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished bars shall be white pickled or bright annealed. Machined surfaces do not require pickling. |
| ***Marking*** | The bars shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. N100S** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Nickel-based alloy type 625*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Studs, bolt and nuts** | ASTM F468/F468M | UNS N06625 | -- | -- |
| | ASTM F467/F467M | UNS N06625 | Grade 2 | -- |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Metal making*** | Basic electric furnace (EF) melt shall be refined by AOD or VOD followed by electro slag remelting (ESR) or vacuum arc remelting (VAR) or equivalent multiple refining methods. In alternative, vacuum induction melting (VIM) can be followed by single refining method such as ESR or VAR. | | | |
| ***Manufacturing*** | Threading of studs, bolts and screws may be done by machining or rolling. Thread rolling shall be done after heat treatment.<br>Threads in nuts shall be machined. | | | |
| ***Tensile testing*** | For sizes above 37,5 mm (1½ in) in diameter the strength properties shall be agreed. | | | |
| ***Non-destructive testing*** | All products shall be 100 % visually examined in all areas of threads, shanks and heads. Discontinuities shall conform with requirements specified in ASTM F788/F788M for bolts/studs and ASTM F812 for nuts. | | | |
| ***Repair of defects*** | Weld repair is not permitted. | | | |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** | The material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and this MDS. | | | |
| | The material shall be traceable in accordance with ISO 15156-3 /ANSI/NACE MR0175 and this MDS. | | | |
| ***Marking*** | Each bolt and nut shall be marked on the end/head to ensure full traceability to heat and heat treatment lot. | | | |

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| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition (annealing temperature and time);<br>— Original inspection documents of the bar material. |

| **Material Data Sheet** | **MDS No. N101S** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Nickel-based alloy type 625*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Seamless pipes and tubes** | ASTM B444 | UNS N06625 Grade 1 | | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Metal making*** | Basic electric furnace (EF) melt shall be refined by AOD or VOD followed by electro slag remelting (ESR) or vacuum arc remelting (VAR) or equivalent multiple refining methods. In alternative, vacuum induction melting (VIM) can be followed by single refining method such as ESR or VAR. | | | |
| ***Heat treatment*** | Pipes and tubes shall be placed in such a way as to ensure free circulation of heating and cooling media around each product during the heat treatment process including any rapid cooling/quenching. | | | |
| ***Repair of defects*** | Weld repair is not permitted. | | | |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** | The material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements. | | | |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. | | | |
| ***Surface treatment and finish*** | Finished pipes and tubes shall be white pickled or bright annealed. Machined surfaces do not require pickling. | | | |
| ***Marking*** | The pipes and tubes shall be marked to ensure full traceability to heat and heat treatment lot. | | | |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition (annealing temperature). | | | |

| **Material Data Sheet** | **MDS No. N102S** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Nickel-based alloy type 625*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |

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|---|---|---|---|---|
| **Welded pipes** | ASTM B705 | UNS N06625 Grade 1 | Class 2 | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Metal making*** | Basic electric furnace (EF) melt shall be refined by AOD or VOD followed by electro slag remelting (ESR) or vacuum arc remelting (VAR) or equivalent multiple refining methods. In alternative, vacuum induction melting (VIM) can be followed by single refining method such as ESR or VAR. | | | |
| ***Welding*** | Welding procedures shall be qualified in accordance with ASME BPVC IX or ISO 15614-1 using the same material grade (UNS number) as used in production. | | | |
| ***Heat treatment*** | 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 any rapid cooling/quenching | | | |
| ***Extent of testing*** | A lot shall consist of all pipes of the same type, size and wall thickness, manufactured from one heat of material, and using the same classification of welding product. | | | |
| ***Repair of defects*** | Weld repair of base material is not permitted.<br>For repair of welds, the requirements for production welding shall apply to the repair WPS. | | | |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** | The material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements. | | | |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. | | | |
| ***Surface treatment and finish*** | Finished pipes shall be white pickled or bright annealed. Machined surfaces do not require pickling. | | | |
| ***Marking*** | The pipe shall be marked to ensure full traceability to heat and heat treatment lot. | | | |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition (annealing temperature). | | | |

| **Material Data Sheet** | **MDS No. N103S** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Nickel-based alloy type 625*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Wrought fittings** | ASTM B366/366M | UNS N06625 Grade 1 | S, W, WX | ASTM B366/366M S3 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Metal making*** | Basic electric furnace (EF) melt shall be refined by AOD or VOD followed by electro slag remelting (ESR) or vacuum arc remelting (VAR) or equivalent multiple refining methods. In alternative, vacuum induction melting (VIM) can be followed by single refining method such as ESR or VAR. | | | |

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| ***Welding*** | Welding procedures shall be qualified in accordance with ISO 15614-1 or ASME BPVC IX using the same material grade (UNS number) as used in production.<br>A change of filler metal classification requires requalification. |
| ***Heat treatment*** | 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 any rapid cooling/quenching. |
| ***Extent of testing*** | A lot shall consist of all fittings of the same type, size, and wall thickness, manufactured from one heat of material, and, if welding is performed, using the same classification of welding product. |
| ***Non-destructive testing*** | S3 shall apply to the weld end area of 10 % of seamless fittings from each lot and 100 % of welded fittings above NPS2. The testing shall be carried out after calibration.<br>For welded fittings the testing shall cover the weld only. The weld of each examined fitting shall be ground flush in a length of 100 mm prior to penetrant testing.<br>The acceptance criteria shall be ASME BPVC VIII, Div. 1, Appendix 8. |
| ***Repair of defects*** | Weld repair of base material is not permitted.<br>For repair of welds, the requirements for production welding shall apply to the repair WPS. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** | The material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished fittings shall be white pickled or bright annealed. Machined surfaces do not require pickling. |
| ***Marking*** | The fittings shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition (annealing temperature). |



| **Material Data Sheet** | **MDS No. N104S** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Nickel-based alloy type 625*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Forgings** | ASTM B564 | UNS N06625 | | ASTM B564 S5.3 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Metal making*** | Basic electric furnace (EF) melt shall be refined by AOD or VOD followed by electro slag remelting (ESR) or vacuum arc remelting (VAR) or equivalent multiple refining methods. In alternative, vacuum induction melting (VIM) can be followed by single refining method such as ESR or VAR. | | | |

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| ***Heat treatment*** | Forgings 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 any rapid cooling/quenching. |
| ***Extent of testing*** | A lot shall consist of all forgings of the same type, size, and wall thickness, manufactured from one heat of material. |
| ***Non-destructive testing*** | *Visual inspection*<br>VT shall be carried out on each forging or bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be white pickled prior to the testing.<br>*Liquid penetrant testing*<br>ASTM B564 supplementary requirement S5.3 shall apply to 10 % of forgings (from the lot as defined for mechanical testing) above NPS 2. The testing shall be carried out in accordance with ASME BPVC V, Article 6 after final machining. Non-machined surfaces shall be pickled prior to the testing. All accessible surfaces shall be examined.<br>The acceptance criteria shall be ASME BPVC VIII, Div. 1, Appendix 8. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** | The material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and this MDS.<br>The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished forgings shall be white pickled. Machined surfaces do not require pickling. |
| ***Marking*** | The component shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition (annealing temperature). |

| **Material Data Sheet** | **MDS No. N105S** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Nickel-based alloy type 625*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Plates, sheets, strips** | ASTM B443 | UNS N06625 Grade 1 | | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Metal making*** | Basic electric furnace (EF) melt shall be refined by AOD or VOD followed by ESR (electro slag remelting) or VAR (vacuum arc remelting) or equivalent multiple refining methods. In alternative, vacuum induction melting (VIM) can be followed by single refining method such as ESR or VAR. | | | |

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| ***Heat treatment*** | Plates, sheets and strips shall be placed in such a way as to ensure free circulation of heating and cooling media around each product during the heat treatment process including any rapid cooling/quenching. |
| ***Non-destructive testing*** | *Visual inspection*<br>VT shall be carried out on each plate in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** | The material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements.<br>The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished plates, sheets or strips shall be white pickled or bright annealed. |
| ***Marking*** | The plates, sheets and strips shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition (annealing temperature). |

| **Material Data Sheet** | **MDS No. N106S** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Nickel-based alloy*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Castings** | ASTM A494/A494M | Grade CW6MC (UNS N26625), CX2MW (UNS N26022) | | ASTM A494/A494M S2, S3<br>ASTM A781/A781M S16<br>ASTM A957/A957M S16 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.<br>For castings produced by the investment casting process, the requirements of ASTM A957/A957M and this MDS shall apply. | | | |
| ***Qualification*** | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| ***Metal making*** | The melt shall be refined by AOD or equivalent method. Induction melting of AOD refined ingot is regarded to be equivalent to AOD refined materials. | | | |
| ***Heat treatment*** | Castings shall be placed in such a way as to ensure free circulation of heating and cooling media around each casting during the heat treatment process including quenching. | | | |

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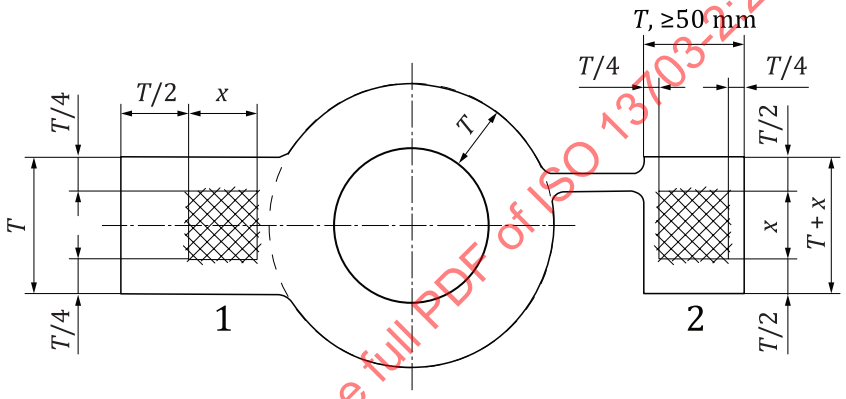
| ***Extent of testing*** | Tensile test and corrosion test shall be made for each heat and heat treatment load (including any PWHT). A test lot shall not exceed 5 000 kg. |
| ***Test sampling*** | Test blocks shall be integral or gated with the casting(s) they represent castings through all heat treatment operations.<br>Thickness of the test block shall be equal to the thickest part of the casting castings; the largest flange thickness is the ruling section.<br>Dimensions of test blocks and location of test specimens within the test blocks are shown in the figure below.<br>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.<br>During any PWHT the test block shall be tack welded onto the casting.<br>  <br><br>1 integrated test block<br>2 gated test block<br>For investment casting, test sampling shall be according to ASTM A957/A957M. Test blocks shall accompany the castings through all heat treatment operations including any post weld stress relieving. |
| ***Corrosion testing*** | Corrosion test according to ASTM G48 Method A is required. Test temperature shall be 50 °C and the exposure time shall be 24 h. The corrosion test specimen shall be at the same location as those for mechanical testing. Cut edges shall be prepared in accordance with ASTM G48. The specimen may be white pickled for 5 min at 60 °C in a solution of 20 % $HNO_3$ + 5 % HF before testing.<br>The acceptance criteria are:<br>— No pitting at 20x magnification;<br>— The weight loss shall be less than 4,0 g/m$^2$. |
| ***Non-destructive testing*** | *General*<br>For definition and NDT of pilot castings reference is made the general part of this document.<br>Non-machined surfaces shall be cleaned prior to testing.<br>*Visual inspection*<br>Visual testing shall be carried out on each casting in accordance with ANSI/MSS SP-55. The testing shall be performed after final machining. |

<u>*Liquid penetrant testing*</u>

ASTM A494/A494M supplementary requirement S3 shall apply as amended by this MDS:

Testing shall be carried out according to ASME BPVC V, Article 6. Each pilot and production casting shall be tested after final machining at all accessible surfaces, including all accessible internal surfaces. Non-machined surfaces shall be white pickled prior to the testing.

Acceptance criteria shall be according to ASME BPVC VIII, Div. 1, Appendix 7.

<u>*Radiographic testing*</u>

ASTM A494/A494M supplementary requirement S2 shall apply as amended by this MDS:

— Method of radiography of radiography shall be according to ASME BPVC SV, Article 2 and acceptance criteria shall be in accordance with ASME BPVC VIII, Div. 1, Appendix 7.

— 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.

— Sketches of the areas to be tested shall be established and agreed with the purchaser.

— When random testing (5 %) 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.

— Pilot castings shall be radiographed to the extent described above.

— Frequency of RT of valve castings shall be according to table below.

| *Frequency of RT based on pressure class and nominal outside diameter:* | | | | | |
|---|---|---|---|---|---|
| *Pressure class:* | | *≤ 300* | *600* | *900* | *≥ 1 500* |
| *Frequency of RT* | Not required | < 10” | < 2” | | |
| | 5 % | ≥ 10” | ≥ 2” | | |
| | 100 % | Not applicable | ≥ 20” | ≥ 16” | ≥ 6” |

— Non-valve 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.

***Repair of defects***

All major repairs as defined by ASTM A494/A494M shall be documented in accordance with ASTM A781/A781M S16 or ASTM A957/A957M S16, as applicable.

The repair welding procedure shall be qualified in accordance with ISO 11970 or ASTM A488/A488M and as follows:

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| | — Welding procedure shall be qualified on the same cast material grade (UNS number) as used in production;<br>— Change of specific make of filler metal (brand names) requires requalification for SMAW and FCAW processes;<br>— A macro and corrosion test specimen shall include the weld zone;<br>— Testing methodology and acceptance criteria shall be in accordance with the requirements of this MDS for the parent material.<br>Examination of major repair welds on pressure containing parts shall also include RT.<br>Weld repairs are not acceptable for castings that leak during pressure testing.<br>Post weld heat treatment is required after all major weld repairs. If a minor cosmetic repair is required, heat treatment may be excluded providing the welding procedure meets all the specified microstructural, mechanical and corrosion material requirements of this data sheet in the as-welded condition. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** | The material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and this MDS. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface finish*** | Finished castings shall be white pickled. Machined surfaces do not require pickling. |
| ***Marking*** | The part shall be marked to ensure full traceability to melt and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition (annealing temperature);<br>— Melting and refining process;<br>— MPS identification or MPCR/QTR number used. |

| **Material Data Sheet** | **MDS No. N107S** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Nickel-based alloy type 625*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Bars** | ASTM B446 | UNS N06625 Grade 1 | | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Metal making*** | Basic electric furnace (EF) melt shall be refined by AOD or VOD followed by electro slag remelting (ESR) or vacuum arc remelting (VAR) or equivalent multiple refining methods. In alternative, vacuum induction melting (VIM) can be followed by single refining method such as ESR or VAR. | | | |

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| ***Heat treatment*** | 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 any rapid cooling/quenching. |
| ***Test sampling*** | *Valve parts manufactured from bar*<br>For bars with outside diameter ≥ 100 mm intended for machining of valve parts, in addition to tensile testing in the longitudinal direction, one tensile test shall be taken in the transverse direction. Acceptance criteria shall conform with this MDS. |
| ***Non-destructive testing*** | *Visual inspection*<br>VT shall be carried out on each bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing. |
| | *NDT (PT) of valve parts manufactured from bar*<br>Inspection of valve parts manufactured from bar shall be according to the applicable valve specification or as specified below.<br>100 % penetrant testing of all accessible internal and external surfaces shall be carried out *in accordance with* ASME BPVC V, article 6 or ASTM A961/A961M supplementary requirement S56. Acceptance criteria shall be according to ASME BPVC VIII, Div. 1, appendix 8. The testing shall be carried out after machining. Non machined surfaces shall be white pickled prior to testing. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** | The material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished parts shall be white pickled. Machined or peeled surfaces do not require pickling. |
| ***Marking*** | The bars shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition (annealing temperature). |



| **Material Data Sheet** | **MDS No. N109S** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Nickel-based alloy type 625*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **HIP Products** | ASTM B834 | UNS N06625 Grade 1 | | ASTM B834 S2 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Metal making*** | Gas atomized powder made from vacuum-refined metal. Powder blends shall be a homogenous mixture of powder heats in terms of composition, particle size and other properties. | | | |

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| ***Heat treatment*** | 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 any rapid cooling/quenching. |
| ***Non-destructive testing*** | *Visual inspection*<br>VT shall be carried out on each item in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be white pickled prior to the testing.<br>*Liquid penetrant testing*<br>All parts shall be penetrant tested. The testing shall be carried out in accordance with ASME BPVC V, Article 6 after final machining. Non-machined surfaces shall be pickled prior to the testing. All accessible surfaces shall be examined.<br>The acceptance criteria shall be ASME BPVC VIII, Div. 1, Appendix 8. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** | The material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements.<br>The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished components shall be white pickled. Machined surfaces do not require pickling. |
| ***Marking*** | The powder blend shall have a unique identity marked on the powder container and this identity shall be recorded and maintained throughout production of the product. The components shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Manufacturer of the starting material (powder) for the finished product;<br>— Heat treatment condition (annealing temperature);<br>— MPS identification or MPCR/QTR number used. |

| **Material Data Sheet** | **MDS No. N112S** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Nickel-based alloy type 625*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Welded pipes** | ASTM B705 | UNS N06625 Grade 1 | Class 2 | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Metal making*** | Basic electric furnace (EF) melt shall be refined by AOD or VOD followed by electro slag remelting (ESR) or vacuum arc remelting (VAR) or equivalent multiple refining methods. In alternative, vacuum induction melting (VIM) can be followed by single refining method such as ESR or VAR. | | | |

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| ***Welding*** | Welding to be carried out by electric fusion welding.<br>Welding procedures shall be qualified in accordance with ISO 15614-1 or ASME BPVC IX using the same material grade (UNS number) as used in production. |
| ***Heat treatment*** | 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 any rapid cooling/quenching |
| ***Extent of testing*** | A lot shall consist of all pipes of the same type, size and wall thickness, manufactured from one heat of material, and using the same classification of welding product. |
| ***Non-destructive testing*** | 100 % RT according to ASME BPVC V Article 2 with acceptance criteria according to ASME B31.3. |
| ***Repair of defects*** | Weld repair of base material is not permitted.<br>For repair of welds, the requirements for production welding shall apply to the repair WPS. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** | The material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements.<br>The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished pipes shall be white pickled or bright annealed. Machined surfaces do not require pickling. |
| ***Marking*** | The pipe shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition (annealing temperature). |

| **Material Data Sheet** | **MDS No. N141S** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Nickel-based alloy type 825*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Seamless pipes and tubes** | ASTM B423 | UNS N08825 | | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Metal making*** | Basic electric furnace (EF) melt shall be refined by AOD or VOD. | | | |
| ***Chemical composition*** | PREN ≥ 32 | | | |
| ***Heat treatment*** | Cold-worked annealed.<br>Pipes and tubes shall be placed in such a way as to ensure free circulation of heating and cooling media around each product during the heat treatment process including any rapid cooling/quenching. | | | |
| ***Corrosion testing*** | Corrosion test according to ASTM G28 Method A is required per lot.<br>Acceptance criteria: | | | |

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| | — Corrosion rate ≤ 0,5 mm/y.<br>— No intergranular attack visible at 50 times magnification. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** | The material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished pipes and tubes shall be white pickled or bright annealed. Machined surfaces do not require pickling. |
| ***Marking*** | The pipes and tubes shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition (annealing temperature). |

| **Material Data Sheet** | **MDS No. N142S** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Nickel-based alloy type 825*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Welded pipes** | ASTM B705 | UNS N08825 | Class 2 | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Metal making*** | Basic electric furnace (EF) melt shall be refined by AOD or VOD. | | | |
| ***Chemical composition*** | PREN ≥ 32 | | | |
| ***Welding*** | Welding procedures shall be qualified in accordance with ASME BPVC IX or ISO 15614-1 using the same material grade (UNS number) as used in production. | | | |
| ***Heat treatment*** | Annealed<br>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 any rapid cooling/quenching | | | |
| ***Corrosion testing*** | Corrosion test according to ASTM G28 Method A is required per lot.<br>Acceptance criteria:<br>— Corrosion rate ≤ 0,5 mm/y.<br>— No intergranular attack visible at 50 times magnification. | | | |
| ***Repair of defects*** | Weld repair of base material is not permitted.<br>For repair of welds, the requirements for production welding shall apply to the repair WPS. | | | |

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| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** | The material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished pipes shall be white pickled or bright annealed. Machined surfaces do not require pickling. |
| ***Marking*** | The pipe shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition (annealing temperature). |

| **Material Data Sheet** | **MDS No. N143S** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Nickel-based alloy type 825*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Wrought fittings** | ASTM B366/366M | UNS N08825 | S, W, WX | ASTM B366/366M S3 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Metal making*** | Basic electric furnace (EF) melt shall be refined by AOD or VOD. | | | |
| ***Chemical composition*** | PREN ≥ 32 | | | |
| ***Welding*** | Welding procedures shall be qualified in accordance with ISO 15614-1 or ASME BPVC IX using the same material grade (UNS number) as used in production.<br>A change of filler metal classification requires requalification. | | | |
| ***Heat treatment*** | 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 any rapid cooling/quenching. | | | |
| ***Extent of testing*** | A lot shall consist of all fittings of the same type, size, and wall thickness, manufactured from one heat of material, and, if welding is performed, using the same classification of welding product. | | | |
| ***Tensile testing*** | Seamless fitting made from seamless pipe shall conform with the tensile testing requirements for cold-worked annealed seamless pipe. | | | |
| ***Corrosion testing*** | Corrosion test according to ASTM G28 Method A is required per lot.<br>Acceptance criteria:<br>— Corrosion rate ≤ 0,5 mm/y.<br>— No intergranular attack visible at 50 times magnification. | | | |
| ***Non-destructive testing*** | S3 shall apply to the weld end area of 10 % of seamless fittings from each lot and 100 % of welded fittings above NPS2. The testing shall be carried out after calibration.<br>The acceptance criteria shall be ASME BPVC VIII, Div. 1, Appendix 8. | | | |

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| ***Repair of defects*** | Weld repair of base material is not permitted.<br>For repair of welds, the requirements for production welding shall apply to the repair WPS. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** | The material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished fittings shall be white pickled or bright annealed. Machined surfaces do not require pickling. |
| ***Marking*** | The fittings shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition (annealing temperature). |

| **Material Data Sheet** | **MDS No. N144S** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Nickel-based alloy type 825*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Forgings** | ASTM B564 | UNS N08825 | | ASTM B564 S5.3 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Metal making*** | Basic electric furnace (EF) melt shall be refined by AOD or VOD. | | | |
| ***Chemical composition*** | PREN ≥ 32 | | | |
| ***Heat treatment*** | Forgings 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 any rapid cooling/quenching. | | | |
| ***Extent of testing*** | A lot shall consist of all forgings of the same type, size, and wall thickness, manufactured from one heat of material. | | | |
| ***Corrosion testing*** | Corrosion test according to ASTM G28 Method A is required per lot.<br>Acceptance criteria:<br>— Corrosion rate ≤ 0,5 mm/y.<br>— No intergranular attack visible at 50 times magnification. | | | |

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| ***Non-destructive testing*** | *Visual inspection*<br>VT shall be carried out on each forging or bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be white pickled prior to the testing.<br>*Liquid penetrant testing*<br>ASTM B564 supplementary requirement S5.3 shall apply to 10 % of forgings (from the lot as defined for mechanical testing) above NPS 2. The testing shall be carried out in accordance with ASME BPVC V, Article 6 after final machining. Non-machined surfaces shall be pickled prior to the testing. All accessible surfaces shall be examined.<br>The acceptance criteria shall be ASME BPVC VIII, Div. 1, Appendix 8. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** | The material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and this MDS. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished forgings shall be white pickled. Machined surfaces do not require pickling. |
| ***Marking*** | The component shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition (annealing temperature). |

| **Material Data Sheet** | **MDS No. N145S** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Nickel-based alloy type 825*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Plates, sheets, strips** | ASTM B424 | UNS N08825 | | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Metal making*** | Basic electric furnace (EF) melt shall be refined by AOD or VOD. | | | |
| ***Chemical composition*** | PREN ≥ 32 | | | |
| ***Heat treatment*** | Plates, sheets and strips shall be placed in such a way as to ensure free circulation of heating and cooling media around each product during the heat treatment process including any rapid cooling/quenching. | | | |
| ***Corrosion testing*** | Corrosion test according to ASTM G28 Method A is required per lot.<br>Acceptance criteria: | | | |

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| | — Corrosion rate ≤ 0,5 mm/y.<br>— No intergranular attack visible at 50 times magnification. |
| ***Non-destructive testing*** | *Visual inspection*<br>VT shall be carried out on each plate in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** | The material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished plates, sheets or strips shall be white pickled or bright annealed. |
| ***Marking*** | The plates, sheets and strips shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition (annealing temperature). |

| **Material Data Sheet** | **MDS No. N146S** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Nickel-based alloy 825*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Castings** | ASTM A494/A494M | GradeCU5MCuC (UNS N08826) | | ASTM A494/A494M S2, S3<br>ASTM A781/A781M S16<br>ASTM A957/A957M S16 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.<br>For castings produced by the investment casting process, the requirements of ASTM A957/A957M and this MDS shall apply. | | | |
| ***Metal making*** | The melt shall be refined by AOD or equivalent method. Induction melting of AOD refined ingot is regarded to be equivalent to AOD refined materials. | | | |
| ***Chemical composition*** | PREN ≥ 32 | | | |
| ***Heat treatment*** | Castings shall be placed in such a way as to ensure free circulation of heating and cooling media around each casting during the heat treatment process including quenching. | | | |
| ***Extent of testing*** | Tensile test and corrosion test shall be made for each heat and heat treatment load (including any PWHT). A test lot shall not exceed 5 000 kg. | | | |

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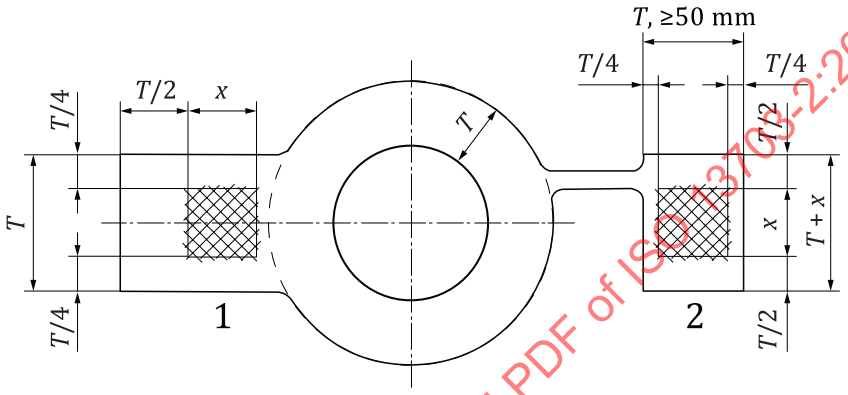
| ***Test sampling*** | Test blocks shall be integral or gated with the casting(s) they represent castings through all heat treatment operations.<br>Thickness of the test block shall be equal to the thickest part of the casting castings; the largest flange thickness is the ruling section.<br>Dimensions of test blocks and location of test specimens within the test blocks are shown in the figure below.<br>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.<br>During any PWHT the test block shall be tack welded onto the casting.<br>  <br>1 integrated test block<br>2 gated test block<br>For investment casting, test sampling shall be according to ASTM A957/A957M. Test blocks shall accompany the castings through all heat treatment operations including any post weld stress relieving. |
| ***Corrosion testing*** | Corrosion test according to ASTM G28 Method A is required per lot.<br>Acceptance criteria:<br>— Corrosion rate ≤ 0,5 mm/y.<br>No intergranular attack visible at 50 times magnification. |
| ***Non-destructive testing*** | *General*<br>For definition and NDT of pilot castings reference is made the general part of this document.<br>Non-machined surfaces shall be cleaned prior to testing.<br>*Visual inspection*<br>Visual testing shall be carried out on each casting in accordance with ANSI/MSS SP-55. The testing shall be performed after final machining.<br>*Liquid penetrant testing*<br>ASTM A494/494M supplementary requirement S3 shall apply as amended by this MDS:<br>Testing shall be carried out in accordance with ASME BPVC V, Article 6. Each pilot and production casting shall be tested after final machining at all accessible surfaces, including all accessible internal surfaces. Non-machined surfaces shall be white pickled prior to the testing.<br>Acceptance criteria shall be according to ASME BPVC VIII, Div. 1, Appendix 7.<br>*Radiographic testing*<br>ASTM A494/A494M supplementary requirement S2 shall apply as amended by this MDS: |

<table>
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— Method of radiography of radiography shall be according to ASME BPVC SV, Article 2 and acceptance criteria shall be in accordance with ASME BPVC VIII, Div. 1, Appendix 7.<br>
— 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.<br>
— Sketches of the areas to be tested shall be established and agreed with the purchaser.<br>
— When random testing (5 %) is specified, minimum one casting of each pattern including feeder and riser system in any purchase order with the foundry shall be examined.<br>
— 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.<br>
— Pilot castings shall be radiographed to the extent described above.<br>
— Frequency of RT of valve castings shall be according to table below.
<table>
<tr><td colspan="5">Frequency of RT based on pressure class and nominal outside diameter:</td></tr>
<tr><td colspan="2">Pressure class:</td><td>≤ 300</td><td>600</td><td>900</td><td>≥ 1 500</td></tr>
<tr><td rowspan="3">Frequency of RT</td><td>Not required</td><td>< 10”</td><td colspan="3">< 2”</td></tr>
<tr><td>5 %</td><td>≥ 10”</td><td colspan="3">≥ 2”</td></tr>
<tr><td>100 %</td><td>Not applicable</td><td>≥ 20”</td><td>≥ 16”</td><td>≥ 6”</td></tr>
</table>
— Non-valve 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.
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<tr>
<td>Repair of defects</td>
<td>
All major repairs as defined by ASTM A494/A494M shall be documented in accordance with ASTM A781/A781M S16 or ASTM A957/A957M S16, as applicable.<br>
The repair welding procedure shall be qualified in accordance with ISO 11970 or ASTM A488/A488M and as follows:<br>
— Welding procedure shall be qualified on the same cast material grade (UNS number) as used in production;<br>
— Change of specific make of filler metal (brand names) requires requalification for SMAW and FCAW processes;<br>
— A macro and corrosion test specimen shall include the weld zone;<br>
— Testing methodology and acceptance criteria shall be in accordance with the requirements of this MDS for the parent material.<br>
Examination of major repair welds on pressure containing parts shall also include RT.<br>
Weld repairs are not acceptable for castings that leak during pressure testing.<br>
Post weld heat treatment is required after all major weld repairs. If a minor cosmetic repair is required, heat treatment may be excluded providing the welding procedure meets all the specified microstructural, mechanical and corrosion material requirements of this data sheet in the as-welded condition.
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| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** | The material shall conform to the requirements of the ISO 15156 series / ANSI/ NACE MR0175 and this MDS. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface finish*** | Finished castings shall be white pickled. Machined surfaces do not require pickling. |
| ***Marking*** | The part shall be marked to ensure full traceability to melt and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition (annealing temperature);<br>— Melting and refining process. |

| **Material Data Sheet** | **MDS No. N147S** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Nickel-based alloy type 825*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Bars and rods** | ASTM B425 | UNS N08825 | | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Metal making*** | Basic electric furnace (EF) melt shall be refined by AOD or VOD. | | | |
| ***Chemical composition*** | PREN ≥ 32 | | | |
| ***Heat treatment*** | 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 any rapid cooling/quenching. | | | |
| ***Test sampling*** | *Valve parts manufactured from bar*<br>For bars with outside diameter ≥ 100 mm intended for machining of valve parts, in addition to tensile testing in the longitudinal direction, one tensile test shall be taken in the transverse direction. Acceptance criteria shall conform with this MDS. | | | |
| ***Corrosion testing*** | Corrosion test according to ASTM G28 Method A is required per lot.<br>Acceptance criteria:<br>— Corrosion rate ≤ 0,5 mm/y.<br>No intergranular attack visible at 50 times magnification. | | | |

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| ***Non-destructive testing*** | *Visual inspection*<br>VT shall be carried out on each bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing. |
| | *NDT (PT) of valve parts manufactured from bar*<br>Inspection of valve parts manufactured from bar shall be according to the applicable valve specification or as described below.<br>100 % penetrant testing of all accessible internal and external surfaces shall be carried out in accordance with ASME BPVC V, Article 6. Non-machined surfaces shall be white pickled prior to the testing. Acceptance criteria shall be according to ASME BPVC VIII, Div. 1, Appendix 8. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** | The material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished parts shall be white pickled. Machined or peeled surfaces do not require pickling. |
| ***Marking*** | The bars shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition (annealing temperature). |

| **Material Data Sheet** | **MDS No. N210S[a] / N210SL** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Nickel-based alloys*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Stud, bolts and nuts** | API Std 6ACRA | UNS N07718 | 120K | ASTM A962/A962M S56 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.<br>NOTE The supplementary suffix "L" is used to designate products impact tested at low temperature –101 °C. | | | |
| ***Manufacturing*** | Manufacturing general requirements shall be according to ASTM A962/A962M as amended by this MDS. Headed bolts shall be machined from bar.<br>Hot forged headed bolts are not permitted.<br>Threads on studs and bolts shall be made by cold rolling after precipitation hardening. Threads in nuts shall be machined. | | | |
| ***Heat treatment*** | Solution annealing and ageing heat treatment shall be carried out after the final hot forming operation. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Impact testing/ Toughness testing*** | Test temperature shall be as follows:<br>MDS N210S: —60 °C<br>MDS N210SL: —101 °C |
| ***Hardness*** | Maximum hardness 40HRC. Hardness shall not be tested in the threaded area. |
| ***Macro etch/ Micrographic examination*** | Bolting shall be examined in accordance with API Std 6ACRA and meet the required acceptance criteria. |
| ***Proof load testing*** | Proof load testing shall be carried out in accordance with ASTM A194/A194M and the acceptance criteria shall conform with the requirements for Grade 7. |
| ***Extent of testing*** | For heat treatment in continuous furnace a heat treatment load (lot) is defined as all bolting heat treated continuously in the same furnace, or maximum for 8 h of operation, of the same heat and nominal thickness. |
| ***Non-destructive testing*** | *Visual inspection*<br>All products shall be 100 % visually examined in all areas of threads, shanks, and heads. Discontinuities shall conform with requirements specified in ASTM F788/F788M for bolts/ studs and ASTM F812 for nuts.<br>*Liquid penetrant testing*<br>Liquid penetrant testing shall be according to ASTM A962/A962M. Supplementary requirement S56 shall apply to 10 % of the bolting. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** | The material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements.<br>The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished parts shall be white pickled or grit blasted. Machined or rolled surfaces do not require pickling. |
| ***Marking*** | Each bolting shall be marked to ensure full traceability to melt and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Steel manufacturer, melting and refining practice;<br>— Heat treatment condition (solution annealing temperature, quenching medium, ageing temperature and holding time). |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. N217/N217S[a] / N217SL** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Nickel-based alloys*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Bars** | API Std 6ACRA | UNS N07718 | 120K, 140K, 150K | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.<br>NOTE The supplementary suffix "L" is used to designate products impact tested at low temperature —101 °C. |
| ***Impact testing/ Toughness testing*** | Test temperature shall be as follows:<br>MDS N217 and N217S: —60 °C<br>MDS N217L and N217SL: —101 °C |
| ***Non-destructive testing*** | *NDT (PT) of valve parts manufactured from bar*<br>Inspection shall be according to the applicable valve specification or as specified below.<br>100 % penetrant testing of all accessible internal and external surfaces shall be carried out in accordance with ASME BPVC V, article 6. Acceptance criteria shall be according to ASME BPVC VIII, Div. 1, appendix 8. Testing shall be carried out after machining. Non-machined surfaces shall be white pickled prior to the testing. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** | The material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements. |
| | Maximum hardness 40 HRC. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished parts shall be white pickled. Machined or peeled surfaces do not require pickling. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Steel manufacturer, melting and refining practice;<br>— Heat treatment condition (solution annealing temperature, quenching medium, ageing temperature and holding time). |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. R111 / R111S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Austenitic stainless steel type 6Mo*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Seamless pipes** | ASTM A312/A312M | UNS S31254, UNS N08367, UNS N08926 | | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Qualification*** | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| ***Metal making*** | The melt shall be refined by AOD or equivalent method. | | | |
| ***Chemical composition*** | PREN ≥ 40,0 | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Heat treatment*** | The pipes shall be solution annealed followed by rapid cooling.<br>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 rapid cooling. |
| ***Corrosion testing*** | Corrosion test according to ASTM G48 Method A is required.<br>Test temperature shall be 50 °C and the exposure time 24 h. 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 G48. The specimen may be white pickled for 5 min at 60 °C in a solution of 20 % $HNO_3$ + 5 % HF before testing.<br>The acceptance criteria are:<br>— No pitting at 20× magnification;<br>— The weight loss shall be less than 4,0 g/m$^2$. |
| ***Extent of testing*** | One tensile and corrosion test shall be carried out for each heat and heat treatment lot. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished pipes shall be white pickled or bright annealed. Machined surfaces do not require pickling. |
| ***Marking*** | The pipes shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— MPS identification or MPCR/QTR number used;<br>— Steel manufacturer;<br>— Solution annealing temperature, holding time and cooling medium (holding time is not applicable for pipes produced hot finished and direct quenched). |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. R112 / R112S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Austenitic stainless steel type 6Mo*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Welded Pipes** | ASTM A358/A358M | UNS S31254, UNS N08367, UNS N08926 | Class 1, 3 and 5 | ASTM A358/A358M S3 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Qualification*** | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| ***Metal making*** | The melt shall be refined by AOD or equivalent method. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Chemical composition*** | PREN ≥ 40,0 |
| ***Welding*** | The WPS shall be qualified in accordance with ISO 15614-1 or ASME BPVC IX and this MDS:<br>— A matching consumable with enhanced Mo or Cr content compared to the base material shall be used; the S content of the consumable shall not exceed 0,015 %.<br>— The welding procedure qualification shall be corrosion tested as specified below.<br>— The qualification shall be carried out on the same material grade (UNS number) as used in production.<br>— A change of specific make (brand name) of welding consumables requires requalification. |
| ***Heat treatment*** | The pipes shall be solution annealed followed by rapid cooling.<br>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 rapid cooling.<br>Post weld solution annealing is not required for pipes with nominal wall thickness up to 7,11 mm manufactured from solution annealed strip/plate material; such pipe shall be marked as stated in ASTM A358/A358M. |
| ***Corrosion testing*** | Corrosion test according to ASTM G48 Method A is required.<br>Test temperature shall be 50 °C and the exposure time 24 h. The test shall expose the external and internal surfaces and a cross section surface including weld zone in full wall thickness. Cut edges shall be prepared according to ASTM G48. The specimen may be white pickled for 5 min at 60 °C in a solution of 20 % $HNO_3$ + 5 % HF before testing.<br>The acceptance criteria are:<br>— No pitting at 20× magnification;<br>— The weight loss shall be less than 4,0 g/m$^2$. |
| ***Extent of testing*** | One tensile and corrosion test shall be carried out for each lot as defined below:<br>— For batch heat treatment, a lot is defined as maximum 60 m (197 ft) of pipes of the same heat, same processing conditions including weld procedure, same size and heat treatment load.<br>— For continuous heat treatment, a lot is defined as maximum 60 m (197 ft) of pipes of the same heat, same processing conditions including weld procedure, same size and which is heat treated the same day. |
| ***Non-destructive testing*** | Eddy current testing according to ASTM A450/A450M is acceptable as replacement for radiography for wall thickness less than 4,0 mm.<br>ASTM A358/A358M supplementary requirement S3 shall apply to the longitudinal weld ends of 10 % of pipes per lot. The weld of each examined pipe shall be ground flush for a length of 100 mm prior to penetrant testing. Method of testing shall be according to ASME BPVC V Article 6 and acceptance criteria shall be to ASME BPVC VIII, Div. 1, Appendix 8. The testing shall be carried out after any calibration. |
| ***Repair of defects*** | Weld repair of base material is not permitted.<br>For repair of welds, the requirements for production welding above shall apply to the repair WPS. Repair welds shall be heat treated as per original production weld. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>Production testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on one length of pipe per lot. The maximum hardness of the base material, HAZ and weld metal shall be 35HRC from three readings taken in close proximity at each location. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished pipes shall be white pickled or bright annealed. Machined surfaces do not require pickling. |
| ***Marking*** | The pipes shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— MPS identification or MPCR/QTR number used;<br>— Steel manufacturer;<br>— Solution annealing temperature, holding time and quench medium. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. R113 / R113S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Austenitic stainless steel type 6Mo*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Wrought fittings** | ASTM A403/A403M | UNS S31254, UNS N08367, UNS N08926 | WP-S, WP-WX and WP-W | ASTM A960/A960M S52 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Qualification*** | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| ***Metal making*** | The melt shall be refined by AOD or equivalent method. | | | |
| ***Chemical composition*** | PREN ≥ 40,0 | | | |
| ***Welding*** | The welding procedure shall be qualified in accordance with ISO 15614-1 or ASME BPVC IX and this MDS:<br>— A matching consumable with enhanced Mo or Cr content compared to the base material shall be used; the S content of the consumable shall not exceed 0,015 %.<br>— The welding procedure qualification shall be corrosion tested as specified below.<br>— The qualification shall be carried out on the same material grade (UNS number) as used in production.<br>— A change of specific make (brand name) of welding consumables requires requalification. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Heat treatment*** | The fittings shall be solution annealed followed by water/liquid quenching.<br>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. |
| ***Corrosion testing*** | Corrosion test according to ASTM G48 Method A is required.<br>Test temperature shall be 50 °C and the exposure time 24 h. The test shall expose the external and internal surfaces and a cross section surface including weld zone in full wall thickness. Cut edges shall be prepared according to ASTM G48. The specimen may be white pickled for 5 min at 60 °C in a solution of 20 % $HNO_3$ + 5 % HF before testing.<br>The acceptance criteria are:<br>— No pitting at 20× magnification;<br>— The weight loss shall be less than 4,0 g/$m^2$. |
| ***Extent of testing*** | One tensile and corrosion test shall be carried out for each lot as defined below.<br>A test lot shall include all fittings from the same heat and heat treatment load, with a wall thickness range of ±5 mm and, where applicable, welded with the same WPS. |
| ***Test sampling*** | Test sampling shall be made from an actual fitting, from a prolongation thereof, or if not possible, a length of starting material that has been heat treated in the same heat treatment load as the fittings it represents. |
| ***Non-destructive testing*** | *Liquid penetrant testing*<br>ASTM A960/A960M supplementary requirement S52 shall apply as amended by this MDS:<br>— 10 % of seamless or minimum one item per lot in any purchase order;<br>— 100 % of welded fittings above NPS 2.<br>The testing shall be carried out after calibration. The test lot shall be as defined for mechanical testing. For welded fittings the testing shall cover the weld only. All accessible internal and external surfaces shall be examined. For welded fittings, the testing shall cover the weld only and the weld of each examined fitting shall be ground flush in a length of 100 mm prior to penetrant testing.<br>The acceptance criteria shall be ASME BPVC VIII, Div. 1, Appendix 8. |
| ***Repair of defects*** | Weld repair of base material is not permitted.<br>For repair of welds, the requirements for production welding above shall apply to the repair WPS. Repair welds shall be heat treated as per the original production weld. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>Production testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on two fittings per lot. When only one fitting is produced, it shall be hardness tested as required. The maximum hardness of the base material, HAZ and weld metal shall be 35HRC from three readings taken in close proximity at each location. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished fittings shall be white pickled. Machined surfaces do not require pickling. |
| ***Marking*** | The fittings shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information: |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| | — MPS identification or MPCR/QTR number used;<br>— Steel manufacturer;<br>— Solution annealing temperature, holding time and quench medium. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. R114 / R114S [a]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Austenitic stainless steel type 6Mo*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Forgings** | ASTM A182/A182M | F44 (UNS S31254), F62 (UNS N08367) | | ASTM A961/A961M S56 |
| | ASTM B462 | UNS N08926 | | ASME BPVC Code Case 2120-1 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.<br>Product covered by this MDS is limited to a maximum thickness of 200 mm. For thickness exceeding 200 mm, qualification and specification requirements shall be subject to agreement. | | | |
| ***Qualification*** | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| ***Metal making*** | The melt shall be refined by AOD or equivalent method. | | | |
| ***Chemical composition*** | PREN ≥ 40,0 | | | |
| ***Heat treatment*** | The forgings shall be solution annealed followed by water/liquid quenching.<br>Forgings 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. | | | |
| ***Extent of testing*** | One tensile and corrosion test shall be carried out for each lot as defined below:<br>A test lot shall include all forgings from the same heat, heat treatment load and shall not exceed 2 000 kg for forgings with as forged weight 50 kg, and 5 000 kg for forgings with as forged weight > 50 kg. | | | |
| ***Test sampling*** | For parts forged by the closed die method, the test specimen shall be obtained from a sacrificial product.<br>For flanges the thickness of the test sample shall minimum be equal to the hub thickness or the flange ring thickness.<br>For other forgings the test samples shall represent the greatest product cross section thickness within the lot and the test specimens shall be taken as follows:<br>— 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.<br>— For forgings having maximum section thickness, T > 50 mm, the test specimens shall be taken at least ¼T from the nearest surface and mid-length of test specimens at least T or 100 mm , whichever is less, from any second surface. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| | Sketches shall be established showing type, and size of test samples and location for extraction of test specimens.<br><br>For parts forged in closed die and flanges exceeding 80 kg, it is recognized that alternative test may be used. This alternative test sampling shall be qualified and shall comprise comparative testing of sacrificial forgings and the proposed alternative test sample. |
| ***Corrosion testing*** | Corrosion test according to ASTM G48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 h. The test shall expose the external and internal surfaces and a cross section surface in full wall thickness. 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 G48. The complete specimen may be white pickled for 5 min at 60 °C in a solution of 20 % $HNO_3$ + 5 % HF before testing.<br><br>The acceptance criteria are:<br>— No pitting at 20× magnification;<br>— The weight loss shall be less than 4,0 g/$m^2$ |
| ***Non-destructive testing*** | *Visual inspection*<br><br>VT shall be carried out on each forging or bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be white pickled prior to the testing.<br><br>ASTM A961/A961M supplementary requirement S56, penetrant testing, shall apply to 10 % of all forgings (from the lot as defined for mechanical testing) above NPS 2. The testing shall be carried out after final machining and pickling. The acceptance criteria shall be to ASME BPVC VIII, Div. 1, Appendix 8. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br><br>Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on two forgings per lot. When only one part is produced, it shall be hardness tested as required. The maximum hardness shall be 35HRC from three readings taken in close proximity. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished forgings shall be white pickled. Machined surfaces do not require pickling. |
| ***Marking*** | The forgings shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br><br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br><br>The inspection documents shall include the following information:<br>— MPS identification or MPCR/QTR number used;<br>— Steel manufacturer;<br>— Solution annealing temperature, holding time and quench medium. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| Material Data Sheet | MDS No. R115 / R115S [a] | | | Rev. 1 |
|---|---|---|---|---|
| *TYPE OF MATERIAL: Austenitic stainless steel type 6Mo* | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Plates, sheets, strips** | ASTM A240/A240M | UNS S31254, UNS N08367, UNS N08926 | | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Manufacturing*** | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| ***Metal making*** | The melt shall be refined by AOD or equivalent method. | | | |
| ***Chemical composition*** | PREN ≥ 40,0 | | | |
| ***Tensile testing*** | Tensile test specimens shall be sampled in the transverse orientation to the direction of final rolling and shall be located in mid-thickness for thickness (t) ≤ 40 mm and in location t/4 for thicknesses (t) > 40 mm, in accordance with ASTM E8/E8M. | | | |
| ***Corrosion testing*** | Corrosion test according to ASTM G48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 h. 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 G48. The specimen may be white pickled for 5 min at 60 °C in a solution of 20 % $HNO_3$ + 5 % HF before testing.<br>The acceptance criteria are:<br>— No pitting at 20× magnification;<br>— Weight loss shall be less than 4,0 g/m$^2$. | | | |
| ***Extent of testing*** | One tensile and corrosion test shall be carried out for each heat of steel and heat treatment lot. | | | |
| ***Non-destructive testing*** | *Visual inspection*<br>VT shall be carried out on each plate in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing. | | | |
| ***Repair of defects*** | Weld repair is not permitted. | | | |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements. | | | |
| | *Hardness testing*<br>Production testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on one plate per lot. For coil, tests shall be carried out at both ends of the coil. The maximum hardness shall be 35HRC from three readings taken in close proximity at each location. | | | |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. | | | |
| ***Surface treatment and finish*** | Finished plates, sheets and strips shall be white pickled. | | | |
| ***Marking*** | The plates, sheets and strips shall be marked to ensure full traceability to heat and heat treatment lot. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— MPS identification or MPCR/QTR number used;<br>— Steel manufacturer;<br>— Solution annealing temperature, holding time and quench medium. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. R116 / R116S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Austenitic stainless steel type 6Mo*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Castings** | ASTM A351/A351M | CK-3MCuN (UNS J93254), CN-3MN (UNS J94651) | | ASTMA351/A351M S5, S6, ASTM A703/A703M S20<br>ASTM A985/A985M S20 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.<br>This MDS is limited to 150 mm thickness. Larger thicknesses shall be subject to special agreement.<br>For castings produced by the investment casting process, the requirements of ASTM A985/A985M and this MDS shall apply. | | | |
| ***Qualification*** | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| ***Metal making*** | The melt shall be refined by AOD or equivalent method. Induction melting of AOD refined ingot or equally refined scrap as permitted by ISO 17782 is regarded to be equivalent to AOD refined materials. | | | |
| ***Chemical composition*** | P ≤ 0,030 %<br>PREN ≥ 40,0 | | | |
| ***Heat treatment*** | Material shall be solution annealed at temperature ≥ 1 225 °C followed by water/liquid quenching.<br>Castings 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. | | | |
| ***Corrosion testing*** | Corrosion test according to ASTM G48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 h. 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 G48. The specimen may be white pickled for 5 min at 60 °C in a solution of 20 % $HNO_3$ + 5 % HF before testing.<br>The acceptance criteria are:<br>— No pitting at 20× magnification;<br>— The weight loss shall be less than 4,0 g/m$^2$. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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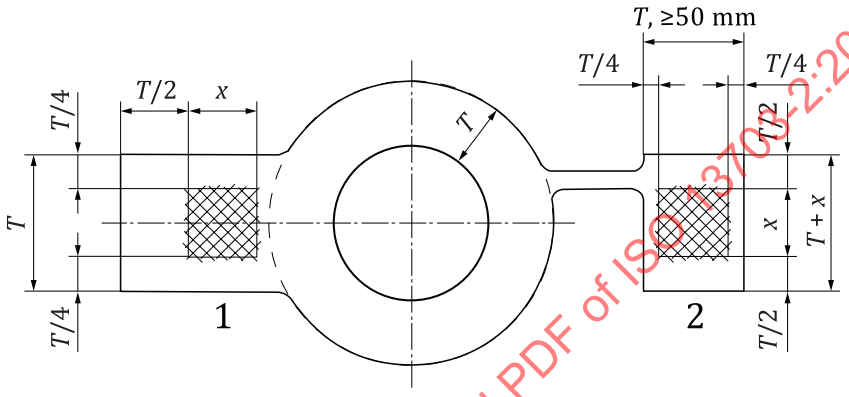
| ***Extent of testing*** | One tensile and corrosion test shall be carried out for each heat of steel and heat treatment load (including any PWHT). A test lot shall not exceed 5 000 kg in weight. |
| ***Test sampling*** | Test blocks shall be integral or gated with the casting(s) they represent and shall accompany the castings through all heat treatment operations.<br>Thickness of the test block shall be equal to the thickest part of the casting represented. For flanged castings, the largest flange thickness is the ruling section.<br>Dimensions of test blocks and location of test specimens within the test blocks are shown in the figure below. The test specimens shall be taken within the cross hatched area and in a distance of T/4 from the ends.<br>During any PWHT the test block shall be tack welded onto the casting.<br>  <br><br>1 integrated test block<br>2 gated test block |
| ***Non-destructive testing*** | *General*<br>For definition and NDT of pilot castings reference is made the general part of this document.<br>Non-machined surfaces shall be cleaned prior to testing.<br>*Visual inspection*<br>Visual testing shall be carried out on each casting in accordance with ANSI/MSS SP-55. The testing shall be performed after final machining.<br>*Liquid penetrant testing*<br>ASTM A494/A494M supplementary requirement S6 shall apply as amended by this MDS:<br>Testing shall be carried out in accordance with ASME BPVC V, Article 6. Each pilot and production casting shall be tested after final machining at all accessible surfaces, including all accessible internal surfaces. Non-machined surfaces shall be white pickled prior to the testing.<br>Acceptance criteria shall be according to ASME BPVC VIII, Div. 1, Appendix 7.<br>*Radiographic testing*<br>ASTMA351/A351M supplementary requirement S5 shall apply as amended by this MDS: |
| [a] The supplementary suffix “S” shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service. | |

— Method of radiography of radiography shall be according to ASME BPVC V, Article 2 and acceptance criteria shall be in accordance with ASME BPVC VIII, Div. 1, Appendix 7.

— 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.

— Sketches of the areas to be tested shall be established and agreed with the purchaser.

— When random testing (5 %) 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.

— Pilot castings shall be radiographed to the extent described above.

— Frequency of RT of valve castings shall be according to table below.

| *Frequency of RT based on pressure class and nominal outside diameter:* | | | | | |
|---|---|---|---|---|---|
| *Pressure class:* | | *≤ 300* | *600* | *900* | *≥ 1 500* |
| *Frequency of RT* | Not required | < 10” | < 2” | | |
| | 5 % | ≥ 10” | ≥ 2” | | |
| | 100 % | Not applicable | ≥ 20” | ≥ 16” | ≥ 6” |

Non-valve 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.

***Repair of defects***

All major repairs, as defined by ASTM A351/A351M, shall be documented in accordance with ASTM A703/A703M S20.2 or ASTM A985/A985M S20, as applicable.

The repair welding procedure shall be qualified in accordance with ISO 11970 or ASTM A488/A488M and the following requirements:

— Welding procedure shall be qualified on the same cast material grade (UNS number) as used in production.

— Welding shall be carried out with Ni-based consumable with enhanced Mo or Cr content compared to the base material; the S content of the consumable shall not exceed 0,015 %.

— Change of specific make of filler metal (brand names) requires requalification for SMAW and FCAW processes.

— Corrosion test specimen shall include the weld zone.

— Testing methodology and acceptance criteria shall be in accordance with the requirements of this MDS for the parent material.

Examination of major repair welds on pressure containing parts shall also include RT.

Weld repairs are not acceptable for castings that leak during pressure testing.

Post weld heat treatment is required after all weld repairs.

If a minor cosmetic repair is required, heat treatment may be excluded providing the welding procedure meets all the specified microstructural, mechanical and corrosion material requirements of this data sheet in the as-welded condition.

[a] The supplementary suffix “S” shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on the pilot casting and one casting per lot thereafter for CK3MCuN castings. The maximum hardness shall be 100HRB (22HRC) from three readings taken in close proximity.<br>For other alloys the maximum hardness shall not exceed 35HRC. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished castings shall be white pickled. Machined surfaces do not require pickling. |
| ***Marking*** | The castings shall be marked to ensure full traceability to heat and heat treatment load. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— MPS identification or MPCR/QTR number used;<br>— Steel manufacturer;<br>— Solution annealing temperature, holding time and quench medium. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. R117 / R117S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Austenitic stainless steel type 6Mo*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Bars** | ASTM A276/A276M | UNS S31254, UNS N08367, UNS N08926 | | |
| | ASTM A479/A479M | UNS S31254, UNS N08367, UNS N08926 | | |
| | ASTM A182/A182M | F44 (UNS S31254), F62 (UNS N08367) | | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.<br>This MDS includes additional requirements for valve parts DN 100 (NPS 4) and under manufactured from bars, when permitted by the valve specification.<br>Product covered by this MDS is limited to a maximum thickness of 200 mm. For thickness exceeding 200 mm, qualification and specification requirements shall be subject to agreement. | | | |
| ***Qualification*** | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| ***Metal making*** | The melt shall be refined by AOD or equivalent method. | | | |
| ***Chemical composition*** | PREN ≥ 40,0 | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Manufacturing*** | Bars shall be hot or cold finished cylindrical shaped with maximum diameter of 200 mm.<br>Cold finishing shall be restricted to turning, grinding or polishing (singly or in combination); cold drawing or cold forming is not permitted. |
| ***Heat treatment*** | Solution annealing followed by water quenching.<br>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. |
| ***Extent of testing*** | Tensile and corrosion tests shall be carried out for each heat and heat treatment lot. |
| ***Test sampling*** | The mid-length of axial (longitudinal) and tangential (transverse) tensile specimens shall be located at a distance equal to the bar outside diameter or 100 mm, whichever is the lesser, from the end of the bar.<br>The centreline of tensile specimen shall be located at a distance from the bar OD in accordance with ASTM A370.<br>*Valve parts manufactured from bar*<br>For bars with outside diameter ≥ 100 mm intended for machining of valve parts, tensile testing shall be taken in both the longitudinal and transverse direction. |
| ***Tensile testing*** | Where tensile testing in both directions is required by this MDS, all tensile tests shall meet the specified properties of the referenced standard specification in both directions. |
| ***Corrosion testing*** | Corrosion test according to ASTM G48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 h. 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 G48. The specimen may be white pickled for 5 min at 60 °C in a solution of 20 % $HNO_3$ + 5 % HF before testing.<br>The acceptance criteria are:<br>— No pitting at 20× magnification;<br>— The weight loss shall be less than 4,0 g/m$^2$. |
| ***Non-destructive testing*** | *Visual inspection*<br>VT shall be carried out on each bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing. |
| | *NDT (PT) of valve parts manufactured from bar*<br>Inspection of valve parts manufactured from bar shall be according to the applicable valve specification or as specified below.<br>100 % penetrant testing of all accessible internal and external surfaces shall be carried out in accordance with ASME BPVC V, article 6 or ASTM A961/A961M supplementary requirement S56. Acceptance criteria shall be according to ASME BPVC VIII, Div. 1, appendix 8. The testing shall be carried out after machining. Non machined surfaces shall be white pickled prior to testing. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on the end surface of one bar per lot. The maximum hardness shall be 35HRC from three readings taken in close proximity. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished parts shall be white pickled. Machined or peeled surfaces do not require pickling. |
| ***Marking*** | The bars shall be marked to ensure full traceability to heat and heat treatment lot. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— MPS identification or MPCR/QTR number used;<br>— Steel manufacturer;<br>— Solution annealing temperature, holding time and quench medium. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. R118 / R118S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Austenitic stainless steel type 6Mo*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Tubes** | ASTM A269/A269M | UNS S31254, UNS N08367, UNS N08926 | | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Qualification*** | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| ***Metal making*** | The melt shall be refined by AOD or equivalent method. | | | |
| ***Chemical composition*** | PREN ≥ 40,0 | | | |
| ***Tensile testing*** | Rp0,2 ≥ 300 MPa, Rm ≥ 650 MPa, A ≥ 35 % | | | |
| ***Heat treatment*** | The tubes shall be solution annealed followed by rapid cooling.<br>Tubes shall be placed in such a way as to ensure free circulation of air and cooling medium around each tube during the heat treatment process including cooling. | | | |
| ***Hardness testing*** | As per product standard.<br>NOTE Compatibility of 6Mo tube in combination with stainless steel type 316 compression fittings needs to be assured by the tubing/fitting supplier. It may be chosen to restrict the hardness value, to for example 90 HRB, if the tube is planned used in connection with stainless steel type 316 compression fittings. | | | |
| ***Corrosion testing*** | Corrosion test according to ASTM G48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 h. The test shall expose the external and internal surfaces and a cross section surface including weld zone in full wall thickness. Cut edges shall be prepared according to ASTM G48. The specimen may be white pickled for 5 min at 60 °C in a solution of 20 % $HNO_3$ + 5 % HF before testing.<br>The acceptance criteria are:<br>— No pitting at 20× magnification;<br>— The weight loss shall be less than 4,0 g/m$^2$. | | | |
| ***Extent of testing*** | Hardness, tensile and corrosion testing to be carried out for each heat and heat treatment lot. | | | |
| ***Repair of defects*** | Weld repair is not permitted. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>Hardness testing shall be performed in accordance with the requirements in ASTM A269/A269M. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished tubes shall be white pickled or bright annealed. Machined surfaces do not require pickling. |
| ***Marking*** | The tubes shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— MPS identification or MPCR/QTR number used;<br>— Steel manufacturer;<br>— Solution annealing temperature, holding time and cooling medium (holding time is not applicable for tubes produced hot finished and direct quenched). |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. R119 / R119S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Austenitic stainless steel type 6Mo*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **HIP Products** | ASTM A988/A988M | UNS S31254, UNS N08367 | | ASTM A988/A988M S5 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.<br>Product covered by this MDS is limited to a maximum thickness of 200 mm. For thickness exceeding 200 mm, qualification and specification requirements shall be subject to agreement. | | | |
| ***Qualification*** | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| ***Manufacturing*** | Gas atomized powder made from AOD-refined metal. Powder blends shall be a homogenous mixture of powder heats in terms of composition, particle size and other properties. | | | |
| ***Chemical composition*** | PREN ≥ 40,0 | | | |
| ***Heat treatment*** | HIP product shall be solution annealed followed by water/liquid quenching.<br>Products 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. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Corrosion testing*** | Corrosion test according to ASTM G48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 h. 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 G48. The specimen may be white pickled for 5 min at 60 °C in a solution of 20 % $HNO_3$ + 5 % HF before testing.<br>The acceptance criteria are:<br>— No pitting at 20× magnification;<br>— The weight loss shall be less than 4,0 g/m$^2$. |
| ***Extent of testing*** | One tensile and corrosion test shall be carried out for each lot as defined below.<br>A lot shall consist of finished parts with the same dimensions made from the same powder blend consolidated in the same hot isostatic press using the same parameters and heat-treated in the same final heat-treatment load. |
| ***Non-destructive testing*** | *Visual inspection*<br>VT shall be carried out on each item in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be white pickled prior to the testing.<br>*Liquid penetrant testing*<br>Supplementary requirement S5, penetrant testing, shall apply to 10 % of all forgings (from the lot as defined for mechanical testing) above NPS 2. The testing shall be carried out after final machining and pickling. The acceptance criteria shall be to ASME BPVC VIII, Div. 1, Appendix 8. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements:<br>*Hardness testing*<br>Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on two parts per lot. When only one part is produced, it shall be hardness tested as required. The maximum hardness shall be 35HRC from three readings taken in close proximity.<br>The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished parts shall be white pickled. Machined surfaces do not require pickling. |
| ***Marking*** | The powder blend shall have a unique identity marked on the powder container and this identity shall be recorded and maintained throughout production of the product. The components shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— MPS identification or MPCR/QTR number used;<br>— Manufacturer of the starting material (powder) for the finished product;<br>— Solution annealing temperature, holding time and quench medium. |

[a] The supplementary suffix “S” shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| Material Data Sheet | MDS No. R211 / R211S [a] | | | Rev. 1 |
|---|---|---|---|---|
| *TYPE OF MATERIAL: Austenitic stainless steel type UNS S34565* | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Seamless pipes** | ASTM A312/A312M | UNS S34565 | | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Metal making*** | The steel melt shall be refined by AOD or equivalent method. | | | |
| ***Heat treatment*** | The pipes shall be solution annealed followed by rapid cooling.<br>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 rapid cooling. | | | |
| ***Extent of testing*** | Corrosion test shall be carried out to the same extent as stated for mechanical tests in the referred standard. | | | |
| ***Corrosion testing*** | Corrosion test according to ASTM G48 Method A is required.<br>Test temperature shall be 50 °C and the exposure time 24 h. 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 G48. The specimen may be white pickled for 5 min at 60 °C in a solution of 20 % $HNO_3$ + 5 % HF before testing.<br>The acceptance criteria are:<br>— No pitting at 20× magnification;<br>— The weight loss shall be less than 4.0 g/m$^2$. | | | |
| ***Surface finish*** | Finished pipes shall be white pickled or bright annealed. | | | |
| ***Repair of defects*** | Weld repair is not permitted. | | | |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements:<br>*Hardness testing*<br>Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on two parts per lot. When only one part is produced, it shall be hardness tested as required. The maximum hardness shall be 35HRC from three readings taken in close proximity.<br>The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. | | | |
| ***Marking*** | Finished pipes shall be marked to ensure full traceability to melt and heat treatment lot. | | | |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— MPS identification or MPCR/QTR number used;<br>— Steel manufacturer;<br>— Solution annealing temperature, holding time and cooling medium (holding time is not applicable for pipes produced hot finished and direct quenched). | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| Material Data Sheet | MDS No. R212 / R212S [a] | | | Rev. 1 |
|---|---|---|---|---|
| *TYPE OF MATERIAL: Austenitic stainless steel type UNS S34565* | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Welded pipes** | ASTM A358/A358M | UNS S34565 | Class 1 and 3 | ASTM A358/A358M S3 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Metal making*** | Steel melt shall be refined with AOD or equivalent method. | | | |
| ***Welding*** | Welding shall be carried out by qualified welders according to qualified procedures in accordance with ISO 15614-1 or ASME BPVC IX and this:<br>— All welding shall be done with ERNiCrMo-7 type consumables with C ≤ 0,03 % and S ≤ 0,015 %.<br>— The WPQR shall be corrosion tested as specified above.<br>— The qualification shall be carried out on the same material grade (UNS number) as used in production.<br>— Change of specific make (brand name) of welding consumables requires requalification. | | | |
| ***Heat treatment*** | The pipes shall be solution annealed at 1 120 °C – 1 150 °C followed by rapid cooling.<br>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 rapid cooling.<br>Post weld solution annealing is not required of pipes with nominal wall thickness up to 7,11 mm manufactured out of solution annealed plate material as in ASTM A358/A358M. | | | |
| ***Extent of testing*** | Tensile and corrosion testing shall be carried out for each lot defined as follows:<br>— For batch furnace a lot is defined as maximum 60 m pipe of the same heat, size and heat treatment charge.<br>— For continuous heat treatment furnace a lot is defined as maximum 60 m of pipe of the same heat and size and heat treated the same day. | | | |
| ***Corrosion testing*** | Corrosion test according to ASTM G48 Method A is required.<br>Test temperature shall be 50 °C and the exposure time 24 h. The test shall expose the external and internal surfaces and a cross section surface including weld zone in full wall thickness. Cut edges shall be prepared according to ASTM G48. The specimen may be white pickled for 5 min at 60 °C in a solution of 20 % $HNO_3$ + 5 % HF before testing.<br>The acceptance criteria are:<br>— No pitting at 20× magnification;<br>— The weight loss shall be less than 4,0 g/m$^2$. | | | |
| ***Non-destructive testing*** | Supplementary requirement S3, penetrant testing, shall apply according to ASME BPVC V Article 6, to the weld area of 10 % of the pipes (same test lot as defined for mechanical testing) delivered. The weld of each examined pipe shall be ground flush in a length of 100 mm prior to penetrant testing. The testing shall be carried out after calibration and pickling.<br>Acceptance criteria shall be to ASME BPVC VIII, Div. 1, Appendix 8. | | | |
| ***Surface finish*** | Finished pipes shall be white pickled or bright annealed. | | | |
| ***Repair of defects*** | Weld repair of base material is not permitted. For repair of welds the same requirements to WPQR as for production welding shall apply. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on two parts per lot. When only one part is produced, it shall be hardness tested as required. The maximum hardness shall be 35HRC from three readings taken in close proximity. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Marking*** | The part shall be marked to ensure full traceability to melt and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— MPS identification or MPCR/QTR number used;<br>— Steel manufacturer;<br>— Solution annealing temperature, holding time and quench medium. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. R213 / R213S [a]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Austenitic stainless steel type UNS S34565*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Wrought fittings** | ASTM A403/ A403M | WP S34565 | WP-S, WP-WX | ASTM A960/A960M S52 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Metal making*** | Steel melt shall be refined with AOD or equivalent method. | | | |
| ***Manufacturing process*** | The hot isostatic pressed (HIP) process is an acceptable alternative manufacturing process. | | | |
| ***Heat treatment*** | The fittings shall be solution annealed at 1 120 °C – 1 150 °C followed by quenching in water.<br>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.<br>Fittings machined directly from solution annealed forging or bar-stock need not be resolution annealed provided start material is tested and certified in accordance with MDS R214 or R217. | | | |
| ***Extent of testing*** | One tensile and corrosion test shall be carried out for each lot as defined below.<br>A test lot shall include all fittings from the same heat and heat treatment load, with a wall thickness range of ±5 mm and, where applicable, welded with the same WPS. | | | |
| ***Test sampling*** | Samples for production testing shall realistically reflect the properties in the actual parts.<br>Test sampling shall be made from an actual fitting or from a prolongation thereof. | | | |
| ***Tensile testing*** | $R_{p0,2} \geq 415$ MPa; $R_M \geq 795$ MPa; $A \geq 35$ %. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Corrosion testing*** | Corrosion test according to ASTM G48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. The test shall expose the external and internal surfaces and a cross section including weld zone (if relevant) in full wall thickness. Cut edges shall be prepared according to ASTM G48. The test specimen may be white pickled for 5 minutes at 60 °C in a solution of 20 % $HNO_3$ + 5 % HF before testing.<br>The acceptance criteria are:<br>— No pitting at 20× magnification.<br>— The weight loss shall be less than 4,0 g/m$^2$. |
| ***Welding*** | Welding shall be carried out by qualified welders according to qualified procedures in accordance with ISO 15614-1 or ASME BPVC IX and this MDS:<br>— All welding shall be done with ERNiCrMo-7 type consumables with C ≤ 0,03 % and S ≤ 0,015 %.<br>— The WPQR shall be corrosion tested as specified above.<br>— The qualification shall be carried out on the same material grade as used in production.<br>— Change of specific make (brand name) of welding consumables requires requalification. |
| ***Non-destructive testing*** | ASTM A960/A960M supplementary requirements S52, penetrant testing, shall apply to:<br>— 10 % of seamless (from the test lot as defined above) or minimum one item per lot in any purchase order;<br>— 100 % of welded fittings above NPS 2.<br>The testing shall be carried out after calibration.<br>For welded fittings the testing shall cover the weld only. The weld of each examined fitting shall be ground flush in a length of 100 mm prior to penetrant testing.<br>The acceptance criteria shall be ASME BPVC VIII, Div. 1, Appendix 8. |
| ***Repair of defects*** | Weld repair of base material is not permitted. For repair of welds the same requirement to WPQR shall apply as for production testing. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on two parts per lot. When only one part is produced, it shall be hardness tested as required. The maximum hardness shall be 35HRC from three readings taken in close proximity. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface finish*** | Finished fittings shall be white pickled. Machined surfaces do not require pickling. |
| ***Marking*** | The part shall be marked to ensure full traceability to melt and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information: |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| | — MPS identification or MPCR/QTR number used;<br>— Steel manufacturer;<br>— Steel melting and refining practice;<br>— Solution annealing temperature, holding time and quench medium. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. R214 / R214S[a]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Austenitic stainless steel type UNS S34565*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Forgings** | ASTM A182/ A182M | Grade F49 (UNS S34565) | | ASTM A961/A961M S56 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.<br>Parts covered by this MDS are limited to a maximum thickness of 200 mm. For thickness exceeding 200 mm, qualification and specification requirements shall be subject to agreement. | | | |
| ***Metal making*** | The steel melt shall be refined with AOD or equivalent method. | | | |
| ***Heat treatment*** | The parts shall be solution annealed followed by water quenching.<br>Parts shall be placed in such a way as to ensure free circulation of heating and cooling media around each part during the heat treatment process including quenching. | | | |
| ***Test sampling*** | For parts forged by the closed die method, the test specimen shall be obtained from a sacrificial part.<br>For flanges the thickness of the test sample shall minimum be equal to the hub thickness or the flange ring thickness.<br>For other forgings the test samples shall represent the greatest part cross section thickness within the lot and the test specimens shall be taken as follows:<br>— 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.<br>— 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.<br>Sketches shall be established showing type, and size of test samples and location for extraction of test specimens.<br>For parts forged in closed die and flanges exceeding 80 kg, it is recognized that alternative test may be used. This alternative test sampling shall be qualified and shall comprise comparative testing of sacrificial forgings and the proposed alternative test sample. | | | |
| ***Extent of testing*** | One set of tensile test and corrosion test shall be carried out for each heat and heat treatment load. The testing shall be carried out on the part with heaviest wall thickness within the load. A test lot shall not exceed 2 000 kg for forgings with as forged weight ≤ 50 kg, and 5 000 kg for forgings with as forged weight > 50 kg. | | | |
| ***Tensile testing*** | $R_{p0,2} \geq 415$ MPa; $R_M \geq 795$ MPa; A ≥ 35 % | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Corrosion testing*** | Corrosion test according to ASTM G48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. The corrosion test specimens shall be at the same location as those for mechanical testing. For forgings with wall thickness less than 100 mm the test specimen shall expose a cross section from surface to mid-thickness. For greater wall thickness the specimen shall expose a cross section from surface to a depth of 50 mm. Cut edges shall be prepared according to ASTM G48. The test specimen may be white pickled for 5 minutes at 60 °C in a solution of 20 % $HNO_3$ + 5 % HF before testing.<br>The acceptance criteria are:<br>— No pitting at 20× magnification.<br>— The weight loss shall be less than 4,0 g/m$^2$. |
| ***Non-destructive testing*** | ASTM A961/A961M supplementary requirement S56, penetrant testing, shall apply to 10 % of all forgings (from the lot as defined for mechanical testing) above NPS 2. The testing shall be carried out after final machining and pickling.<br>The acceptance criteria shall be to ASME BPVC VIII, Div. 1, Appendix 8. |
| ***Surface finish*** | Finished forgings shall be white pickled. Machined surfaces do not require pickling. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on two parts per lot. When only one part is produced, it shall be hardness tested as required. The maximum hardness shall be 35HRC from three readings taken in close proximity. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Marking*** | The part shall be marked to ensure full traceability to melt and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— MPS identification or MPCR/QTR number used;<br>— Steel manufacturer;<br>— Steel melting and refining practice;<br>— Solution annealing temperature, holding time and quench medium. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. R215 / R215S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Austenitic stainless steel type UNS S34565*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Plates** | ASTM A240/A240M | UNS S34565 | | - |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Metal making*** | The steel melt shall be refined with AOD or equivalent method. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Extent of testing*** | Tensile, hardness and corrosion testing shall be carried out for each heat, nominal thickness and heat treatment load. For heat treatment in continuous furnace a heat treatment load is defined as all plates heat treated continuously in the same furnace, of the same heat and nominal thickness. |
| ***Test sampling*** | Tensile test specimens shall be sampled in transverse orientation of final rolling and shall be located in mid-thickness for thickness (t) ≤ 40 mm and in location t/4 for thicknesses (t) > 40 mm, in accordance with ASTM E8/E8M. |
| ***Corrosion testing*** | Corrosion test according to ASTM G48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. The test shall expose the external and internal surfaces and a cross section surface in full wall thickness. Cut edges shall be prepared according to ASTM G48. The test specimen may be white pickled for 5 minutes at 60 °C in a solution of 20 % $HNO_3$ + 5 % HF before testing.<br>The acceptance criteria are:<br>— No pitting at 20× magnification.<br>— The weight loss shall be less than 4,0 g/$m^2$. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on two parts per lot. When only one part is produced, it shall be hardness tested as required. The maximum hardness shall be 35HRC from three readings taken in close proximity. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface finish*** | Finished plates, sheets and strips shall be white pickled. |
| ***Marking*** | The plates, sheets and strips shall be marked to ensure full traceability to melt and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— MPS identification or MPCR/QTR number used;<br>— Steel manufacturer;<br>— Steel melting and refining practice;<br>— Solution annealing temperature, holding time and quench medium. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. R217 / R217S[a]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Austenitic stainless steel type UNS S34565*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Bars** | ASTM A276/A276M<br>ASTM A479/A479M | UNS S34565 | - | - |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.<br>This MDS includes additional requirements for valve parts DN 100 (NPS 4) and under manufactured from bars, when permitted by the valve specification.<br>Parts covered by this MDS is limited to a maximum thickness of 200 mm. For thickness exceeding 200 mm, qualification and specification requirements shall be subject to agreement. |
| ***Metal making*** | The steel melt shall be refined with AOD or equivalent method. |
| ***Heat treatment*** | Solution annealing followed by water quenching.<br>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. |
| ***Tensile testing*** | $R_{p0,2} \geq 415$ MPa; $R_M \geq 795$ MPa; $A \geq 35$ %. |
| ***Corrosion testing*** | Corrosion test according to ASTM G48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. The corrosion test specimens shall be at the same location as those for mechanical testing. For bars with wall thickness less than 100 mm the test specimen shall expose a cross section from surface to mid-thickness. For greater wall thickness the specimen shall expose a cross section from surface to a depth of 50 mm. Cut edges shall be prepared according to ASTM G48. The test specimen may be white pickled for 5 minutes at 60 °C in a solution of 20 % $HNO_3$ + 5 % HF before testing.<br>The acceptance criteria are:<br>— No pitting at 20× magnification.<br>— The weight loss shall be less than 4,0 g/m$^2$. |
| ***Extent of testing*** | One tensile test and corrosion test shall be carried out for each heat and heat treatment load. |
| ***Test sampling*** | Samples for production testing shall realistically reflect the properties in the actual parts.<br>Test location shall be:<br>— For bars having maximum section thickness, T ≤ 50 mm, the test specimens shall be taken at mid thickness and its mid length shall be at least 50 mm from any second surface.<br>— For bars having maximum section thickness, T > 50 mm, the test specimen shall be taken at least ¼ T from the nearest surface and at least T or 100 mm, whichever is less, from any second surface.<br>*Valve parts manufactured from bar*<br>For bars with outside diameter ≥ 100 mm intended for machining of valve parts, tensile testing shall be taken in both the longitudinal and transverse direction. |
| ***Surface treatment and finish*** | Finished parts shall be white pickled. Machined surfaces do not require pickling. |
| ***Non-destructive testing*** | *NDT (PT) of valve parts manufactured from bar*<br>Inspection of valve parts manufactured from bar shall be according to the applicable valve specification or as specified below.<br>100 % penetrant testing of all accessible internal and external surfaces shall be carried out in accordance with ASME BPVC V, article 6 or ASTM A961/A961M supplementary requirement S56. Acceptance criteria shall be according to ASME BPVC VIII, Div. 1, appendix 8. The testing shall be carried out after machining. Non machined surfaces shall be white pickled prior to testing. |
| ***Repair of defects*** | Weld repair is not permitted. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on two parts per lot. When only one part is produced, it shall be hardness tested as required. The maximum hardness shall be 35HRC from three readings taken in close proximity. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Marking*** | The part shall be marked to ensure full traceability to melt and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— MPS identification or MPCR/QTR number used;<br>— Steel manufacturer;<br>— Steel melting and refining practice;<br>— Solution annealing temperature, holding time and quench medium. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. R219 / R219S[a]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Austenitic stainless steel type UNS S34565*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **HIP parts** | ASTM A988/A988M | UNS S34565 | - | ASTM A988/A988M S5 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Metal making*** | Gas atomized powder made from vacuum-refined metal. Powder blends shall be a homogenous mixture of powder heats in terms of composition, particle size and other properties. | | | |
| ***Heat treatment*** | HIP part shall be solution annealed followed by water/liquid quenching.<br>Parts shall be placed in such a way as to ensure free circulation of heating and cooling media around each part during the heat treatment process including quenching. | | | |
| ***Extent of testing*** | One tensile and corrosion test shall be carried out for each lot as defined below.<br>A lot shall consist of all fittings of the same type, size, and wall thickness, manufactured from one heat of material, and, if welding is performed, using the same classification of welding product. | | | |
| ***Corrosion testing*** | Corrosion test according to ASTM G48 Method A is required. Test temperature shall be 50 °C and the exposure time 24 hours. The test shall expose the external and internal surfaces and a cross section surface including weld zone in full wall thickness. Cut edges shall be prepared according to ASTM G48. The test specimen may be white pickled performed for 5 minutes at 60 °C in a solution of 20 % $HNO_3$ + 5 % HF.<br>The acceptance criteria are: | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| | — No pitting at 20× magnification.<br>— The weight loss shall be less than 4,0 g/m$^2$. |
| ***Non-destructive testing*** | Supplementary requirement S5, penetrant testing, shall apply to 10 % of parts (from the lot as defined for mechanical testing) above NPS 2. The testing shall be carried out in accordance with ASME BPVC V, Article 6 after final machining. Non-machined surfaces shall be white pickled prior to the testing.<br>The acceptance criteria shall be ASME BPVC VIII, Div. 1, Appendix 8. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on two parts per lot. When only one part is produced, it shall be hardness tested as required. The maximum hardness shall be 35HRC from three readings taken in close proximity. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface finish*** | Finished parts shall be white pickled. Machined surfaces do not require pickling. |
| ***Marking*** | The powder blend shall have a unique identity marked on the powder container and this identity shall be recorded and maintained throughout production of the part. The parts shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— MPS identification or MPCR/QTR number used;<br>— Steel manufacturer;<br>— Steel melting and refining practice;<br>— Solution annealing temperature, holding time and quench medium. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. S100 / S100S [a]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Precipitation-hardened stainless steel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Stud, bolts and nuts** | ASTM A453/A453M | Grade 660 (UNS S66286) | Class A, B or D | - |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Manufacturing*** | Threading of studs, bolts and screws may be done by machining or rolling. Thread rolling shall be done after heat treatment.<br>Threads in nuts shall be machined. | | | |
| ***Heat treatment*** | Heat treatment shall be carried out after the final hot forming operation. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Impact testing/ Toughness testing*** | Impact testing shall be carried out at minus 101 °C. The minimum absorbed energy shall be 27 J average and 20 J single, the lateral expansion shall be 0,38 mm.<br>Reduction factors for sub-size specimens shall be: 7,5 mm - 5/6 and 5 mm - 2/3. |
| ***Proof load testing*** | Proof load testing shall be according to ASTM A962/A962M and the load shall conform with ASTM A194/A194M Grade 7. |
| ***Hardness testing*** | Maximum 35 HRC. |
| ***Non-destructive testing*** | All products shall be 100 % visually examined in all areas of threads, shanks and heads. Discontinuities shall conform with requirements specified in ASTM F788/F788M for bolts/ studs and ASTM F812 for nuts. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished parts shall be white pickled or grit blasted. Machined or rolled surfaces do not require pickling. |
| ***Marking*** | Each bolt and nut shall be marked on the end/head to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition (solution annealing and annealing temperature).<br>— Original material certificate of the bar material. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. S101 / S101S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Austenitic stainless steel, type 316*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Seamless pipes** | ASTM A312/A312M | TP316 | | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Chemical composition*** | The chemical composition shall conform with UNS S31603 (dual certified 316/316L). | | | |
| ***Tensile testing*** | Elongation shall be minimum 35 % | | | |
| ***Repair of defects*** | Weld repair is not permitted. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on one length of pipe per lot. The maximum hardness shall be 22HRC from three readings taken in close proximity. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished pipes shall be white pickled or bright annealed. Machined surfaces do not require pickling. |
| ***Marking*** | The pipes shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition;<br>— Confirmation of conformance to both UNS S31603 and S31600. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. S102 / S102S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Austenitic stainless steel, type 316*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Welded pipes** | ASTM A312/A312M | TP316 | | |
| | ASTM A358/A358M | 316 | Class 1, 3, 4 or 5 | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Chemical composition*** | The chemical composition shall conform with UNS S31603 (dual certified 316/316L). | | | |
| ***Tensile testing*** | Pipes according to ASTM A312/312M: Elongation shall be minimum 35 % | | | |
| ***Repair of defects*** | ASTM A358/A358M: Weld repair of base material is not permitted.<br>ASTM A312/A312M: Weld repair is not permitted. | | | |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: | | | |
| | *Hardness testing*<br>— Welding procedure qualification testing for manufacturing and any repair welding shall meet the requirements of ISO 15156-3 / ANSI/NACE MR0175 with a maximum hardness of 70,8HR 15N or 250HV.<br>— Hardness testing shall be performed on one length of pipe per lot. The maximum hardness of the base material, HAZ and weld metal shall be 22HRC from three readings taken in close proximity at each location. | | | |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Surface treatment and finish*** | Finished pipes shall be white pickled or bright annealed. Machined surfaces do not require pickling. |
| ***Marking*** | The pipes shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition;<br>— Confirmation of conformance to both UNS S31603 and S31600. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. S103 / S103S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Austenitic stainless steel, type 316*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Wrought fittings** | ASTM A403/A403M | WP316 | W or S or WX | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Chemical composition*** | The chemical composition shall conform with UNS S31603 (dual certified 316/316L). | | | |
| ***Heat treatment*** | During heat treatment fittings shall be placed in such a way as to ensure free circulation around each fitting during the heat treatment process including possible quenching operation. | | | |
| ***Tensile testing*** | Elongation shall be minimum 35 % | | | |
| ***Non-destructive testing*** | Ultrasonic testing is not acceptable as replacement for radiography. | | | |
| ***Repair of defects*** | Weld repair of base material is not acceptable.<br>For repair of welds, the requirements for production welding above shall apply to the repair WPS. Repair welds shall be heat treated as per original production weld. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>— Seamless fittings:<br>— Production testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on one fitting per lot. The maximum hardness shall be 22HRC from three readings taken in close proximity.<br>— Welded fittings:<br>— Welding procedure qualification testing for manufacturing and any repair welding shall meet the requirements of ISO 15156-3 / ANSI/NACE MR0175 with a maximum hardness of 70,8HR 15N or 250HV.<br>— Production testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on one fitting per lot. The maximum hardness of the base material, HAZ and weld metal shall be 22HRC from three readings taken in close proximity at each location. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished fittings shall be white pickled or bright annealed. Machined surfaces do not require pickling. |
| ***Marking*** | The fittings shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition;<br>— Confirmation of conformance to both UNS S31603 and S31600. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. S104 / S104S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Austenitic stainless steel, type 316*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Forgings** | ASTM A182/A182M | F316 | | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Chemical composition*** | The chemical composition shall conform with F316L (dual certified F316/F316L). | | | |
| ***Tensile testing*** | Elongation shall be minimum 35 % | | | |
| ***Heat treatment*** | Forgings shall be supplied in the solution annealed conditions.<br>Forgings shall be placed in such a way as to ensure free circulation around each forging during the heat treatment process including possible quenching operation. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Non-destructive testing*** | *Visual inspection*<br>VT shall be carried out on each forging or bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be white pickled prior to the testing. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on one forging per lot. The maximum hardness shall be 22HRC from three readings taken in close proximity. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished forgings shall be white pickled or bright annealed. Machined surfaces do not require pickling. |
| ***Marking*** | The forgings shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition;<br>— Confirmation of conformance to both F316 and F316L. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. S105 / S105S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Austenitic stainless steel, type 316*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| ***Plates, sheets, strips*** | ASTM A240/A240M | 316 | | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Chemical composition*** | The chemical composition shall conform with UNS S31603 (dual certified 316/316L). | | | |
| ***Non-destructive testing*** | *Visual inspection*<br>VT shall be carried out on each plate in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing. | | | |
| ***Repair of defects*** | Weld repair is not permitted. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on one plate per lot. The maximum hardness shall be 22HRC from three readings taken in close proximity. |
| | The material shall be traceable in accordance with ISO 15156- 3/ ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished plates, sheets and strips shall be white pickled, descaled or bright annealed. |
| ***Marking*** | The plates, sheets and strips shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1, shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition;<br>— Confirmation of conformance to both UNS S31603 and UNS S31600. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. S106 / S106S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Austenitic stainless steel, type 316*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Castings** | ASTM A351/A351M | CF8M, CF3M | | ASTM A351/A351M S5, S6<br>ASTM A703/A703M S20 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Extent of testing*** | Tensile testing is required for each heat and heat treatment lot including any PWHT. | | | |
| ***Test sampling*** | For castings with a weight of 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.<br>During any PWHT the test block shall be tack welded onto the casting. | | | |
| ***Non-destructive testing*** | *General*<br>For definition and NDT of pilot castings reference is made the general part of this document.<br>Non-machined surfaces shall be cleaned prior to testing.<br>*Visual inspection*<br>Visual testing shall be carried out on each casting in accordance with ANSI/MSS SP-55. The testing shall be performed after final machining.<br>*Radiographic testing*<br>ASTMA351/A351M supplementary requirement S5 shall apply as amended by this MDS: | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

— Method of radiography of radiography shall be according to ASME BPVC V, Article 2 and acceptance criteria shall be in accordance with ASME BPVC VIII, Div. 1, Appendix 7.

— 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.

— Sketches of the areas to be tested shall be established and agreed with the purchaser.

— When random testing (5 %) 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.

— Pilot castings shall be radiographed to the extent described above.

— Frequency of RT of valve castings shall be according to table below.

| *Frequency of RT based on pressure class and nominal outside diameter:* | | | | | |
|---|---|---|---|---|---|
| *Pressure class:* | | *≤ 300* | *600* | *900* | *≥ 1 500* |
| *Frequency of RT* | Not required | < 10” | < 2” | | |
| | 5 % | ≥ 10” | ≥ 2” | | |
| | 100 % | Not applicable | ≥ 20” | ≥ 16” | ≥ 6” |

Non-valve 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.

*Liquid penetrant testing*

ASTMA351/A351M supplementary requirement S6 shall apply as amended by this MDS:

Testing shall be carried out in accordance with ASME BPVC V, Article 6. Each pilot and production casting shall be tested after final machining at all accessible surfaces, including all accessible internal surfaces. Non-machined surfaces shall be white pickled prior to the testing.

Acceptance criteria shall be according to ASME BPVC VIII, Div. 1, Appendix 7.

***Repair of defects***

All major repairs, as defined by ASTM A351/A351M, shall be documented in accordance with ASTM A703/A703M S20.2.

The repair welding procedure shall be qualified in accordance with ISO 11970 or ASTM A488/A488M and this MDS:

— Welding procedure shall be qualified on casting or plate of the same cast material grade as used in production;

— Testing methodology and acceptance criteria shall be in accordance with the requirements of this MDS for the parent material.

Weld repairs are not acceptable for castings that leak during pressure testing.

Solution annealing heat treatment is required after all major weld repairs.

If a minor cosmetic repair is required to a semi-finished or finished cast component, heat treatment may be omitted provided the welding procedure meets all the test requirements of this data sheet in the as-welded condition.

[a] The supplementary suffix “S” shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>— Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on the pilot casting and one casting per lot thereafter. The maximum hardness shall be 22HRC from three readings taken in close proximity.<br>— Welding procedure qualification testing for all repair welding on shall meet the requirements of ISO 15156-3 / ANSI/NACE MR0175 with a maximum hardness of 70,8HR 15N or 250HV. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished castings shall be white pickled. Machined surfaces do not require pickling. |
| ***Marking*** | The castings shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. S107 / S107S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Austenitic stainless steel, type 316*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Bars** | ASTM A276/A276M | 316 | | |
| | ASTM A479/A479M | 316 | | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Manufacturing*** | Bars shall be hot or cold finished cylindrical shaped with maximum diameter of 300 mm.<br>Cold finishing shall be restricted to turning, grinding or polishing (singly or in combination); cold drawing or cold forming is not permitted. | | | |
| ***Chemical composition*** | The chemical composition shall conform with UNS S31603 (dual certified 316/316L). | | | |
| ***Heat treatment*** | Bars shall be supplied in the solution annealing conditions.<br>Bars shall be placed in such a way as to ensure free circulation around each component during the heat treatment process including possible quenching operation. | | | |
| ***Tensile testing*** | Where tensile testing in both directions is required by this MDS, all tensile tests shall meet the specified properties of the referenced standard specification in both directions. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Test sampling*** | The mid-length of axial (longitudinal) and tangential (transverse) tensile specimens shall be located at a distance equal to the bar outside diameter or minimum of 100 mm, whichever is the smallest from the end of the bar.<br>The centreline of tensile specimen shall be located at a distance from the bar surface in accordance with ASTM A370.<br>*Valve parts manufactured from bar*<br>For bars with outside diameter ≥ 100 mm intended for machining of valve parts, tensile testing shall be taken in both the longitudinal and transverse direction. |
| ***Non-destructive testing*** | *Visual inspection*<br>VT shall be carried out on each bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing. |
| | *NDT (PT) of valve parts manufactured from bar*<br>Inspection of valve parts manufactured from bar shall be according to the applicable valve specification or as specified below.<br>100 % penetrant testing of all accessible internal and external surfaces shall be carried out *in accordance with* ASME BPVC V, article 6 or ASTM A961/A961M supplementary requirement S56. Acceptance criteria shall be according to ASME BPVC VIII, Div. 1, appendix 8. The testing shall be carried out after machining. Non machined surfaces shall be white pickled prior to testing. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on the end surface of one bar per lot. The maximum hardness shall be 22HRC from three readings taken in close proximity.<br>The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished parts shall be white pickled or bright annealed. Machined or peeled surfaces do not require pickling. |
| ***Marking*** | The bars shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition;<br>— Confirmation of conformance to both UNS S31603 and UNS S31600. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. S108 / S108S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Austenitic stainless steel, type 316*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Tubes** | ASTM A269/A269M | TP316 | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. |
| ***Chemical composition*** | The chemical composition shall conform with UNS S31603 (dual certified 316/316L). |
| ***Extent of testing*** | Tensile testing shall be carried out for each lot as defined in the standard for mechanical tests. |
| ***Tensile testing*** | The following acceptance criteria shall apply: Rp0,2 ≥ 205 MPa, Rm ≥ 515 MPa, A ≥ 35 %. |
| ***Non-destructive testing*** | Welded tubes: non-destructive electric testing is required. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>Hardness testing shall be performed in accordance with the requirements in ASTM A269/A269M. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished tubes shall be white pickled or bright annealed. Machined surfaces do not require pickling. |
| ***Marking*** | The tubes shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition; |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. S109 / S109S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Austenitic stainless steel, type 316*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Studs and bolts** | ASTM A320/A320M | B8M | Class 1 or 2 | |
| **Nuts** | ASTM A194/A194M | 8M | | |

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| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| Material Data Sheet | MDS No. S201 / S201S [a] | | | Rev. 1 |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Austenitic stainless steel, type 304*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Seamless pipes** | ASTM A312/A312M | TP304 | | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Chemical composition*** | The chemical composition shall conform with UNS S30403 (dual certified 304/304L). | | | |
| ***Tensile testing*** | Elongation shall be minimum 35 % | | | |
| ***Repair of defects*** | Weld repair is not permitted. | | | |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: | | | |
| | *Hardness testing*<br>Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on one length of pipe per lot. The maximum hardness shall be 22HRC from three readings taken in close proximity. | | | |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. | | | |
| ***Surface treatment and finish*** | Finished pipes shall be white pickled or bright annealed. Machined surfaces do not require pickling. | | | |
| ***Marking*** | The pipes shall be marked to ensure full traceability to heat and heat treatment lot. | | | |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition;<br>— Confirmation of conformance to both UNS S30403 and UNS S30400. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| Material Data Sheet | MDS No. S202 / S202S [a] | | | Rev. 1 |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Austenitic stainless steel, type 304*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Welded pipes** | ASTM A312/A312M | TP304 | | |
| | ASTM A358/A358M | 304 | Class 1, 3, 4 or 5 | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Chemical composition*** | The chemical composition shall conform with UNS S30403 (dual certified 304/304L). | | | |
| ***Tensile testing*** | Pipes according to ASTM A312/312M: Elongation shall be minimum 35 % | | | |
| ***Repair of defects*** | ASTM A358/A358M: Weld repair of base material is not permitted.<br>ASTM A312/A312M: Weld repair is not permitted. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>— Welding procedure qualification testing for manufacturing and any repair welding shall meet the requirements of ISO 15156-3 / ANSI/NACE MR0175 with a maximum hardness of 70,8HR 15N or 250HV.<br>— Hardness testing shall be performed on one length of pipe per lot. The maximum hardness of the base material, HAZ and weld metal shall be 22HRC from three readings taken in close proximity at each location. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished pipes shall be white pickled or bright annealed. Machined surfaces do not require pickling. |
| ***Marking*** | The pipes shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition;<br>— Confirmation of conformance to both UNS S30403 and UNS S30400. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. S203 / S203S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Austenitic stainless steel, type 304*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Wrought fittings** | ASTM A403/A403M | WP304 | W or S or WX | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Chemical composition*** | The chemical composition shall conform with UNS S30403 (dual certified 304/304L). | | | |
| ***Heat treatment*** | During heat treatment fittings shall be placed in such a way as to ensure free circulation around each fitting during the heat treatment process including possible quenching operation. | | | |
| ***Tensile testing*** | Elongation shall be minimum 35 % | | | |
| ***Non-destructive testing*** | Ultrasonic testing is not acceptable as replacement for radiography. | | | |
| ***Repair of defects*** | Weld repair of base material is not acceptable.<br>For repair of welds, the requirements for production welding above shall apply to the repair WPS. Repair welds shall be heat treated as per original production weld. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>— Seamless fittings:<br>— Production testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on one fitting per lot. The maximum hardness shall be 22HRC from three readings taken in close proximity.<br>— Welded fittings:<br>— Welding procedure qualification testing for manufacturing and any repair welding shall meet the requirements of ISO 15156-3 / ANSI/NACE MR0175 with a maximum hardness of 70,8HR 15N or 250HV.<br>— Production testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on one fitting per lot. The maximum hardness of the base material, HAZ and weld metal shall be 22HRC from three readings taken in close proximity at each location. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished fittings shall be white pickled or bright annealed. Machined surfaces do not require pickling. |
| ***Marking*** | The fittings shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition;<br>— Confirmation of conformance to both UNS S30403 and UNS S30400. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. S204 / S204S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Austenitic stainless steel, type 304*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Forgings** | ASTM A182/A182M | F304 | | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Chemical composition*** | The chemical composition shall conform with F304L (dual certified F304/F304L). | | | |
| **Tensile testing** | Elongation shall be minimum 35 % | | | |
| ***Heat treatment*** | Forgings shall be supplied in the solution annealed conditions.<br>Forgings shall be placed in such a way as to ensure free circulation around each component during the heat treatment process including possible quenching operation. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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|---|---|
| ***Non-destructive testing*** | *Visual inspection*<br>VT shall be carried out on each forging or bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be white pickled prior to the testing. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on one forging per lot. The maximum hardness shall be 22HRC from three readings taken in close proximity. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished forgings shall be white pickled or bright annealed. Machined surfaces do not require pickling. |
| ***Marking*** | The forgings shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition;<br>— Confirmation of conformance to both F304 and F304L. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. S205 / S205S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Austenitic stainless steel, type 304*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Plates, sheets, strips** | ASTM A240/A240M | 304 | | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Chemical composition*** | The chemical composition shall conform with UNS S30403 (dual certified 304/304L). | | | |
| ***Non-destructive testing*** | *Visual inspection*<br>VT shall be carried out on each plate in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing. | | | |
| ***Repair of defects*** | Weld repair is not permitted. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on one plate per lot. The maximum hardness shall be 22HRC from three readings taken in close proximity. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished plates, sheets and strips shall be white pickled, descaled or bright annealed. |
| ***Marking*** | The plates, sheets and strips shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition;<br>— Confirmation of conformance to both UNS S30403 and UNS S30400. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. S206 / S206S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Austenitic stainless steel, type 304*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Castings** | ASTM A351/A351M | CF8, CF3 | | ASTM A351/A351M S5, S6<br>ASTM A703/A703M S20 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Extent of testing*** | Tensile testing is required for each heat and heat treatment lot including any PWHT. | | | |
| ***Test sampling*** | For castings with a weight of 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.<br>During any PWHT the test block shall be tack welded onto the casting. | | | |
| ***Non-destructive testing*** | *General*<br>For definition and NDT of pilot castings reference is made the general part of this document.<br>Non-machined surfaces shall be cleaned prior to testing.<br>*Visual inspection*<br>Visual testing shall be carried out on each casting in accordance with ANSI/MSS SP-55. The testing shall be performed after final machining.<br>*Radiographic testing*<br>ASTMA351/A351M supplementary requirement S5 shall apply as amended by this MDS: | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

— Method of radiography of radiography shall be according to ASME BPVC V, and acceptance criteria shall be in accordance with ASME BPVC VIII, Div. 1, Appendix 7.

— 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.

— Sketches of the areas to be tested shall be established and agreed with the purchaser.

— When random testing (5 %) 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.

— Pilot castings shall be radiographed to the extent described above.

— Frequency of RT of valve castings shall be according to table below.

| *Frequency of RT based on pressure class and nominal outside diameter:* | | | | | |
|---|---|---|---|---|---|
| *Pressure class:* | | *≤ 300* | *600* | *900* | *≥ 1 500* |
| *Frequency of RT* | Not required | < 10” | < 2” | | |
| | 5 % | ≥ 10” | ≥ 2” | | |
| | 100 % | Not applicable | ≥ 20” | ≥ 16” | ≥ 6” |

Non-valve 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.

*Liquid penetrant testing*

ASTMA351/A351M supplementary requirement S6 shall apply as amended by this MDS:

Testing shall be carried out in accordance with ASME BPVC V, Article 6. Each pilot and production casting shall be tested after final machining at all accessible surfaces, including all accessible internal surfaces. Non-machined surfaces shall be white pickled prior to the testing.

Acceptance criteria shall be according to ASME BPVC VIII, Div. 1, Appendix 7.

***Repair of defects***

All major repairs, as defined by ASTM A351/A351M, shall be documented in accordance with ASTM A703/A703M S20.2.

The repair welding procedure shall be qualified in accordance with ISO 11970 or ASTM A488/A488M and this MDS:

— welding procedure shall be qualified on casting or plate of the same cast material grade as used in production;

— testing methodology and acceptance criteria shall be in accordance with the requirements of this MDS for the parent material.

Weld repairs are not acceptable for castings that leak during pressure testing.

Solution annealing heat treatment is required after all major weld repairs.

If a minor cosmetic repair is required to a semi-finished or finished cast component, heat treatment may be omitted provided the welding procedure meets all the test requirements of this data sheet in the as-welded condition.

[a] The supplementary suffix “S” shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>— Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on the pilot casting and one casting per lot thereafter. The maximum hardness shall be 22HRC from three readings taken in close proximity.<br>— Welding procedure qualification testing for all repair welding on shall meet the requirements of ISO 15156-3 / ANSI/NACE MR0175 with a maximum hardness of 70,8HR 15N or 250HV. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished castings shall be white pickled. Machined surfaces do not require pickling. |
| ***Marking*** | The castings shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. S207 / S207S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Austenitic stainless steel, type 304*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Bars** | ASTM A276/A276M | 304 | | |
| | ASTM A479/A479M | 304 | | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Manufacturing*** | Bars shall be hot or cold finished cylindrical shaped with maximum diameter of 300 mm.<br>Cold finishing shall be restricted to turning, grinding or polishing (singly or in combination); cold drawing or cold forming is not permitted. | | | |
| ***Chemical composition*** | The chemical composition shall UNS S30403 conform with UNS S30403 (dual certified 304/304L). | | | |
| ***Heat treatment*** | Bars shall be supplied in the solution annealing conditions.<br>Bars shall be placed in such a way as to ensure free circulation around each bar during the heat treatment process including possible quenching operation. | | | |
| ***Tensile testing*** | Where tensile testing in both directions is required by this MDS, all tensile tests shall meet the specified properties of the referenced standard specification in both directions. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Test sampling*** | The mid-length of axial (longitudinal) and tangential (transverse) tensile specimens shall be located at a distance equal to the bar outside diameter or minimum of 100 mm , whichever is the smallest from the end of the bar.<br>The centreline of tensile specimen shall be located at a distance from the bar surface in accordance with ASTM A370.<br>*Valve parts manufactured from bar*<br>For bars with outside diameter ≥ 100 mm intended for machining of valve parts, tensile testing shall be taken in both the longitudinal and transverse direction. |
| ***Non-destructive testing*** | *Visual inspection*<br>VT shall be carried out on each bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing. |
| | *NDT (PT) of valve parts manufactured from bar*<br>Inspection of valve parts manufactured from bar shall be according to the applicable valve specification or as specified below.<br>100 % penetrant testing of all accessible internal and external surfaces shall be carried out in accordance with ASME BPVC V, article 6 or ASTM A961/A961M supplementary requirement S56. Acceptance criteria shall be according to ASME BPVC VIII, Div. 1, appendix 8. The testing shall be carried out after machining. Non machined surfaces shall be white pickled prior to testing. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on the end surface of one bar per lot. The maximum hardness shall be 22HRC from three readings taken in close proximity. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished parts shall be white pickled or bright annealed. Machined or peeled surfaces do not require pickling. |
| ***Marking*** | The bars shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition;<br>— Confirmation of conformance to both UNS S30403 and UNS S30400. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. S208 / S208S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Austenitic stainless steel, type 304*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Tubes** | ASTM A269/A269M | TP304 | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. |
| ***Chemical composition*** | The chemical composition shall conform with UNS S30403 (dual certified 304/304L). |
| ***Extent of testing*** | Tensile testing shall be carried out for each lot as defined in the standard for mechanical tests. |
| ***Tensile testing*** | The following acceptance criteria shall apply: Rp0,2 ≥ 205 MPa, Rm ≥ 515 MPa, A ≥ 35 %. |
| ***Non-destructive testing*** | Welded tubes: non-destructive electric testing is required. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>Hardness testing shall be performed in accordance with the requirements in ASTM A269/A269M. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished tubes shall be white pickled or bright annealed. Machined surfaces do not require pickling. |
| ***Marking*** | The tubes shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition; |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. S301 / S301S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Austenitic stainless steel, stabilized grade*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Seamless pipes** | ASTM A312/A312M | TP321, TP347 | - | ASTM A312/A312M S6 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Heat Treatment*** | Supplementary requirement S6 applies with the following requirement:<br>Stabilization heat treatment temperature shall be in the range of 815 °C to 900 °C. | | | |
| ***Tensile testing*** | Elongation shall be minimum 35 % | | | |
| ***Repair of defects*** | Weld repair is not permitted. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on one length of pipe per lot. The maximum hardness shall be 22HRC from three readings taken in close proximity. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished pipes shall be white pickled or bright annealed. Machined surfaces do not require pickling. |
| ***Marking*** | The pipes shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. S302 / S302S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Austenitic stainless steel, stabilized grade*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Welded pipes** | ASTM A312/A312M | TP321, TP347 | - | ASTM A312/A312M S6 |
| | ASTM A358/A358M | 321, 347 | Class 1, 3, 4 or 5 | ASTM A358/A358M S5 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Heat Treatment*** | Supplementary requirement ASTM A312/A312M S6 or ASTM A358/A358M S5 apply with the following requirement:<br>Stabilization heat treatment temperature shall be in the range of 815 °C to 900 °C. | | | |
| ***Tensile testing*** | Elongation shall be minimum 35 % | | | |
| ***Repair of defects*** | ASTM A312/A312M: Weld repair is not permitted.<br>ASTM A358/A358M: Weld repair of base material is not permitted.<br>Repair welds shall be heat treated as per original production weld. | | | |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: | | | |
| | *Hardness testing*<br>Production hardness testing shall be performed on one length of pipe per lot. The maximum hardness of the base material, HAZ and weld metal shall be 22HRC from three readings taken in close proximity at each location. | | | |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. | | | |
| ***Surface treatment and finish*** | Finished pipes shall be white pickled or bright annealed. Machined surfaces do not require pickling. | | | |
| ***Marking*** | The pipes shall be marked to ensure full traceability to heat and heat treatment lot. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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|---|---|
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. S303 / S303S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Austenitic stainless steel, stabilized grade*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Wrought fittings** | ASTM A403/A403M | WP321, WP347 | W or S or WX | ASTM A403/A403M S2 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Heat treatment*** | Supplementary requirement ASTM A403/A403M S2 shall apply.<br>During heat treatment fittings shall be placed in such a way as to ensure free circulation around each fitting during the heat treatment process including quenching operation. | | | |
| ***Tensile testing*** | Elongation shall be minimum 35 % | | | |
| ***Non-destructive testing*** | Ultrasonic testing is not acceptable as replacement for radiography. | | | |
| ***Repair of defects*** | Weld repair of base material is not acceptable.<br>For repair of welds, the requirements for production welding above shall apply to the repair WPS. Repair welds shall be heat treated as per original production weld. | | | |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements:<br>*Hardness testing*<br>— Seamless fittings:<br>Production testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on one fitting per lot. The maximum hardness shall be 22HRC from three readings taken in close proximity.<br>— Welded fittings:<br>Production testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on one fitting per lot. The maximum hardness of the base material, HAZ and weld metal shall be 22HRC from three readings taken in close proximity at each location.<br>The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. | | | |
| ***Surface treatment and finish*** | Finished fittings shall be white pickled or bright annealed. Machined surfaces do not require pickling. | | | |
| ***Marking*** | The fittings shall be marked to ensure full traceability to heat and heat treatment lot. | | | |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information: | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| | |
|---|---|
| | — Heat treatment condition. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. S304 / S304S [a]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Austenitic stainless steel, stabilized grade*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Forgings** | ASTM A182/A182M | F321, F347 | - | ASTM A182/A182M S10 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Heat treatment*** | Supplementary requirement ASTM A182/A182M S10 shall apply.<br>Forgings shall be placed in such a way as to ensure free circulation around each component during the heat treatment process including quenching operation. | | | |
| ***Tensile testing*** | Elongation shall be minimum 35 %. | | | |
| ***Non-destructive testing*** | *Visual inspection*<br>VT shall be carried out on each forging or bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be white pickled prior to the testing. | | | |
| ***Repair of defects*** | Weld repair is not permitted. | | | |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: | | | |
| | *Hardness testing*<br>Production testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on one fitting per lot. The maximum hardness of the base material, HAZ and weld metal shall be 22HRC from three readings taken in close proximity at each location. | | | |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. | | | |
| ***Surface treatment and finish*** | Finished forgings shall be white pickled or bright annealed. Machined surfaces do not require pickling. | | | |
| ***Marking*** | The forgings shall be marked to ensure full traceability to heat and heat treatment lot. | | | |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. S305 / S305S [a]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Austenitic stainless steel, stabilized grade*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| ***Plates, sheets, strips*** | ASTM A240/A240M | 321, 347 | - | - |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. |
| ***Heat Treatment*** | Following annealing, a stabilization heat treatment shall be carried out in the temperature range of 815 °C to 900 °C. |
| ***Non-destructive testing*** | *Visual inspection*<br>VT shall be carried out on each plate in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>Production testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on one fitting per lot. The maximum hardness of the base material, HAZ and weld metal shall be 22HRC from three readings taken in close proximity at each location. |
| | The material shall be traceable in accordance with ISO 15156- 3/ ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished plates shall be white pickled, descaled or bright annealed. |
| ***Marking*** | The plates, sheets and strips shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1, shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. S306 / S306S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Austenitic stainless steel, stabilized grade*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Castings** | ASTM A351/A351M | CF8C | - | ASTMA351/A351M S5, S6, S33<br>ASTM A703/A703M S20 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Heat Treatment*** | ASTMA351/A351M supplementary requirement S33 shall apply. | | | |
| ***Extent of testing*** | Tensile testing is required for each heat and heat treatment lot including any PWHT. | | | |
| ***Test sampling*** | For castings with a weight of 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.<br>During any PWHT the test block shall be tack welded onto the casting. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

<table>
<tr>
<td>Non-destructive testing</td>
<td>
<u>General</u><br>
For definition and NDT of pilot castings reference is made the general part of this document.<br>
Non-machined surfaces shall be cleaned prior to testing.<br>
<u>Visual inspection</u><br>
Visual testing shall be carried out on each casting in accordance with ANSI/MSS SP-55. The testing shall be performed after final machining.<br>
<u>Radiographic testing</u><br>
ASTMA351/A351M supplementary requirement S5 shall apply as amended by this MDS:<br>
— Method of radiography of radiography shall be according to ASME BPVC V, Article 2 and acceptance criteria shall be in accordance with ASME BPVC VIII, Div. 1, Appendix 7.<br>
— 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.<br>
— Sketches of the areas to be tested shall be established and agreed with the purchaser.<br>
— When random testing (5 %) is specified, minimum one casting of each pattern including feeder and riser system in any purchase order with the foundry shall be examined.<br>
— 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.<br>
— Pilot castings shall be radiographed to the extent described above.<br>
— Frequency of RT of valve castings shall be according to table below.
<table>
<tr><td colspan="6">Frequency of RT based on pressure class and nominal outside diameter:</td></tr>
<tr><td colspan="2">Pressure class:</td><td>≤ 300</td><td>600</td><td>900</td><td>≥ 1 500</td></tr>
<tr><td rowspan="3">Frequency of RT</td><td>Not required</td><td>< 10”</td><td colspan="3">< 2”</td></tr>
<tr><td>5 %</td><td>≥ 10”</td><td colspan="3">≥ 2”</td></tr>
<tr><td>100 %</td><td>Not applicable</td><td>≥ 20”</td><td>≥ 16”</td><td>≥ 6”</td></tr>
</table>
Non-valve 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.<br>
<u>Liquid penetrant testing</u><br>
ASTMA351/A351M supplementary requirement S6 shall apply as amended by this MDS:<br>
Testing shall be carried out in accordance with ASME BPVC V, Article 6. Each pilot and production casting shall be tested after final machining at all accessible surfaces, including all accessible internal surfaces. Non-machined surfaces shall be white pickled prior to the testing.<br>
Acceptance criteria shall be according to ASME BPVC VIII, Div. 1, Appendix 7.
</td>
</tr>
<tr>
<td>Repair of defects</td>
<td>All major repairs, as defined by ASTM A351/A351M, shall be documented in accordance with ASTM A703/A703M S20.2.<br>
The repair welding procedure shall be qualified in accordance with ISO 11970 or ASTM A488/A488M and this MDS:</td>
</tr>
<tr>
<td colspan="2">[a] The supplementary suffix “S” shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.</td>
</tr>
</table>

| | |
|---|---|
| | — Welding procedure shall be qualified on casting or plate of the same cast material grade as used in production;<br>— Testing methodology and acceptance criteria shall be in accordance with the requirements of this MDS for the parent material.<br>Weld repairs are not acceptable for castings that leak during pressure testing.<br>Solution annealing heat treatment is required after all major weld repairs.<br>If a minor cosmetic repair is required to a semi-finished or finished cast component, heat treatment may be omitted provided the welding procedure meets all the test requirements of this data sheet in the as-welded condition. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>Production testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on one fitting per lot. The maximum hardness of the base material, HAZ and weld metal shall be 22HRC from three readings taken in close proximity at each location. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished castings shall be white pickled. Machined surfaces do not require pickling. |
| ***Marking*** | The castings shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition. |
| [a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service. | |

| **Material Data Sheet** | **MDS No. S307 / S307S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Austenitic stainless steel, stabilized grade*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Bars** | ASTM A276/A276M | 321, 347 | - | - |
| | ASTM A479/A479M | 321, 347 | - | - |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Manufacturing*** | Bars shall be hot or cold finished cylindrical shaped with maximum diameter of 300 mm.<br>Cold finishing shall be restricted to turning, grinding or polishing (singly or in combination); cold drawing or cold forming is not permitted. | | | |
| ***Heat treatment*** | Bars shall be supplied in the solution annealing conditions.<br>Stabilization heat treatment temperature shall be in the range of 815 °C to 900 °C.<br>Bars shall be placed in such a way as to ensure free circulation around each component during the heat treatment process including possible quenching operation. | | | |
| [a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service. | | | | |

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| ***Tensile testing*** | Where tensile testing in both directions is required by this MDS, all tensile tests shall meet the specified properties of the referenced standard specification in both directions.<br>Elongation shall be minimum 35 %. |
| ***Test sampling*** | The mid-length of axial (longitudinal) and tangential (transverse) tensile specimens shall be located at a distance equal to the bar outside diameter or minimum of 100 mm, whichever is the smallest from the end of the bar.<br>The centreline of tensile specimen shall be located at a distance from the bar surface in accordance with ASTM A370.<br>*Valve parts manufactured from bar*<br>For bars with outside diameter ≥ 100 mm intended for machining of valve parts, tensile testing shall be taken in both the longitudinal and transverse direction. |
| ***Non-destructive testing*** | *Visual inspection*<br>VT shall be carried out on each bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing.<br>*NDT (PT) of valve parts manufactured from bar*<br>100 % penetrant testing to ASME BPVC V, article 6 shall apply to all finished parts. The testing shall be carried out after machining. Non-machined surfaces shall be white pickled prior to testing. All accessible external and internal surfaces shall be examined. The acceptance criteria shall be ASME BPVC VIII, Div. 1, appendix 8. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements:<br>*Hardness testing*<br>Production testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on one fitting per lot. The maximum hardness of the base material, HAZ and weld metal shall be 22HRC from three readings taken in close proximity at each location.<br>The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished parts shall be white pickled or bright annealed. Machined or peeled surfaces do not require pickling. |
| ***Marking*** | The bars shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition. |
| [a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service. | |

| **Material Data Sheet** | **MDS No. S308 / S308S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Austenitic stainless steel, stabilized grade*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Tubes** | ASTM A269/A269M | TP321, TP347 | - | ASTM A269/A269M S3 |
| [a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service. | | | | |

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| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. |
| ***Heat Treatment*** | Supplementary requirement ASTM A269/A269M S3 shall apply with stabilization heat treatment carried out in the temperature range of 815 °C to 900 °C. |
| ***Tensile testing*** | The following acceptance criteria shall apply: Rp0,2 ≥ 207 MPa; Rm ≥ 517 MPa ; A ≥ 35 %. |
| ***Extent of testing*** | Tensile testing shall be carried out for each lot as defined in the standard for mechanical tests. |
| ***Non-destructive testing*** | Welded tubes: non-destructive electric testing is required. |
| ***Repair of defects*** | Weld repair of base material is not permitted.<br>For repair of welds, the requirements for production welding above shall apply to the repair WPS. Repair welds shall be heat treated as per original production weld. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>Production hardness testing shall be performed in accordance with the requirements in ASTM A269/A269M. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished tubes shall be white pickled or bright annealed. Machined surfaces do not require pickling. |
| ***Marking*** | The tubes shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. S321 / S321S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Austenitic stainless steel, stabilized grade*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Seamless pipes** | ASTM A312/A312M | TP321H, TP347H | - | ASTM A312/A312M S6 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Chemical Composition*** | C ≤ 0,08 % | | | |
| ***Heat Treatment*** | Supplementary requirement S6 applies with the following requirement:<br>Stabilization heat treatment temperature shall be in the range of 815 °C to 900 °C. | | | |
| ***Tensile testing*** | Elongation shall be minimum 35 % | | | |
| ***Repair of defects*** | Weld repair is not permitted. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>Production hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on one length of pipe per lot. The maximum hardness shall be 22HRC from three readings taken in close proximity. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished pipes shall be white pickled or bright annealed. Machined surfaces do not require pickling. |
| ***Marking*** | The pipes shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition;<br>— Chemical composition |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. S322 / S322S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Austenitic stainless steel, stabilized grade*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Welded pipes** | ASTM A312/A312M | TP321H, TP347H | - | ASTM A312/A312M S6 |
| | ASTM A358/A358M | 321H, 347H | Class 1, 3, 4 or 5 | ASTM A358/A358M S5 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Chemical Composition*** | C ≤ 0,08 % | | | |
| ***Heat Treatment*** | Supplementary requirement ASTM A312/A312M S6 or ASTM A358/A358M S5 apply with the following requirement:<br>Stabilization heat treatment temperature shall be in the range of 815 °C to 900 °C. | | | |
| ***Tensile testing*** | Elongation shall be minimum 35 % | | | |
| ***Repair of defects*** | Weld repair of base material is not permitted.<br>For repair of welds, the requirements for production welding above shall apply to the repair WPS. Repair welds shall be heat treated as per original production weld. | | | |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: | | | |
| | *Hardness testing*<br>Production hardness testing shall be performed on one length of pipe per lot. The maximum hardness of the base material, HAZ and weld metal shall be 22HRC from three readings taken in close proximity at each location. | | | |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Surface treatment and finish*** | Finished pipes shall be white pickled or bright annealed. Machined surfaces do not require pickling. |
| ***Marking*** | The pipes shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition;<br>— Chemical composition |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. S323 / S323S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Austenitic stainless steel, stabilized grade*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Wrought fittings** | ASTM A403/A403M | WP321H, WP347H | W or S or WX | ASTM A403/A403M S2 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Chemical Composition*** | C ≤ 0,08 % | | | |
| ***Heat treatment*** | Supplementary requirement ASTM A403/A403M S2 shall apply.<br>During heat treatment fittings shall be placed in such a way as to ensure free circulation around each fitting during the heat treatment process including quenching operation. | | | |
| ***Tensile testing*** | Elongation shall be minimum 35 % | | | |
| ***Non-destructive testing*** | Ultrasonic testing is not acceptable as replacement for radiography. | | | |
| ***Repair of defects*** | Weld repair of base material is not acceptable.<br>For repair of welds, the requirements for production welding above shall apply to the repair WPS. Repair welds shall be heat treated as per original production weld. | | | |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements:<br>*Hardness testing*<br>— Seamless fittings:<br>— Production testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on one fitting per lot. The maximum hardness shall be 22HRC from three readings taken in close proximity.<br>— Welded fittings:<br>— Production testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on one fitting per lot. The maximum hardness of the base material, HAZ and weld metal shall be 22HRC from three readings taken in close proximity at each location.<br>The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Surface treatment and finish*** | Finished fittings shall be white pickled or bright annealed. Machined surfaces do not require pickling. |
| ***Marking*** | The fittings shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition<br>— Chemical composition. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. S324 / S324S [a]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Austenitic stainless steel, stabilized grade*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Forgings** | ASTM A182/A182M | F321H, F347H | - | ASTM A182/A182M S10 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Chemical Composition*** | C ≤ 0,08 % | | | |
| ***Heat treatment*** | Supplementary requirement ASTM A182/A182M S10 shall apply.<br>Forgings shall be placed in such a way as to ensure free circulation around each component during the heat treatment process including quenching operation. | | | |
| ***Tensile testing*** | Elongation shall be minimum 35 % | | | |
| ***Non-destructive testing*** | *Visual inspection*<br>VT shall be carried out on each forging or bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be white pickled prior to the testing. | | | |
| ***Repair of defects*** | Weld repair is not permitted. | | | |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: | | | |
| | *Hardness testing*<br>Production hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on one forging per lot. The maximum hardness shall be 22HRC from three readings taken in close proximity. | | | |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. | | | |
| ***Surface treatment and finish*** | Finished forgings shall be white pickled or bright annealed. Machined surfaces do not require pickling. | | | |
| ***Marking*** | The forgings shall be marked to ensure full traceability to heat and heat treatment lot. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| | |
|---|---|
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition<br>— Chemical composition |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. S325 / S325S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Austenitic stainless steel, stabilized grade*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| ***Plates, sheets, strips*** | ASTM A240/A240M | 321H, 347H | - | - |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Chemical Composition*** | C ≤ 0,08 % | | | |
| ***Heat Treatment*** | Following annealing, a stabilization heat treatment shall be carried out in the temperature range of 815 °C to 900 °C. | | | |
| ***Non-destructive testing*** | *Visual inspection*<br>VT shall be carried out on each plate in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing. | | | |
| ***Repair of defects*** | Weld repair is not permitted. | | | |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: | | | |
| | *Hardness testing*<br>Production hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on one plate per lot. The maximum hardness shall be 22HRC from three readings taken in close proximity. | | | |
| | The material shall be traceable in accordance with ISO 15156- 3/ ANSI/NACE MR0175 and this MDS. | | | |
| ***Surface treatment and finish*** | Finished plates shall be white pickled, descaled or bright annealed. | | | |
| ***Marking*** | The plates, sheets and strips shall be marked to ensure full traceability to heat and heat treatment lot. | | | |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1, shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition<br>— Chemical composition | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| Material Data Sheet | MDS No. S327 / S327S [a] | | | Rev. 1 |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Austenitic stainless steel, stabilized grade*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Bars** | ASTM A479/A479M | 321H, 347H | - | - |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Manufacturing*** | Bars shall be hot or cold finished cylindrical shaped with maximum diameter of 300 mm.<br>Cold finishing shall be restricted to turning, grinding or polishing (singly or in combination); cold drawing or cold forming is not permitted. | | | |
| ***Chemical Composition*** | C ≤ 0,08 % | | | |
| ***Heat treatment*** | Bars shall be supplied in the solution annealing conditions.<br>Stabilization heat treatment temperature shall be in the range of 815 °C to 900 °C.<br>Bars shall be placed in such a way as to ensure free circulation around each component during the heat treatment process including possible quenching operation. | | | |
| ***Tensile testing*** | Where tensile testing in both directions is required by this MDS, all tensile tests shall meet the specified properties of the referenced standard specification in both directions.<br>Elongation shall be minimum 35 %. | | | |
| ***Test sampling*** | The mid-length of axial (longitudinal) and tangential (transverse) tensile specimens shall be located at a distance equal to the bar outside diameter or minimum of 100 mm, whichever is the smallest from the end of the bar.<br>The centreline of tensile specimen shall be located at a distance from the bar surface in accordance with ASTM A370.<br>*Valve parts manufactured from bar*<br>For bars with outside diameter ≥ 100 mm intended for machining of valve parts, tensile testing shall be taken in both the longitudinal and transverse direction. | | | |
| ***Non-destructive testing*** | *Visual inspection*<br>VT shall be carried out on each bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing.<br>*NDT (PT) of valve parts manufactured from bar*<br>100 % penetrant testing to ASME BPVC V, article 6 shall apply to all finished parts. The testing shall be carried out after machining. Non-machined surfaces shall be white pickled prior to testing. All accessible external and internal surfaces shall be examined. The acceptance criteria shall be ASME BPVC VIII, Div. 1, appendix 8. | | | |
| ***Repair of defects*** | Weld repair is not permitted. | | | |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: | | | |
| | *Hardness testing*<br>Production hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on the end surface of one bar per lot. The maximum hardness shall be 22HRC from three readings taken in close proximity. | | | |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Surface treatment and finish*** | Finished parts shall be white pickled or bright annealed. Machined or peeled surfaces do not require pickling. |
| ***Marking*** | The bars shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition<br>— Chemical composition |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. S404 / S404S [a]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Austenitic stainless steel, 200-series*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Forgings** | ASTM A182/A182M | FXM-19 (UNS S20910) | | - |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Heat treatment*** | Forgings shall be placed in such a way as to ensure free circulation around each component during the heat treatment process including quenching operation. | | | |
| ***Non-destructive testing*** | *Visual inspection*<br>VT shall be carried out on each forging or bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be white pickled prior to the testing. | | | |
| ***Repair of defects*** | Weld repair is not permitted. | | | |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: | | | |
| | *Hardness testing*<br>Production hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on one forging per lot. The maximum hardness shall be 35HRC from three readings taken in close proximity. | | | |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. | | | |
| ***Surface treatment and finish*** | Finished forgings shall be white pickled or bright annealed. Machined surfaces do not require pickling. | | | |
| ***Marking*** | The forgings shall be marked to ensure full traceability to heat and heat treatment lot. | | | |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| Material Data Sheet | MDS No. S407 / S407S [a] | | | Rev. 1 |
|---|---|---|---|---|
| *TYPE OF MATERIAL: Austenitic stainless steel, 200-series* | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Forgings** | ASTM A276/A276M<br>ASTM A479/A479M | FXM-19 (UNS S20910) | - | - |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Manufacturing*** | Bars shall be hot finished cylindrical shaped with maximum diameter of 300 mm. | | | |
| ***Heat treatment*** | Bars shall be placed in such a way as to ensure free circulation around each component during the heat treatment process including quenching operation. | | | |
| ***Tensile testing*** | Where tensile testing in both directions is required by this MDS, all tensile tests shall meet the specified properties of the referenced standard specification in both directions. | | | |
| ***Test sampling*** | The mid-length of axial (longitudinal) and tangential (transverse) tensile specimens shall be located at a distance equal to the bar outside diameter or minimum of 100 mm, whichever is the smallest from the end of the bar.<br>The centreline of tensile specimen shall be located at a distance from the bar surface in accordance with ASTM A370.<br>*Valve parts manufactured from bar*<br>For bars with outside diameter ≥ 100 mm intended for machining of valve parts, tensile testing shall be taken in both the longitudinal and transverse direction. | | | |
| ***Non-destructive testing*** | Visual inspection<br>VT shall be carried out on each bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing.<br>NDT (PT) of valve parts manufactured from bar<br>100 % penetrant testing to ASME BPVC V, article 6 shall apply to all finished parts. The testing shall be carried out after machining. Non-machined surfaces shall be white pickled prior to testing. All accessible external and internal surfaces shall be examined. The acceptance criteria shall be ASME BPVC VIII, Div. 1, appendix 8. | | | |
| ***Repair of defects*** | Weld repair is not permitted. | | | |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: | | | |
| | *Hardness testing*<br>Production hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on one forging per lot. The maximum hardness shall be 35HRC from three readings taken in close proximity. | | | |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. | | | |
| ***Surface treatment and finish*** | Finished parts shall be white pickled or bright annealed. Machined surfaces do not require pickling. | | | |
| ***Marking*** | The bars shall be marked to ensure full traceability to heat and heat treatment lot. | | | |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| Material Data Sheet | MDS No. T101 / T101S [a] | | | Rev. 1 |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Titanium Grade 2*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Seamless pipes** | ASTM B861 | 2 (UNS R50400) | | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Qualification*** | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| ***Repair of defects*** | Repair welding is not permitted. | | | |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: | | | |
| | *Hardness testing*<br>Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on one length of pipe per lot. The maximum hardness shall be 100HRB from three readings taken in close proximity at each location. | | | |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. | | | |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— MPS identification or MPCR/QTR number used. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| Material Data Sheet | MDS No. T102 / T102S [a] | | | Rev. 1 |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Titanium Grade 2*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Welded pipes** | ASTM B862 | 2 (UNS R50400) | | ASTM B862 S1.2.1 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Qualification*** | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| ***Welding*** | Welding procedures shall be qualified in accordance with ISO 15614-5 or ASME BPVC IX. | | | |
| ***Non-destructive testing*** | Supplementary requirement ASTM B862 S1.2.1 shall apply to pipe with outside diameter 600 mm (24") and above. | | | |
| ***Repair of defects*** | Repair welding of base material is not permitted. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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|---|---|
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>— Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on one length of pipe per lot. The maximum hardness of the base material, HAZ and weld metal shall be 100HRB from three readings taken in close proximity at each location.<br>— Welding procedure qualification testing for manufacturing and any repair welding shall meet the requirements of ISO 15156-3 / ANSI/NACE MR0175 with a maximum hardness of 70,8HR 15N or 250HV. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— MPS identification or MPCR/QTR number used. |
| [a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service. | |

| **Material Data Sheet** | **MDS No. T103 / T103S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Titanium Grade 2*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Wrought fittings** | ASTM B363 | WPT2 / WPT2W (UNS R50400) | | ASTM B363 S1, S2 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Qualification*** | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| ***Heat treatment*** | Annealed condition unless the tensile properties in the referenced standard can be achieved in the as formed condition. | | | |
| ***Extent of testing*** | Tensile test specimens shall be taken from each heat and heat treatment lot, for each type and size. | | | |
| ***Non-destructive testing*** | *Liquid penetrant testing*<br>Supplementary requirements S1, penetrant testing, shall apply to:<br>— 10 % of seamless or minimum one item per lot in any purchase order.<br>— 100 % of welded fittings above NPS 2.<br>The testing shall be carried out after calibration and machining. Non machined surfaces shall be cleaned prior to testing. For welded fittings the testing shall cover the weld only. The acceptance criteria shall be ASME BPVC VIII, Div. 1, Appendix 8.<br>*Radiographic testing*<br>Supplementary requirement S2 shall apply to fittings with outside diameter 600 mm (24") and above. | | | |
| [a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service. | | | | |

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| ***Repair of defects*** | Repair welding of base material is not permitted.<br>For repair of welds, the requirements for production welding shall apply to the repair WPS. Repair welds shall be heat treated as per original production weld (if applicable). |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>— Seamless fittings:<br>— Production testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on one fitting per lot. The maximum hardness shall be 100HRB from three readings taken in close proximity.<br>— Welded fittings:<br>— Welding procedure qualification testing for manufacturing and any repair welding shall meet the requirements of ISO 15156-3 / ANSI/NACE MR0175 with a maximum hardness of 70,8HR 15N or 250HV.<br>— Production testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on one fitting per lot. The maximum hardness of the base material, HAZ and weld metal shall be 100HRB from three readings taken in close proximity at each location. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— MPS identification or MPCR/QTR number used. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. T104 / T104S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Titanium Grade 2*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Forgings** | ASTM B381 | F2 (UNS R50400) | | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Qualification*** | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| ***Extent of testing*** | Tensile test specimens shall be taken from each heat and heat treatment lot, with a maximum deviation from the test block thickness of ±10 mm. | | | |
| ***Repair of defects*** | Repair welding is not permitted. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on one forging per lot. The maximum hardness shall be 100HRB from three readings taken in close proximity at each location. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— MPS identification or MPCR/QTR number used. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. T105 / T105S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Titanium Grade 2*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Plates, sheets, strips** | ASTM B265 | 2 (UNS R50400) | | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Qualification*** | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| ***Repair of defects*** | Repair welding is not permitted. | | | |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: | | | |
| | *Hardness testing*<br>Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on one plate per lot. The maximum hardness shall be 100HRB from three readings taken in close proximity at each location. | | | |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. | | | |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— MPS identification or MPCR/QTR number used. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| Material Data Sheet | MDS No. T106 / T106S [a] | | | Rev. 1 |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Titanium Grade 2*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Castings** | ASTM B367 | C2 (UNS R52550) | | ASTM B367 S7 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Qualification*** | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| ***Manufacturing*** | All castings shall be subject to hot isostatic pressing (HIP). | | | |
| ***Heat treatment*** | All castings, which due to size limitations cannot be HIP, shall be heat treated and radiographed. Heat treatment is also required for all weld repairs carried out after HIP.<br>When the HIP operation is applied, this shall be in accordance with ASTM A1080/A1080M. | | | |
| ***Extent of testing*** | Tensile testing is required for each heat and HIP batch or heat treatment load. | | | |
| ***Test sampling*** | Samples for production testing shall be cut from the gating system of the casting. For castings with weight 150 kg and above, the test blocks shall be integrally cast with the casting.<br>Size of the test block shall be 140 mm in length and 80 mm in height with thickness (T):<br>— T = 22 mm for t ≤ 30 mm<br>— T = 50 mm for 30 mm < t ≤ 60 mm<br>— T = 75 mm for t > 60 mm<br>t = section (shell) thickness of castings, for flanged castings, the largest flange thickness is the ruling thickness.<br>Test samples shall accompany the castings through HIP and any heat treatment, chemical cleaning process or any other operation that may alter metallurgical or mechanical properties. | | | |
| ***Non-destructive testing*** | *General*<br>For definition and NDT of pilot castings reference is made the general part of this document.<br>Non-machined surfaces shall be cleaned prior to testing.<br>*Visual inspection*<br>Visual testing shall be carried out on each casting in accordance with ANSI/MSS SP-55. The testing shall be performed after final machining.<br>*Liquid penetrant testing*<br>Testing shall be carried out in accordance with ASME BPVC V, Article 6. Each pilot and production casting shall be tested after final machining at all accessible surfaces, including all accessible internal surfaces. Non-machined surfaces shall be cleaned prior to the testing.<br>Acceptance criteria shall be according to ASME BPVC VIII, Div. 1, Appendix 7. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

<table>
<tr><td>Non-destructive testing</td><td>
<u>Radiographic testing</u><br>
— Method of radiography of radiography shall be according to ASME BPVC V, Article 2 and acceptance criteria shall be in accordance with ASME BPVC VIII, Div. 1, Appendix 7.<br>
— 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.<br>
— Sketches of the areas to be tested shall be established and agreed with the purchaser.<br>
— When random testing (5 %) is specified, minimum one casting of each pattern including feeder and riser system in any purchase order with the foundry shall be examined.<br>
— 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.<br>
— Pilot castings shall be radiographed to the extent described above.<br>
— Frequency of RT of valve castings shall be according to table below.
<table>
<tr><td colspan="6">Frequency of RT based on pressure class and nominal outside diameter:</td></tr>
<tr><td colspan="2">Pressure class:</td><td>≤ 300</td><td>600</td><td>900</td><td>≥ 1 500</td></tr>
<tr><td rowspan="3">Frequency of RT</td><td>Not required</td><td>< 10”</td><td colspan="3">< 2”</td></tr>
<tr><td>5 %</td><td>≥ 10”</td><td colspan="3">≥ 2”</td></tr>
<tr><td>100 %</td><td>Not applicable</td><td>≥ 20”</td><td>≥ 16”</td><td>≥ 6”</td></tr>
</table>
Non-valve 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.
</td></tr>
<tr><td>Repair of defects</td><td>
All major repairs shall be documented, where a major repair is defined as excavations exceeding 20 % of the casting section or wall thickness, and/or 4 % of the casting surface area.<br>
Weld repairs are not acceptable for castings that leak during pressure testing.<br>
All major repairs shall be documented with a sketch showing location and size of excavations.<br>
A change of filler metal brand names requires requalification.<br>
Repairs by peening and impregnation are prohibited.<br>
The repair welding procedure shall be qualified in accordance with ISO 15614-5 or ASME BPVC IX and this MDS.
</td></tr>
<tr><td>Sour service (additional metallurgical, manufacturing, testing and certification requirements)[a]</td><td>
Material covered by this MDS is not referenced in the ISO 15156 series / ANSI/NACE MR0175.<br>
Use of this material in sour service shall require separate qualification according to ISO 15156-3 / ANSI/NACE MR0175.
</td></tr>
<tr><td></td><td>
The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS.<br>
The inspection documents required in this MDS shall also include the qualification test reports.
</td></tr>
<tr><td>Surface treatment and finish</td><td>
For castings manufactured to this MDS alfa-case in the casting surface shall be completely removed at the foundry from the following locations:<br>
— All surfaces, which shall be machined.<br>
— All weld bevels including an area of 20 mm on each side of the bevel.<br>
— All highly stressed areas including areas prone to fatigue.
</td></tr>
<tr><td colspan="2">[a] The supplementary suffix “S” shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.</td></tr>
</table>

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|---|---|
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— MPS identification or MPCR/QTR number used. |
| [a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service. | |

| **Material Data Sheet** | **MDS No. T107 / T107S [a]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Titanium Grade 2*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Bars** | ASTM B348 | 2 (UNS R50400) | | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Qualification*** | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| ***Manufacturing*** | Applicable to bars used for manufacture of valve parts. Such parts may be machined from bar under the following conditions:<br>— Purchaser's acceptance shall be obtained in each case.<br>— The parts shall be tested and certified according to this MDS with the following amendments:<br>— The bar diameter is less than 300 mm;<br>— For bars with outside diameter ≥ 100 mm intended for machining of valve parts, one tensile test specimen shall be taken in both the longitudinal and transverse direction.<br>— 100 % penetrant testing to ASTM A363 SR S1 shall apply to all finished parts. The acceptance criteria shall be ASME BPVC VIII, Div. 1, Appendix 8. | | | |
| ***Extent of testing*** | Tensile test specimens shall be taken from each heat and heat treatment lot. | | | |
| ***Non-destructive testing*** | *Visual inspection*<br>VT shall be carried out on each bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing. | | | |
| ***Repair of defects*** | Repair welding is not permitted. | | | |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: | | | |
| | *Hardness testing*<br>Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on the end surface of one bar per lot. The maximum hardness shall be 100HRB from three readings taken in close proximity. | | | |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. | | | |
| [a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service. | | | | |

| | |
|---|---|
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— MPS identification or MPCR/QTR number used. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. T108 / T108S [a]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Titanium Grade 2*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Tubes** | ASTM B338 | 2 (UNS R50400) | | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Qualification*** | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| ***Repair of defects*** | Repair welding of base material is not permitted.<br>For repair of welds, the requirements for production welding shall apply to the repair WPS. Repair welds shall be heat treated as per original production weld (if applicable) | | | |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: | | | |
| | *Hardness testing*<br>Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on one tube per lot. The maximum hardness shall be 100HRB from three readings taken in close proximity. | | | |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. | | | |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— MPS identification or MPCR/QTR number used. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. V101 / V101S [a] / V101K [b]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL:* 1¼ Cr ½ Mo alloy steel** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Seamless pipes** | ASTM A335/A335M | P11 (UNS K11597) | - | ASTM A335/A335M S2 |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

[b] The supplementary suffix "K" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for hydrogen service.

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| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. |
| ***Metal making*** | For pipes with governing thickness 50 mm and greater, the steel shall be vacuum degassed and made to fine grain practice. |
| ***Chemical composition*** | For pipes with governing thickness 50 mm and greater, the requirements of API RP 934-C shall apply. |
| ***Heat treatment*** | Minimum tempering temperature shall be 725 °C. |
| ***Tensile testing*** | Supplementary requirement S2 shall apply on one specimen per finished pipe per lot. Specimen shall be removed from mid-thickness location. |
| ***Hardness testing*** | Hardness testing shall be made on one finished pipe per lot and shall not exceed 225 HBW. |
| ***Extent of testing*** | Product analysis shall be carried out in accordance with the standard. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Chemical composition*<br>S ≤ 0,010 % |
| | *Hardness testing*<br>Production hardness testing shall be performed in accordance with the requirements in ASTM A370/A1058 on one length of pipe per lot. |
| | The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS. |
| ***Hydrogen service (additional metallurgical, manufacturing, testing and certification requirements) b*** | When hydrogen service requirements are specified by the purchaser, the material shall conform to the following additional requirements in the MDS.<br>Products shall be delivered in the normalized and tempered or quenched and tempered condition.<br>Tensile testing and impact testing shall be carried out in accordance with API RP 934-C. |
| ***Marking*** | The pipes shall be marked to ensure full traceability to melt and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser. |
| | The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition including tempering temperature and holding time shall be stated. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

[b] The supplementary suffix "K" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for hydrogen service.

| **Material Data Sheet** | **MDS No. V102 / V102S [a] / V102SH [b] / V102K [c]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: 1¼ Cr ½ Mo alloy steel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

[b] The supplementary suffix "SH" shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

[c] The supplementary suffix "K" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for hydrogen service.

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| **Welded pipes** | ASTM A691/A691M | 1 ¼ Cr (UNS K11789) | Class 22 or Class 42 | ASTM A691/A691M S3, S7, S12 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Metal making*** | Starting plate material shall conform with ASTM A387/A387M Grade 11 Class 1.<br>For pipes with governing thickness 50 mm and greater, the steel shall be vacuum degassed and made to fine grain practice. | | | |
| ***Manufacturing*** | The longitudinal weld shall be straight.<br>Welds shall be made using the SAW process. | | | |
| ***Chemical composition*** | For pipes with governing thickness 50 mm and greater, the requirements of API RP 934-C shall apply. | | | |
| ***Heat treatment*** | For Class 22 pipes, the starting plate shall be in the normalized and tempered or quenched and tempered conditions.<br>Tempering temperature shall be minimum 725 °C. | | | |
| ***Hardness testing*** | Supplementary requirement S3 shall apply on one finished pipe per lot. | | | |
| ***Extent of testing*** | Mechanical testing shall be carried out on one finished pipe per lot. Supplementary requirement S12 shall apply for lot definition. | | | |
| ***Non-destructive testing*** | Radiographic examination shall be performed after heat treatment.<br>Supplementary requirement S7 shall apply. Acceptance criteria shall be according to ASME BPVC VIII, Div. 1, Appendix 6. Examination shall be performed after calibration. | | | |
| ***Repair of defects*** | Weld repair is not permitted. | | | |
| | Repairs to weld metal are acceptable in accordance with the standard specification and shall meet the chemistry requirements of the original manufacturing weld. | | | |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a,b] | Class 42 pipes shall be used in sour service.<br>When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: | | | |
| | *Chemical composition*<br>S ≤ 0,003 % | | | |
| | *Hardness testing*<br>In addition to the production hardness requirement in the MDS, welding procedure qualification testing for manufacturing and any repair welding shall meet the requirements of ANSI/NACE MR0175/ISO 15156-2:2020, 7.3.3, using Vickers method, with a maximum hardness of 235HV. | | | |
| | The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS. | | | |
| | HIC testing and UT examination<br>When suffix SH applies, one plate per lot shall be tested as follows.<br>— HIC testing:<br>HIC testing in accordance with NACE TM0284, using Test Solution A.<br>Acceptance criteria per specimen shall be CLR ≤ 15 %, CTR ≤ 5 %, CSR ≤ 2 %.<br>Maximum individual crack length shall be reported for each section.<br>— UT examination:<br>ASTM A691/A691M, S10 shall apply. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

[b] The supplementary suffix "SH" shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

[c] The supplementary suffix "K" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for hydrogen service.

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| ***Hydrogen service (additional metallurgical, manufacturing, testing and certification requirements)*** [c] | When hydrogen service requirements are specified by the purchaser, the material shall conform to the following additional requirements in the MDS.<br>Products shall be delivered in the normalized and tempered or quenched and tempered condition.<br>Tensile testing and impact testing shall be carried out in accordance with API RP 934-C. |
| ***Marking*** | The pipes shall be marked to ensure full traceability to melt and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser. |
| | The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition including stress relieving PWHT temperature or tempering temperature and holding time shall be stated. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

[b] The supplementary suffix "SH" shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

[c] The supplementary suffix "K" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for hydrogen service.

| **Material Data Sheet** | **MDS No. V103/ V103S [a] / V103SH [b] / V103K [c]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: 1¼ Cr ½ Mo alloy steel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Wrought fittings** | ASTM A234/A234M | WP11, WP11W | Class 1 or Class 2 | ASTM A960/A960M S51, S53, S69 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Metal making*** | For fittings with governing thickness 50 mm and greater, the steel shall be vacuum degassed and made to fine grain practice. | | | |
| ***Chemical composition*** | For fittings with governing thickness 50 mm and greater, the requirements of API RP 934-C shall apply. | | | |
| ***Heat treatment*** | Tempering temperature shall be minimum 725 °C.<br>All hot formed or forged fittings, including those manufactured by locally heating a portion of the fitting stock, shall be heat treated after manufacture.<br>During the heat treatment process, fittings shall be placed in such a way as to ensure free circulation around each fitting including any quenching operation. | | | |
| ***Tensile testing*** | ASTM A960/A960M supplementary requirement S51 shall apply as amended by this MDS.<br>Tensile testing shall be carried out on specimens cut from a fitting where dimensions permit. When removal of specimens is not possible due to the size of the fitting, a prolongation or a length of starting material that has been heat treated in the same heat treatment load as the fittings it represents shall be used. | | | |
| ***Hardness testing*** | Hardness testing shall be carried out on two fittings for each test lot, including parent material, weld and HAZ. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

[b] The supplementary suffix "SH" shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

[c] The supplementary suffix "K" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for hydrogen service.

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| ***Non-destructive testing*** | ASTM A960/A960M supplementary requirement S53 and S69 shall apply as amended by this MDS. Acceptance criteria shall be according to ASME BPVC VIII, Div. 1, Appendix 6. Examination shall be performed after final heat treatment and after final machining or calibration.<br>NDT shall be carried out after final heat treatment. |
| ***Repair of defects*** | Weld repair of the base material is not permitted. |
| | Repairs to weld metal are acceptable in accordance with the standard specification and shall meet the chemistry requirements of the original manufacturing weld. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a,b] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Chemical composition*<br>S ≤ 0,003 % for WP11W fitting made from flat-rolled products<br>S ≤ 0,007 % for WP11 fitting made from forging |
| | *Hardness testing*<br>For WP11W fittings, in addition to the production hardness requirement in the MDS, welding procedure qualification testing for manufacturing and any repair welding shall meet the requirements of ANSI/NACE MR0175/ISO 15156-2, 7.3.3, using Vickers method, with a maximum hardness of 235HV. |
| | The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS. |
| | *HIC testing and UT examination*<br>When suffix SH applies, one finished WPBW fitting made from flat-rolled products per lot shall be tested as follows.<br>— HIC testing:<br>— HIC testing in accordance with NACE TM0284, using Test Solution A.<br>— Acceptance criteria per specimen shall be CLR ≤ 15 %, CTR ≤ 5 %, CSR ≤ 2 %.<br>— Maximum individual crack length shall be reported for each section.<br>— UT testing of flat-rolled product before manufacture:<br>— ASTM A578/A578M S1, S2.1 shall apply. |
| ***Hydrogen service (additional metallurgical, manufacturing, testing and certification requirements)*** [c] | When hydrogen service requirements are specified by the purchaser, the material shall conform to the following additional requirements in the MDS.<br>Products shall be delivered in the normalized and tempered or quenched and tempered condition.<br>Impact testing<br>Impact testing shall be carried out in accordance with API RP 934-C. |
| ***Marking*** | The fittings shall be marked to ensure full traceability to melt and heat treatment lot. |

[a] The supplementary suffix “S” shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

[b] The supplementary suffix “SH” shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

[c] The supplementary suffix “K” shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for hydrogen service.

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| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser. |
| | The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition including tempering temperature and holding time shall be stated. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

[b] The supplementary suffix "SH" shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

[c] The supplementary suffix "K" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for hydrogen service.

| **Material Data Sheet** | **MDS No. V104/ V104S [a] / V104K [b]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: 1¼ Cr ½ Mo alloy steel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Forgings** | ASTM A182/A182M | F11 | Class 2 | ASTM A961/A961M S55 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Metal making*** | Forgings with governing thickness 50 mm and greater shall be manufactured from steel vacuum degassed and made to fine grain practice. | | | |
| ***Chemical composition*** | For forgings with governing thickness 50 mm and greater, the requirements of API RP 934-C shall apply. | | | |
| ***Heat treatment*** | Tempering temperature shall be minimum 725 °C.<br>During the heat treatment process, forgings shall be placed in such a way as to ensure free circulation around each fitting including any quenching operation. | | | |
| ***Non-destructive testing*** | 10 % of all forgings per lot or a minimum of one item per lot in any purchase order shall be examined with magnetic particle testing. All accessible internal and external surfaces shall be examined according to ASTM A961/A961M supplementary requirement S55. Acceptance criteria shall be according to ASME BPVC VIII, Div. 1, Appendix 6. Examination shall be performed after final heat treatment and final machining. | | | |
| ***Repair of defects*** | Weld repair is not permitted. | | | |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements) [a]*** | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: | | | |
| | The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS. | | | |
| ***Hydrogen service (additional metallurgical, manufacturing, testing and certification requirements) [b]*** | When hydrogen service requirements are specified by the purchaser, the material shall conform to the following additional requirements in the MDS.<br>Products shall be delivered in the normalized and tempered or quenched and tempered condition.<br>Tensile testing and impact testing shall be carried out in accordance with API RP 934-C.<br>Sketches shall be established showing type, and size of test samples and location for extraction of test specimens. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

[b] The supplementary suffix "K" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for hydrogen service.

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| ***Marking*** | The forgings shall be marked to ensure full traceability to melt and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser. |
| | The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition including tempering temperature and holding time shall be stated.<br>— Sketches for test sampling. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

[b] The supplementary suffix "K" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for hydrogen service.

| **Material Data Sheet** | **MDS No. V105 / V105S [a] / V105SH [b] / V105K [c]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: 1¼ Cr ½ Mo alloy steel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Plates** | ASTM A387/A387M | 11 (UNS K11789) | Class 1 or Class 2 | ASTM A387/A387M S53 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Metal making*** | Steel plate with thickness 50 mm and greater shall be vacuum degassed and made to fine grain practice. | | | |
| ***Chemical composition*** | For plate with thickness 50 mm and greater, the requirements of API RP 934-C shall apply. | | | |
| ***Heat treatment*** | Tempering temperature shall be minimum 725 °C.<br>During the heat treatment process, plates shall be placed in such a way as to ensure free circulation around each fitting including any quenching operation. | | | |
| ***Hardness testing*** | Hardness testing shall be carried out on in accordance with ASTM A370 on one plate per lot. Hardness shall not exceed 197HBW. | | | |
| ***Test Sampling*** | Supplementary requirement S53 shall apply. Specimens shall be oriented transverse to the final rolling direction. | | | |
| ***Non-destructive testing*** | *Visual inspection*<br>VT shall be carried out on each plate in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing. | | | |
| ***Repair of defects*** | Weld repair is not permitted. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

[b] The supplementary suffix "SH" shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

[c] The supplementary suffix "K" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for hydrogen service.

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| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a,b] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Chemical composition*<br>S ≤ 0,003 % |
| | The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS. |
| | HIC testing and UT examination<br>When suffix SH applies, one plate per lot shall be tested as follows.<br>— HIC testing:<br>HIC testing in accordance with NACE TM0284, using Test Solution A.<br>Acceptance criteria per specimen shall be CLR ≤ 15 %, CTR ≤ 5 %, CSR ≤ 2 %.<br>Maximum individual crack length shall be reported for each section.<br>— UT examination:<br>ASTM A387/A387M supplementary requirement S8 shall apply. |
| ***Hydrogen service (additional metallurgical, manufacturing, testing and certification requirements)*** [c] | When hydrogen service requirements are specified by the purchaser, the material shall conform to the following additional requirements in the MDS.<br>Products shall be delivered in the normalized and tempered or quenched and tempered condition.<br>Tensile testing and impact testing shall be carried out in accordance with API RP 934-C. |
| ***Marking*** | The plates shall be marked to ensure full traceability to melt and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser. |
| | The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition. Tempering temperature and holding time shall be stated. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

[b] The supplementary suffix "SH" shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

[c] The supplementary suffix "K" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for hydrogen service.

| **Material Data Sheet** | **MDS No. V106 / V106S [a] / V106K [b]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL:*** **1¼ Cr ½ Mo alloy steel** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Castings** | ASTM A217/A217M | WC6 (UNS J12072) | - | ASTM A217/A217M S4, S5, S21, S52.2<br>ASTM A703/A703M S14, S20 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

[b] The supplementary suffix "K" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for hydrogen service.

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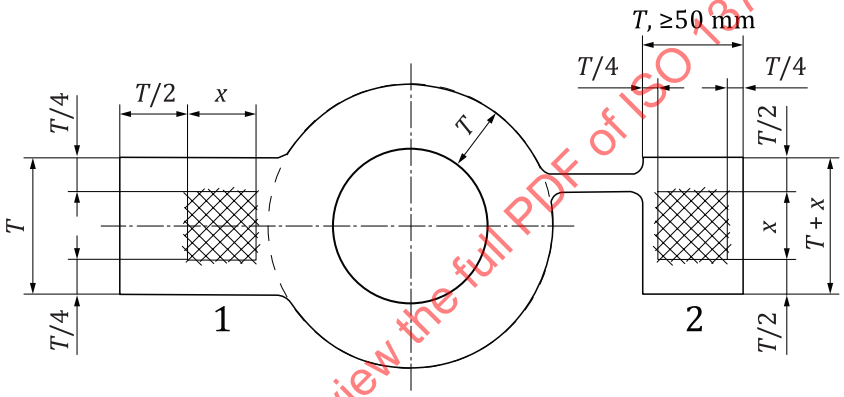
| ***Chemical composition*** | Supplementary requirement ASTM A217/A217M S52.2 shall apply. |
| ***Heat treatment*** | Tempering temperature shall be minimum 725 °C.<br>During the heat treatment process, castings shall be placed in such a way as to ensure free circulation around each item. |
| ***Extent of testing*** | ASTM A703/A703M supplementary requirement S14 shall apply. |
| ***Test sampling*** | For castings with a weight of 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. including any post weld stress relieving.<br>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.<br>Dimensions of test blocks and location of test specimens within the test blocks are shown in the figure below for integral and gated test block. 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.<br>  <br>1 integrated test block<br>2 gated test block |
| ***Non-destructive testing*** | *General*<br>For definition and NDT of pilot castings reference is made the general part of this document.<br>Non-machined surfaces shall be cleaned prior to testing.<br>*Visual inspection*<br>Visual testing shall be carried out on each casting in accordance with ANSI/MSS SP-55. The testing shall be performed after final machining.<br>*Radiographic testing*<br>ASTMA351/A351M supplementary requirement S5 shall apply as amended by this MDS:<br>— Method of radiography of radiography shall be according to ASME BPVC V, Article 2 and acceptance criteria shall be in accordance with ASME BPVC VIII, Div. 1, Appendix 7.<br>— 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.<br>— Sketches of the areas to be tested shall be established and agreed with the purchaser. |

[a] The supplementary suffix “S” shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

[b] The supplementary suffix “K” shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for hydrogen service.

— When random testing (5 %) 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.

— Pilot castings shall be radiographed to the extent described above.

— Frequency of RT of valve castings shall be according to table below.

| *Frequency of RT based on pressure class and nominal outside diameter:* | | | | | |
|---|---|---|---|---|---|
| *Pressure class:* | | *≤ 300* | *600* | *900* | *≥ 1 500* |
| *Frequency of RT* | Not required | < 10” | < 2” | | |
| | 5 % | ≥ 10” | ≥ 2” | | |
| | 100 % | Not applicable | ≥ 20” | ≥ 16” | ≥ 6” |

Non-valve 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.

*Magnetic particle testing*

ASTM A217/A217M supplementary requirement S4 shall apply as amended by this MDS:

Surface testing and acceptance criteria shall be in accordance with ASME BPVC VIII, Div. 1, Appendix 7.

Each pilot and production casting shall be tested after final machining at all accessible external and internal surfaces. Non-machined surfaces shall be cleaned prior to the testing.

***Repair of defects***

All major repairs, as defined by ASTM A217/A217M, shall be documented in accordance with ASTM A703/A703M S20.2.

The repair welding procedure shall be qualified in accordance with ASTM A488/A488M or ISO 11970 and this MDS:

— Welding procedure shall be qualified on casting or plate of the same cast material grade as used in production;

— Testing methodology and acceptance criteria shall be in accordance with the requirements of this MDS for the parent material.

Weld repairs are not acceptable for castings that leak during pressure testing.

Stress relieving PWHT shall be required after all major weld repair.

If a minor cosmetic repair is required to a semi-finished or finished cast component, PWHT may be omitted provided the welding procedure meets all the test requirements of this data sheet in the as-welded condition and preheat is applied according to the standard.

The weld metal composition shall conform with the following requirement:

10P + 5Sb + 4Sn + As ≤ 1 500 (values in mg/Kg)

C ≤ 0,15 %, Cu ≤ 0,20 %, Ni ≤ 0,30 %

[a] The supplementary suffix “S” shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

[b] The supplementary suffix “K” shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for hydrogen service.

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| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>Production hardness testing shall be performed in accordance with the requirements in ASTM A370/A1058 on the pilot casting and one casting per lot thereafter. The maximum hardness shall be 22HRC from three readings taken in close proximity. |
| | The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS. |
| ***Hydrogen service (additional metallurgical, manufacturing, testing and certification requirements) b*** | When hydrogen service requirements are specified by the purchaser, the material shall conform to the following additional requirements in the MDS.<br>Tensile testing and impact testing shall be carried out in accordance with API RP 934-C. |
| ***Marking*** | The castings shall be marked to ensure full traceability to melt and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser. |
| | The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition including tempering temperature and holding time shall be stated. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

[b] The supplementary suffix "K" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for hydrogen service.

| **Material Data Sheet** | **MDS No. V107 / V107S [a] / V107K [b]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: 1¼ Cr ½ Mo alloy steel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Bars** | ASTM A739 | B11 | - | - |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.<br>This MDS includes additional requirements for valve parts DN 100 (NPS 4) and under manufactured from bars, when permitted by the valve specification. | | | |
| ***Metal making*** | For bar thickness 50 mm and greater the steel shall be vacuum degassed and made to fine grain practice. | | | |
| ***Chemical composition*** | For bar thickness 50 mm and greater, the following requirements shall apply:<br>10P + 5Sb + 4Sn + As ≤ 1 500 (values in mg/kg)<br>C ≤ 0,15 %, P ≤ 0,010 %, S ≤ 0,007 %, Cu ≤ 0,20 %, Ni ≤ 0,30 % | | | |
| ***Heat treatment*** | Tempering temperature shall be minimum 725 °C.<br>During the heat treatment process, bars shall be placed in such a way as to ensure free circulation around each bar including any quenching operation. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

[b] The supplementary suffix "K" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for hydrogen service.

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| ***Hardness testing*** | Hardness testing shall be carried out on in accordance with ASTM A370 on the end surface of one bar per lot. The maximum hardness shall not exceed 207HBW. |
| ***Test sampling*** | *Valve parts manufactured from bar*<br>Sampling of test specimens for bars intended for machining of valve parts shall conform with the following requirements:<br>— The mid-length of the axial tensile specimens shall be located at a distance equal to the bar outside diameter or minimum of 100 mm, whichever is the greater, from the end of the bar, and the centreline of the specimen shall be located at mid thickness (1/2 OD).<br>— The centreline of the tangential tensile specimens shall be located at mid thickness (1/2 OD) and the mid-point of the specimens at a minimum of 100 mm from the end of the bar.<br>— For bar with outside diameter < 100 mm: one tensile specimen and one set of impact test specimens shall be taken.<br>— For bar with outside diameter ≥ 100 mm: one tensile specimen and one set of impact test specimens shall be taken in axial direction of the bar. In addition, one tensile test specimen and one set of impact test specimens shall be taken in tangential direction of the bar.<br>— The specified minimum tensile strength of the referenced standard shall be met in both directions. |
| ***Non-destructive testing*** | *Visual inspection*<br>VT shall be carried out on each bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing. |
| | *NDT (MT) of valve parts manufactured from bar*<br>Inspection shall be according to the applicable valve specification or as specified below.<br>100 % magnetic particle testing of all accessible internal and external surfaces shall be carried out in accordance with ASME BPVC V, article 7 or ASTM A961/A961M supplementary requirement S55. Acceptance criteria shall be according to ASME BPVC VIII, Div. 1, appendix 6. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS. |
| ***Hydrogen service (additional metallurgical, manufacturing, testing and certification requirements)*** [b] | When hydrogen service requirements are specified by the purchaser, the material shall conform to the following additional requirements in the MDS.<br>Products shall be delivered in the normalized and tempered or quenched and tempered condition.<br>Tensile testing and impact testing shall be carried out in accordance with API RP 934-C. |
| ***Marking*** | The bars shall be marked to ensure full traceability to melt and heat treatment lot. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

[b] The supplementary suffix "K" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for hydrogen service.

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| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser. |
| | The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition including tempering temperature and holding time shall be stated. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

[b] The supplementary suffix "K" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for hydrogen service.

| **Material Data Sheet** | **MDS No. V201 / V201S [a] / V201K [b]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: 2¼ Cr 1 Mo alloy steel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Seamless pipes** | ASTM A335/A335M | P22 (UNS K21590) | - | - |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Metal making*** | For pipes with governing thickness 50 mm and greater, the steel shall be vacuum degassed and made to fine grain practice. | | | |
| ***Chemical composition*** | For pipes with governing thickness 50 mm and greater, the requirements of API RP 934-A shall apply. | | | |
| ***Heat treatment*** | Minimum tempering temperature shall be 725 °C. | | | |
| ***Hardness testing*** | Hardness testing shall be made on one finished pipe per lot and shall not exceed 235 HBW. | | | |
| ***Extent of testing*** | Product analysis shall be carried out in accordance with the standard. | | | |
| ***Repair of defects*** | Weld repair is not permitted. | | | |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements) [a]*** | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: | | | |
| | *Chemical composition*<br>S ≤ 0,010 % | | | |
| | The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS. | | | |
| ***Hydrogen service (additional metallurgical, manufacturing, testing and certification requirements) b*** | When hydrogen service requirements are specified by the purchaser, the material shall conform to the following additional requirements in the MDS.<br>Products shall be delivered in the normalized and tempered or quenched and tempered condition.<br>Tensile testing and impact testing shall be carried out in accordance with API RP 934-A. | | | |
| ***Marking*** | The pipes shall be marked to ensure full traceability to melt and heat treatment lot. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

[b] The supplementary suffix "K" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for hydrogen service.

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| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser. |
| | The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition including tempering temperature and holding time shall be stated. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

[b] The supplementary suffix "K" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for hydrogen service.

| **Material Data Sheet** | **MDS No. V202 / V202S [a] / V202SH [b] / V202K [c]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: 2¼ Cr 1 Mo alloy steel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Welded pipes** | ASTM A691/A691M | 2 ¼ Cr (UNS K21590) | Class 22 or Class 42 | ASTM A691/A691M S3, S7, S12 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Metal making*** | For pipes with governing thickness 50 mm and greater, the steel shall be vacuum degassed and made to fine grain practice. | | | |
| ***Manufacturing*** | The longitudinal weld shall be straight.<br>Welds shall be made using the SAW process. | | | |
| ***Chemical composition*** | For pipes with governing thickness 50 mm and greater, the requirements of API RP 934-A shall apply. | | | |
| ***Heat treatment*** | For Class 22 pipes, the starting plate shall be in the normalized and tempered or quenched and tempered conditions.<br>Tempering temperature shall be minimum 725 °C. | | | |
| ***Hardness testing*** | Supplementary requirement S3 shall apply on one finished pipe per lot. | | | |
| ***Extent of testing*** | Mechanical testing shall be carried out on one finished pipe per lot. Supplementary requirement S12 shall apply for lot definition. | | | |
| ***Non-destructive testing*** | Radiographic examination shall be performed after heat treatment.<br>Supplementary requirement S7 shall apply. Acceptance criteria shall be according to ASME BPVC VIII, Div. 1, Appendix 6. Examination shall be performed after calibration. | | | |
| ***Repair of defects*** | Weld repair is not permitted. | | | |
| | Repairs to weld metal are acceptable in accordance with the standard specification and shall meet the chemistry requirements of the original manufacturing weld. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

[b] The supplementary suffix "SH" shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

[c] The supplementary suffix "K" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for hydrogen service.

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|---|---|
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a,b] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Chemical composition*<br>S ≤ 0,003 % |
| | *Hardness testing*<br>In addition to the production hardness requirement in the MDS, welding procedure qualification testing for manufacturing and any repair welding shall meet the requirements of ANSI/NACE MR0175/ISO 15156-2, 7.3.3, using Vickers method, with a maximum hardness of 225HV. |
| | The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS. |
| | HIC testing and UT examination<br>When suffix SH applies, one plate per lot shall be tested as follows.<br>— HIC testing:<br>HIC testing in accordance with NACE TM0284, using Test Solution A.<br>Acceptance criteria per specimen shall be CLR ≤ 15 %, CTR ≤ 5 %, CSR ≤ 2 %.<br>Maximum individual crack length shall be reported for each section.<br>— UT examination:<br>ASTM A691/A691M S10 shall apply. |
| ***Hydrogen service (additional metallurgical, manufacturing, testing and certification requirements)*** [c] | When hydrogen service requirements are specified by the purchaser, the material shall conform to the following additional requirements in the MDS.<br>Products shall be delivered in the normalized and tempered or quenched and tempered condition.<br>Tensile testing and impact testing shall be carried out in accordance with API RP 934-A. |
| ***Marking*** | The pipes shall be marked to ensure full traceability to melt and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser. |
| | The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition including stress relieving PWHT temperature or tempering temperature and holding time shall be stated. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

[b] The supplementary suffix "SH" shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

[c] The supplementary suffix "K" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for hydrogen service.



| **Material Data Sheet** | **MDS No. V203 / V203S [a] / V203SH [b] / V203K [c]** | **Rev. 1** |
|---|---|---|
| ***TYPE OF MATERIAL: 2¼ Cr 1 Mo alloy steel*** | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

[b] The supplementary suffix "SH" shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

[c] The supplementary suffix "K" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for hydrogen service.

| *PRODUCT FORM* | *STANDARD* | *GRADE* | *ACCEPTANCE CLASS* | *SUPPLEMENTARY REQUIREMENT* |
|---|---|---|---|---|
| **Wrought fittings** | ASTM A234/A234M | WP22, WP22W | Class 1 or Class 3 | ASTM A960/A960M S51, S53, S69 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Metal making*** | For fittings with governing thickness 50 mm and greater, the steel shall be vacuum degassed and made to fine grain practice. | | | |
| ***Chemical composition*** | For fittings with governing thickness 50 mm and greater, the requirements of API RP 934-A shall apply. | | | |
| ***Heat treatment*** | Tempering temperature shall be minimum 725 °C.<br>All hot formed or forged fittings, including those manufactured by locally heating a portion of the fitting stock, shall be heat treated after manufacture.<br>During the heat treatment process, fittings shall be placed in such a way as to ensure free circulation around each fitting including any quenching operation. | | | |
| ***Tensile testing*** | ASTM A960/A960M supplementary requirement S51 shall apply as amended by this MDS.<br>Tensile testing shall be carried out on specimens cut from a fitting where dimensions permit. When removal of specimens is not possible due to the size of the fitting, a prolongation or a length of starting material that has been heat treated in the same heat treatment load as the fittings it represents shall be used. | | | |
| ***Hardness testing*** | Hardness testing shall be carried out on two fittings for each test lot, including parent material, weld and HAZ. | | | |
| ***Non-destructive testing*** | ASTM A960/A960M supplementary requirement S53 and S69 shall apply as amended by this MDS. Acceptance criteria shall be according to ASME BPVC VIII, Div. 1, Appendix 6. Examination shall be performed after final heat treatment and after final machining or calibration.<br>NDT shall be carried out after final heat treatment. | | | |
| ***Repair of defects*** | Weld repair of the base material is not permitted. | | | |
| | Repairs to weld metal are acceptable in accordance with the standard specification and shall meet the chemistry requirements of the original manufacturing weld. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

[b] The supplementary suffix "SH" shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

[c] The supplementary suffix "K" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for hydrogen service.

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|---|---|
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a,b] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Chemical composition*<br>S ≤ 0,003 % for WP22W fitting made from flat-rolled products<br>S ≤ 0,007 % for WP22 fitting made from forging |
| | *Hardness testing*<br>For WP22W fittings, in addition to the production hardness requirement in the MDS, welding procedure qualification testing for manufacturing and any repair welding shall meet the requirements of ANSI/NACE MR0175/ISO 15156-2, 7.3.3, using Vickers method, with a maximum hardness of 225HV. |
| | The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS. |
| | *HIC testing and UT examination*<br>When suffix SH applies, one finished WPBW fitting made from flat-rolled products per lot shall be tested as follows.<br>— HIC testing:<br>— HIC testing in accordance with NACE TM0284, using Test Solution A.<br>— Acceptance criteria per specimen shall be CLR ≤ 15 %, CTR ≤ 5 %, CSR ≤ 2 %.<br>— Maximum individual crack length shall be reported for each section.<br>— UT testing of flat-rolled product before manufacture:<br>— ASTM A578/A578M S1, S2.1 shall apply. |
| ***Hydrogen service (additional metallurgical, manufacturing, testing and certification requirements)*** [c] | When hydrogen service requirements are specified by the purchaser, the material shall conform to the following additional requirements in the MDS.<br>Products shall be delivered in the normalized and tempered or quenched and tempered condition.<br>Impact testing<br>Impact testing shall be carried out in accordance with API RP 934-A. |
| ***Marking*** | The fittings shall be marked to ensure full traceability to melt and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser. |
| | The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition including tempering temperature and holding time shall be stated. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

[b] The supplementary suffix "SH" shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

[c] The supplementary suffix "K" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for hydrogen service.

| Material Data Sheet | MDS No. V204 / V204S [a] / V204K [b] | | | Rev. 1 |
|---|---|---|---|---|
| *TYPE OF MATERIAL: 2¼ Cr 1 Mo alloy steel* | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Forgings** | ASTM A182/ A182M | F22 | Class 3 | ASTM A961/A961M S55 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Metal making*** | Forgings with governing thickness 50 mm and greater shall be manufactured from steel vacuum degassed and made to fine grain practice. | | | |
| ***Chemical composition*** | For forgings with governing thickness 50 mm and greater, the requirements of API RP 934-A shall apply. | | | |
| ***Heat treatment*** | Tempering temperature shall be minimum 725 °C.<br>During the heat treatment process, forgings shall be placed in such a way as to ensure free circulation around each fitting including any quenching operation. | | | |
| ***Non-destructive testing*** | 10 % of all forgings per lot or a minimum of one item per lot in any purchase order shall be examined with magnetic particle testing. All accessible internal and external surfaces shall be examined according to ASTM A961/A961M supplementary requirement S55. Acceptance criteria shall be according to ASME BPVC VIII, Div. 1, Appendix 6. Examination shall be performed after final heat treatment and final machining. | | | |
| ***Repair of defects*** | Weld repair is not permitted. | | | |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: | | | |
| | *Chemical composition*<br>S ≤ 0,025 % | | | |
| | The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS. | | | |
| ***Hydrogen service (additional metallurgical, manufacturing, testing and certification requirements)*** [b] | When hydrogen service requirements are specified by the purchaser, the material shall conform to the following additional requirements in the MDS.<br>Products shall be delivered in the normalized and tempered or quenched and tempered condition.<br>Tensile testing and impact testing shall be carried out in accordance with API RP 934-A.<br>Sketches shall be established showing type, and size of test samples and location for extraction of test specimens. | | | |
| ***Marking*** | The forgings shall be marked to ensure full traceability to melt and heat treatment lot. | | | |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser. | | | |
| | The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition including tempering temperature and holding time shall be stated.<br>— Sketches for test sampling. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

[b] The supplementary suffix "K" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for hydrogen service.

| Material Data Sheet | MDS No. V205 / V205S [a] / V205SH [b] / V205K [c] | | | Rev. 1 |
|---|---|---|---|---|
| *TYPE OF MATERIAL: 2¼ Cr 1 Mo alloy steel* | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Plates** | ASTM A387/ A387M | 22 (UNS K21590) | Class 2 | ASTM A387/A387M S53 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Metal making*** | Steel plate with thickness 50 mm and greater shall be vacuum degassed and made to fine grain practice. | | | |
| ***Chemical composition*** | For plate with thickness 50 mm and greater, the requirements of API RP 934-A shall apply. | | | |
| ***Heat treatment*** | Tempering temperature shall be minimum 725 °C.<br>During the heat treatment process, plates shall be placed in such a way as to ensure free circulation around each fitting including any quenching operation. | | | |
| ***Hardness testing*** | Hardness testing shall be carried out on in accordance with ASTM A370 on one plate per lot. Hardness shall not exceed 197HBW. | | | |
| ***Test Sampling*** | Supplementary requirement S53 shall apply. Specimens shall be oriented transverse to the final rolling direction. | | | |
| ***Non-destructive testing*** | *Visual inspection*<br>VT shall be carried out on each plate in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing. | | | |
| ***Repair of defects*** | Weld repair is not permitted. | | | |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements) [a,b]*** | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: | | | |
| | *Chemical composition*<br>S ≤ 0,003 % | | | |
| | The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS. | | | |
| | HIC testing and UT examination<br>When suffix SH applies, one plate per lot shall be tested as follows.<br>— HIC testing:<br>HIC testing in accordance with NACE TM0284, using Test Solution A.<br>Acceptance criteria per specimen shall be CLR ≤ 15 %, CTR ≤ 5 %, CSR ≤ 2 %.<br>Maximum individual crack length shall be reported for each section.<br>— UT examination:<br>ASTM A387/A387M supplementary requirement S8 shall apply. | | | |
| ***Hydrogen service (additional metallurgical, manufacturing, testing and certification requirements) [c]*** | When hydrogen service requirements are specified by the purchaser, the material shall conform to the following additional requirements in the MDS.<br>Products shall be delivered in the normalized and tempered or quenched and tempered condition.<br>Tensile testing and impact testing shall be carried out in accordance with API RP 934-A. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

[b] The supplementary suffix "SH" shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

[c] The supplementary suffix "K" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for hydrogen service.

| | |
|---|---|
| ***Marking*** | The plates shall be marked to ensure full traceability to melt and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser. |
| | The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition. Tempering temperature and holding time shall be stated. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

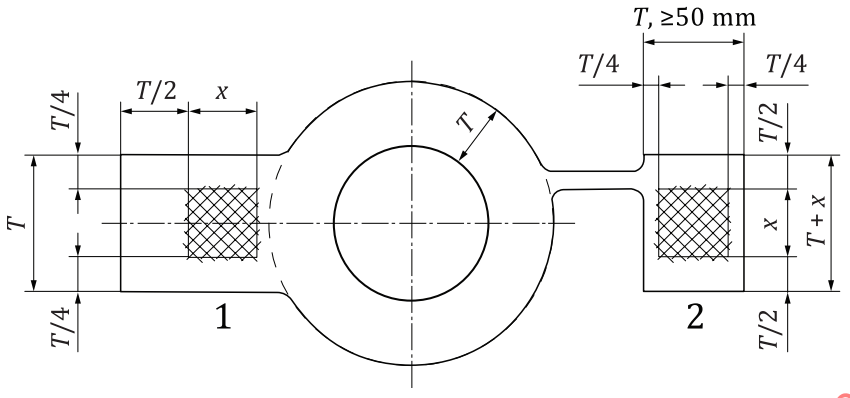
[b] The supplementary suffix "SH" shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

[c] The supplementary suffix "K" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for hydrogen service.

| **Material Data Sheet** | **MDS No. V206 / V206S [a] / V206K [b]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL:* 2¼ Cr *1* Mo alloy steel** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Castings** | ASTM A217/A217M | WC9 (UNS J21890) | | ASTM A217/A217M S4, S5, S21, S52.2, S53<br>ASTM A703/A703M S14, S20 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Chemical composition*** | Supplementary requirement ASTM A217/A217M S52.2 and S53 shall apply with a J-factor ≤ 100. | | | |
| ***Heat treatment*** | Tempering temperature shall be minimum 725 °C.<br>During the heat treatment process, castings shall be placed in such a way as to ensure free circulation around each item. | | | |
| ***Extent of testing*** | ASTM A703/A703M supplementary requirement S14 shall apply. | | | |
| ***Test sampling*** | For castings with a weight of 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. including any post weld stress relieving.<br>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.<br>Dimensions of test blocks and location of test specimens within the test blocks are shown in the figure below for integral and gated test block. 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. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

[b] The supplementary suffix "K" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for hydrogen service.




1 integrated test block

2 gated test block

***Non-destructive testing***

General

For definition and NDT of pilot castings reference is made the general part of this document.

Non-machined surfaces shall be cleaned prior to testing.

Visual inspection

Visual testing shall be carried out on each casting in accordance with ANSI/MSS SP-55. The testing shall be performed after final machining.

Radiographic testing

ASTMA351/A351M supplementary requirement S5 shall apply as amended by this MDS:

— Method of radiography of radiography shall be according to ASME BPVC V, Article 2 and acceptance criteria shall be in accordance with ASME BPVC VIII, Div. 1, Appendix 7.

— 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.

— Sketches of the areas to be tested shall be established and agreed with the purchaser.

— When random testing (5 %) 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.

— Pilot castings shall be radiographed to the extent described above.

— Frequency of RT of valve castings shall be according to table below.

| Frequency of RT based on pressure class and nominal outside diameter: | | | | | |
|---|---|---|---|---|---|
| Pressure class: | | ≤ 300 | 600 | 900 | ≥ 1 500 |
| Frequency of RT | Not required | < 10” | < 2” | | |
| | 5 % | ≥ 10” | ≥ 2” | | |
| | 100 % | Not applicable | ≥ 20” | ≥ 16” | ≥ 6” |

[a] The supplementary suffix “S” shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

[b] The supplementary suffix “K” shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for hydrogen service.

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| | Non-valve 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.<br><br>Magnetic particle testing<br><br>ASTM A217/A217M supplementary requirement S4 shall apply as amended by this MDS:<br><br>Surface testing and acceptance criteria shall be in accordance with ASME BPVC VIII, Div. 1, Appendix 7.<br><br>Each pilot and production casting shall be tested after final machining at all accessible external and internal surfaces. Non-machined surfaces shall be cleaned prior to the testing. |
| ***Repair of defects*** | All major repairs, as defined by ASTM A217/A217M, shall be documented in accordance with ASTM A703/A703M S20.2.<br><br>The repair welding procedure shall be qualified in accordance with ASTM A488/A488M or ISO 11970 and this MDS:<br><br>— Welding procedure shall be qualified on casting or plate of the same cast material grade as used in production;<br><br>— Testing methodology and acceptance criteria shall be in accordance with the requirements of this MDS for the parent material.<br><br>Weld repairs are not acceptable for castings that leak during pressure testing.<br><br>Stress relieving PWHT shall be required after all major weld repair.<br><br>If a minor cosmetic repair is required to a semi-finished or finished cast component, PWHT may be omitted provided the welding procedure meets all the test requirements of this data sheet in the as-welded condition and preheat is applied according to the standard.<br><br>The weld metal composition shall conform with supplementary requirement ASTM A217/A217M S53.1.3. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br><br>Production hardness testing shall be performed in accordance with the requirements in ASTM A370/A1058 on the pilot casting and one casting per lot thereafter. The maximum hardness shall be 22HRC from three readings taken in close proximity. |
| | The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS. |
| ***Hydrogen service (additional metallurgical, manufacturing, testing and certification requirements) b*** | When hydrogen service requirements are specified by the purchaser, the material shall conform to the following additional requirements in the MDS.<br><br>Tensile testing and impact testing shall be carried out in accordance with API RP 934-A. |
| ***Marking*** | The castings shall be marked to ensure full traceability to melt and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser. |
| | The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 type 3.1 and shall confirm compliance with this specification.<br><br>The inspection documents shall include the following information:<br><br>— Heat treatment condition including tempering temperature and holding time shall be stated. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

[b] The supplementary suffix "K" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for hydrogen service.

| Material Data Sheet | MDS No. V207 / V207S [a] / V207K [b] | | | Rev. 1 |
|---|---|---|---|---|
| *TYPE OF MATERIAL:2¼ Cr 1 Mo alloy steel* | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Bars** | ASTM A739 | B22 | - | - |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification.<br>This MDS includes additional requirements for valve parts DN 100 (NPS 4) and under manufactured from bars, when permitted by the valve specification. | | | |
| ***Metal making*** | For bar thickness 50 mm and greater the steel shall be vacuum degassed and made to fine grain practice. | | | |
| ***Chemical composition*** | For bar thickness 50 mm and greater, the requirements of API RP 934-A shall apply. | | | |
| ***Heat treatment*** | Tempering temperature shall be minimum 725 °C.<br>During the heat treatment process, bars shall be placed in such a way as to ensure free circulation around each bar including any quenching operation. | | | |
| ***Hardness testing*** | Hardness testing shall be carried out on in accordance with ASTM A370 on the end surface of one bar per lot. The maximum hardness shall not exceed 207HBW. | | | |
| ***Test sampling*** | *Valve parts manufactured from bar*<br>Sampling of test specimens for bars intended for machining of valve parts shall conform with the following requirements:<br>— The mid-length of the axial tensile specimens shall be located at a distance equal to the bar outside diameter or minimum of 100 mm, whichever is the greater, from the end of the bar, and the centreline of the specimen shall be located at mid thickness (1/2 OD).<br>— The centreline of the tangential tensile specimens shall be located at mid thickness (1/2 OD) and the mid-point of the specimens at a minimum of 100 mm from the end of the bar.<br>— For bar with outside diameter < 100 mm: one tensile specimen and one set of impact test specimens shall be taken.<br>— For bar with outside diameter ≥ 100 mm: one tensile specimen and one set of impact test specimens shall be taken in axial direction of the bar. In addition, one tensile test specimen and one set of impact test specimens shall be taken in tangential direction of the bar.<br>— The specified minimum tensile strength of the referenced standard shall be met in both directions. | | | |
| ***Non-destructive testing*** | *Visual inspection*<br>VT shall be carried out on each bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing. | | | |
| | *NDT (MT) of valve parts manufactured from bar*<br>Inspection shall be according to the applicable valve specification or as specified below.<br>100 % magnetic particle testing of all accessible internal and external surfaces shall be carried out according to ASME BPVC V, article 7 or ASTM A961/A961M supplementary requirement S55. Acceptance criteria shall be according to ASME BPVC VIII, Div. 1, appendix 6. | | | |
| ***Repair of defects*** | Weld repair is not permitted. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

[b] he supplementary suffix "K" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for hydrogen service.

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| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS. |
| ***Hydrogen service (additional metallurgical, manufacturing, testing and certification requirements)*** [b] | When hydrogen service requirements are specified by the purchaser, the material shall conform to the following additional requirements in the MDS.<br>Products shall be delivered in the normalized and tempered or quenched and tempered condition.<br>Tensile testing and impact testing shall be carried out in accordance with API RP 934-A. |
| ***Marking*** | The bars shall be marked to ensure full traceability to melt and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser. |
| | The inspection documents shall be issued in accordance with ISO 10474 /EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition including tempering temperature and holding time shall be stated. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

[b] he supplementary suffix "K" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for hydrogen service.

| **Material Data Sheet** | **MDS No. X100 / X100S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: High strength low alloy steel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Studs, bolts and nuts (HDG)** | ASTM A320/A320M | L7, L7M, L43 | | - |
| | ASTM A194/A194M | 7 or 7M | | ASTM A194/A194M S3, S4, S5 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Manufacturing*** | Threading of studs and bolts may be done by machining or rolling. Thread rolling shall be done after heat treatment.<br>Threads in nuts shall be machined. | | | |
| ***Impact testing/ Toughness testing*** | Nuts to ASTM A194/A194M: S3 shall apply. | | | |
| ***Proof load testing*** | Nuts to ASTM A194/A194M: S4 shall apply. | | | |
| ***Non-destructive testing*** | All products shall be 100 % visually examined in all areas of threads, shanks and heads. Discontinuities shall conform with requirements specified in ASTM F788/F788M for bolts/studs and ASTM F812 for nuts. | | | |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service is specified by the purchaser, only Grade L7M/7M is acceptable.<br>The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Surface treatment and finish*** | All studs, bolts, nuts and washers shall be hot dip spun galvanized in accordance with ISO 10684 or ASTM F2329/F2329M. The zinc coating on threads shall not be subject to cutting, rolling or finishing tool operation. Nuts may be tapped after galvanizing. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>S5 shall apply for nuts to ASTM A194/A194M.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Steel manufacturer of starting material;<br>— Heat treatment condition. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. X100 / X100S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: High strength low alloy steel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Studs, bolts and nuts (HDG)** | ASTM A320/A320M | L7, L7M, L43 | | - |
| | ASTM A194/A194M | 7 or 7M | | ASTM A194/A194M S3, S4, S5 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Manufacturing*** | Threading of studs and bolts may be done by machining or rolling. Thread rolling shall be done after heat treatment.<br>Threads in nuts shall be machined. | | | |
| ***Impact testing/ Toughness testing*** | Nuts to ASTM A194/A194M: S3 shall apply. | | | |
| ***Proof load testing*** | Nuts to ASTM A194/A194M: S4 shall apply. | | | |
| ***Non-destructive testing*** | All products shall be 100 % visually examined in all areas of threads, shanks and heads. Discontinuities shall conform with requirements specified in ASTM F788/F788M for bolts/studs and ASTM F812 for nuts. | | | |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service is specified by the purchaser, only Grade L7M/7M is acceptable.<br>The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS. | | | |
| ***Surface treatment and finish*** | All studs, bolts, nuts and washers shall be hot dip spun galvanized in accordance with ISO 10684 or ASTM F2329/F2329M. The zinc coating on threads shall not be subject to cutting, rolling or finishing tool operation. Nuts may be tapped after galvanizing. | | | |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>S5 shall apply for nuts to ASTM A194/A194M.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information: | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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|---|---|
| | — Steel manufacturer of starting material;<br>— Heat treatment condition. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. X109 / X109S [a]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: High strength low alloy steel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Studs, bolts and nuts (black or uncoated)** | ASTM A320/A320M | L7, L7M, L43 | | - |
| | ASTM A194/A194M | 7 or 7M | | ASTM A194/A194M S3, S4, S5 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Manufacturing*** | Threading of studs and bolts may be done by machining or rolling. Thread rolling shall be done after heat treatment.<br>Threads in nuts shall be machined. | | | |
| ***Impact testing/ Toughness testing*** | Nuts to ASTM A194/A194M: S3 shall apply. | | | |
| ***Proof load testing*** | Nuts to ASTM A194/A194M: S4 shall apply. | | | |
| ***Non-destructive testing*** | All products shall be 100 % visually examined in all areas of threads, shanks and heads. Discontinuities shall conform with requirements specified in ASTM F788/F788M for bolts/ studs and ASTM F812 for nuts. | | | |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service is specified by the purchaser, only Grade L7M/7M is acceptable.<br>The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS. | | | |
| ***Surface treatment and finish*** | End user or purchaser may define surface treatment of finish. | | | |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>S5 shall apply for nuts to ASTM A194/A194M<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Steel manufacturer of starting material;<br>— Heat treatment condition. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. X110 / X110S [a]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: High strength low alloy steel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| **Studs, bolts and nuts (black or uncoated)** | ASTM A193/A193M | B7, B7M | | - |
| | ASTM A194/A194M | 2H, 2HM | | - |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Manufacturing*** | Threading of studs and bolts may be done by machining or rolling. Thread rolling shall be done after heat treatment.<br>Threads in nuts shall be machined. | | | |
| ***Non-destructive testing*** | All products shall be 100 % visually examined in all areas of threads, shanks and heads. Discontinuities shall conform with requirements specified in ASTM F788/F788M for bolts/studs and ASTM F812 for nuts. | | | |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service is specified by the purchaser, only Grade B7M/2HM is acceptable.<br>The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS. | | | |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 2.2 as minimum. | | | |
| [a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service. | | | | |

| **Material Data Sheet** | **MDS No. X120 / X120S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: High strength low alloy steel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Studs, bolts and nuts (HDG)** | ASTM A193/A193M | B7, B7M | | - |
| | ASTM A194/A194M | 2H, 2HM | | - |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Manufacturing*** | Threading of studs and bolts may be done by machining or rolling. Thread rolling shall be done after heat treatment.<br>Threads in nuts shall be machined. | | | |
| ***Non-destructive testing*** | All products shall be 100 % visually examined in all areas of threads, shanks and heads. Discontinuities shall conform with requirements specified in ASTM F788/F788M for bolts/studs and ASTM F812 for nuts. | | | |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service is specified by the purchaser, only Grade B7M/2HM is acceptable.<br>The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS. | | | |
| ***Surface treatment and finish*** | All studs, bolts, nuts and washers shall be hot dip spun galvanized according to ISO 10684 or ASTM F2329/F2329M. The zinc coating on threads shall not be subject to cutting, rolling or finishing tool operation. Nuts may be tapped after galvanizing. | | | |
| [a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service. | | | | |

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| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>S5 shall apply for nuts to ASTM A194.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 2.2 as minimum. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. X124 / X124S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: High strength low alloy steel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Forged Clamp** | ASTM A788/A788M | Grade 4140 | | S18 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Manufacturing*** | The forgings shall be finished hot-worked. | | | |
| ***Chemical composition*** | According to ASTM A29/A29M, AISI 4140. Other chemical compositions may be used provided the specified mechanical properties are complied with.<br>The following limitations shall apply: S ≤ 0,025 %; P ≤ 0,030 %; N ≤ 0,010 %; Al < 0,06 %; Al: N > 2: 1 | | | |
| ***Heat treatment*** | The forgings shall be austenitized, liquid quenched and tempered.<br>Parts shall be placed in such a way as to ensure free circulation around each part during the heat treatment process including quenching. | | | |
| ***Extent of testing*** | One set of tensile and impact test shall be carried out for each melt, section thickness +/- 25 % and heat treatment load. A test lot shall not exceed 5 000 kg. | | | |
| ***Test sampling*** | 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.<br>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.<br>For all forging sketches shall be established showing type, and size of test samples and location for extraction of test specimens. | | | |
| ***Tensile testing*** | Minimum yield strength: $R_{eh}$ ≥ 515 MPa<br>Minimum tensile strength: $R_M$ ≥ 690 MPa<br>Minimum elongation: A ≥ 15 % | | | |
| ***Impact testing*** | Charpy V-notch testing is required according to ASTM A370 at −46 °C. The notch shall be perpendicular to the surface. The minimum absorbed energy for full size specimens shall be 41 J average and 33 J single. Reduction factors for sub-size specimens shall be: 7,5 mm -5/6 and 5 mm - 2/3. | | | |
| ***Hardness testing*** | Except when only one forging is produced, a minimum of two forgings shall be hardness tested per batch or continuous run to ensure that forgings are within the hardness limits 237 HB or 22 HRC. | | | |
| ***Non-destructive testing*** | Supplementary requirement, S18, magnetic particle testing, shall apply to all forgings.<br>The acceptance criteria shall be to ASME BPVC VIII, Div. 1, Appendix 6. | | | |
| ***Repair of defects*** | Weld repair is not permitted. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements:<br>The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS. |
| ***Marking*** | The part shall be marked to ensure full traceability to melt and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The material certificate shall be issued in accordance with ISO 10474 / EN 10204 type 3.1, confirm compliance with this specification, and include the following information:<br>— steel manufacturer of starting material;<br>— heat treatment condition, for QT condition austenitisation and tempering temperature and quenching medium. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. X127 / X127S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: High strength low alloy steel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Bars** | ASTM A29/A29M | 4140 | - | - |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced ASTM standard specification.<br>Valve parts machined from bar covered by this MDS are restricted to pressure controlling parts only. | | | |
| ***Manufacturing*** | Bars shall be manufactured to the following requirements:<br>— bar forgings as defined in ASTM A788/A788M and certified to ASTM A694/A694M; or<br>— hot rolled/wrought bars with a maximum outside diameter 250 mm; or<br>— All bars shall be supplied in heat treatment condition as specified below.<br>Cold finishing shall be restricted to turning, grinding or polishing (singly or in combination); cold drawing or cold forming is not permitted. | | | |
| ***Chemical composition*** | S ≤ 0,020 %, P ≤ 0,025 % | | | |
| ***Heat treatment*** | For products delivered in quenched and tempered condition the minimum tempering temperature shall be 650 °C.<br>Bars shall be placed in such a way that free circulation around each bar is ensured during the heat treatment process, including quenching. | | | |
| ***Tensile testing*** | — Minimum yield strength: ≥ 515 MPa (75 ksi)<br>— Minimum tensile strength: ≥ 690 MPa (100 ksi)<br>— Minimum elongation: ≥ 15 % | | | |
| ***Impact testing/ Toughness testing*** | Impact testing shall be carried out at −46 °C. One set of three samples shall be tested.<br>Acceptance criteria minimum 45 J average and 35 J single for full size specimens.<br>Reduction factors for sub-size specimens shall be: 7,5 mm - 5/6 and 5 mm - 2/3. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Extent of testing*** | Impact test, tensile test and hardness test 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 bars heat treated continuously in the same furnace, of the same heat and nominal thickness. A test lot shall not exceed 2 000 kg for bars with weight ≤ 50 kg, and 5 000 kg for forgings with weight > 50 kg. |
| ***Test sampling*** | *Valve parts manufactured from bar*<br>Sampling of test specimens for bars intended for machining pressure controlling parts of valve DN 100 (NPS 4) and under shall conform with the following requirements:<br>— The mid-length of the axial tensile test specimen shall be located at a distance equal to the bar outside diameter or minimum of 100 mm , whichever is the greater, from the end of the bar, and the centreline of the specimen shall be located at a minimum distance of OD/4 from the surface.<br>— The centreline of the tangential tensile test specimen shall be located at a minimum distance of OD/4 from the surface and the mid-point of the specimens at a minimum of 100 mm from the end of the bar.<br>— The notch of the impact test specimen shall be located perpendicular to the bar surface.<br>— For bar with outside diameter < 100 mm: one tensile and one set impact test specimens shall be taken.<br>— For bar with outside diameter ≥ 100 mm: one tensile and one set impact test specimens shall be taken in axial direction of the bar. In addition, one tensile test specimen and one set impact test specimens shall be taken in tangential direction of the bar; the centreline of the tensile test specimen shall be located a minimum of 100 mm from the end of the bar.<br>— The specified minimum tensile strength of the referenced standard specification and impact energies specified in this data sheet shall be met in both directions. |
| ***Non-destructive testing*** | *Visual inspection*<br>VT shall be carried out on each bar in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | Grade 4140 material is not referenced in the ISO 15156 series / ANSI/NACE MR0175. Use of Grade 4140 in sour service shall require separate qualification according to ISO 15156-2 / ANSI/NACE MR0175.<br>The inspection documents required in this MDS shall also include the qualification test reports.<br>The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS. |
| ***Marking*** | The bars shall be marked to ensure full traceability to melt and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1, unless specified otherwise by the purchaser.<br>The inspection documents shall include the following information:<br>— Steel manufacturer, melting and refining practice;<br>— Heat treatment condition (for tempered condition, tempering temperature and holding time). |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| Material Data Sheet | MDS No. X134 / X134S [a] | | | Rev. 1 |
|---|---|---|---|---|
| *TYPE OF MATERIAL: High strength low alloy steel* | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Forged clamp** | ASTM A508/508M | 22 | 4, 5 or 6 | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Heat treatment*** | Parts shall be placed in such a way as to ensure free circulation around each part during the heat treatment process including quenching. | | | |
| ***Extent of testing*** | One set of tensile and impact test shall be carried out for each heat and heat treatment load. A test lot shall not exceed 5 000 kg. | | | |
| ***Test sampling*** | Samples for mechanical testing shall be taken from sacrificial parts or prolongations in accordance with Method 2 or 3. Use of any other method shall be agreed with Purchaser.<br>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.<br>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.<br>For all forging sketches shall be established showing type, and size of test samples and location for extraction of test specimens. | | | |
| ***Impact testing*** | Charpy V-notch testing is required according to ASTM A370 at —46 °C. The notch shall be perpendicular to the surface. The minimum absorbed energy for full size specimens shall be 41 J average and 33 J single. Reduction factors for sub-size specimens shall be: 7,5 mm 6 and 5 mm - 2/3. | | | |
| ***Hardness testing*** | Except when only one forging is produced, a minimum of two forgings shall be hardness tested per batch or continuous run to ensure that forgings are within the hardness limits 237 HB or 22 HRC. | | | |
| ***Non-destructive testing*** | Magnetic particle testing using test method to ASTM A966/A966M shall apply to all forgings covering all accessible surface. | | | |
| ***Repair of defects*** | Weld repair of base material is not permitted. | | | |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements:<br>The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS. | | | |
| ***Marking*** | The part shall be marked to ensure full traceability to melt and heat treatment lot. | | | |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The material certificate shall be issued in accordance with ISO 10474 / EN 10204 type 3.1, confirm compliance with this specification, and include the following information:<br>— steel manufacturer of starting material;<br>— heat treatment condition, for QT condition, austenitisation and tempering temperature and quenching medium. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

## A.3 Material datasheets for high pressure service according to ASME B31.3

| Material Data Sheet | MDS No. C221 / C221S[a] | | | Rev. 1 |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Impact tested carbon steel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Seamless pipes** | API Spec 5L | X42N, X42NO, X42Q, X42QO, X52N, X52NO, X52Q, X52QO (SMLS) | PSL2 | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Manufacturing*** | Seamless pipe (SMLS) according to the product standard | | | |
| ***Chemical composition*** | The chemical composition in API Spec 5L shall apply for all thicknesses with the addition of Ti+Nb+V ≤ 0,10. | | | |
| ***Heat treatment*** | For pipes delivered in quenched and tempered condition the minimum tempering temperature shall be 630 °C. | | | |
| ***Impact testing/ Toughness testing*** | Charpy V-notch testing according to ASTM A370 at −46 °C is required for nominal thickness ≥ 6 mm.<br>Where pipe dimension does not allow testing in the transverse direction, the specimen shall be oriented in longitudinal direction.<br>The minimum absorbed energy for full size specimens shall be 41J average of three specimens and 33J single value in the transverse direction and 81J average of three specimens and 65J single value in the longitudinal direction.<br>Reduction factors for sub-size specimens shall be: 7,5 mm - 5/6 and 5 mm - 2/3. | | | |
| ***Hardness testing*** | Hardness testing of pipe body shall be performed on one pipe per lot in accordance with Annex J.<br>The maximum hardness shall be 22 HRC or 250 HV10. | | | |
| ***Non-destructive testing*** | The pipe shall undergo testing and pass acceptance criteria according to ASME BPVC VIII Div. 3 KE-240. | | | |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements:<br>The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS. | | | |
| ***Dimensional tolerances*** | For t > 25 mm the dimensional tolerances shall be the same as for t ≤ 25 mm. | | | |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The material certificate shall be issued in accordance with ISO 10474 / EN 10204 type 3.1, confirm compliance with this specification, and include the following information:<br>— melting and refining practice;<br>— heat treatment condition; for QT condition, austenitisation and tempering temperature and quenching medium;<br>— NDT standards and acceptance criteria. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| Material Data Sheet | MDS No. C223 /C223S[a] / C223SH[b] | | | Rev. 1 |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Impact tested carbon steel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Wrought fittings** | ASTM A860/A860M | WPHY 42, WPHY 52 | Seamless or welded | ASTM A960/A960M S53, S57, S69 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Chemical composition*** | (V + Nb + Ti) ≤ 0,10 % | | | |
| ***Heat treatment*** | During the heat treatment process, fittings shall be placed in such a way as to ensure free circulation around each fitting including any quenching operation.<br>For products delivered in the tempered condition, the minimum tempering temperature shall be 630 °C. | | | |
| ***Test sampling*** | Samples for production testing shall realistically reflect the properties in the actual parts.<br>Test sampling shall be made from an actual fitting, from a prolongation thereof, or if not possible, a length of starting material that has been heat treated in the same heat treatment load as the fittings it represents. | | | |
| ***Extent of testing*** | Impact and hardness testing shall be carried out for each heat and heat treatment load. | | | |
| ***Impact testing/ Toughness testing*** | Impact testing is required for thickness ≥ 6 mm; for fittings with a weld end, the weld end thickness shall govern.<br>Test specimens shall be oriented in the transverse direction or alternatively in both transverse and longitudinal direction as far as size permits. Acceptance criteria for transverse direction is minimum 41 J average and 33 J single. Acceptance criteria for longitudinal direction is minimum 81 J average and 65 J single.<br>Reduction factors for sub-size specimens shall be: 7,5 mm - 5/6 and 5 mm - 2/3.<br>The impact test specimens shall be taken from mid-thickness position. | | | |
| ***Hardness testing*** | ASTM A960/A960M supplementary requirement S57 shall apply with the following requirements: hardness testing shall be carried out on a minimum two fittings, including parent material, weld and HAZ, for each test lot. | | | |
| ***Non-destructive testing*** | *Ultrasonic testing*<br>Ultrasonic testing shall apply to all fittings with greatest cross section thickness exceeding 50 mm. The testing shall be carried out according to ASTM A388/A388M and dedicated procedure with scanning plan. Supplementary requirement S1 shall apply.<br>Acceptance criteria:<br>— no single indication exceeding reference distance amplitude curve;<br>— no multiple indications exceeding 50 % of reference distance amplitude curve is allowed. Multiple indications are defined as two or more indications (each exceeding 50 % of the reference distance amplitude curve) within 13 mm of each other in any direction.<br>*Magnetic particle testing*<br>ASTM A960/A960M supplementary requirement S53 and S69 shall apply. 100 % magnetic particle testing shall be carried out in accordance with ASME BPVC V, Article 7. Acceptance criteria shall be according to ASME BPVC VIII, Div. 1, Appendix 6. All accessible internal and external surfaces shall be examined. Testing shall be carried out after machining if applicable. Non-machined surfaces shall be cleaned prior to testing. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service, but excluding HIC testing and UT examination.

[b] The supplementary suffix "SH" shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

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| ***Repair of defects*** | Weld repair of the base material is not permitted.<br>Repairs to weld metal are acceptable in accordance with the standard specification and shall meet the chemistry requirements of the original manufacturing weld. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a, b] | When suffix S is specified is specified the following requirements apply:<br>— The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS.<br>— Chemical composition:<br>— S ≤ 0,010 % for fittings made from seamless pipe;<br>— S ≤ 0,003 % for welded fittings made from flat-rolled parts;<br>— S ≤ 0,020 % for fittings made from forging;<br>— Ni < 1,0 % for the weld metal.<br>— Hardness testing:<br>For fittings, in addition to the hardness testing requirement in the MDS, welding procedure qualification testing for manufacturing and any repair welding shall meet the requirements of ISO 15156-2 / ANSI/NACE MR0175 using Vickers method, with a maximum hardness of 250 HV.<br>When suffix SH is specified is specified the following requirements apply:<br>— HIC testing in accordance with NACE TM0284, using Test Solution A shall apply.<br>— Acceptance criteria per specimen shall be CLR ≤ 15 %, CTR ≤ 5 %, CSR ≤ 2 %.<br>— Maximum individual crack length shall be reported for each section.<br>— UT testing of flat-rolled product before manufacture:<br>— ASTM A578/A578M S1, S2.1 shall apply. |
| ***Marking*** | The fittings shall be marked to ensure full traceability to melt and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition (for tempered condition, tempering temperature). |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service, but excluding HIC testing and UT examination.

[b] The supplementary suffix "SH" shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.



| **Material Data Sheet** | **MDS No. C224 /C224S[a]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Impact tested carbon steel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Forgings** | ASTM A694/A694M | F42, F52 | | ASTM A961/A961M S55 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Chemical composition*** | C ≤ 0,20 %, S ≤ 0,020 %, P ≤ 0,025 %, Ti ≤ 0,05 %, Nb ≤ 0,04 %, (V + Nb + Ti) ≤ 0,10 %, CE ≤ 0,43 % | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Heat treatment*** | For products delivered in the quenched and tempered condition the minimum tempering temperature shall be 630 °C.<br>Forgings shall be placed in such a way that free circulation around each forging is ensured during the heat treatment process, including quenching. |
| ***Test sampling*** | Test sampling shall be made from an actual forging or from a prolongation thereof.<br>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. |
| ***Extent of testing*** | Impact test, tensile test and hardness test shall be carried out for each heat, nominal thickness and heat treatment load.<br>The testing shall be carried out representing the part with heaviest wall thickness within the heat treatment load.<br>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. A test lot shall not exceed 2 000 kg for forgings with as forged weight ≤ 50 kg, and 5 000 kg for forgings with as forged weight > 50 kg. |
| ***Impact testing/ Toughness testing*** | Impact testing shall be carried out at −46 °C. One set of three samples shall be tested. Test samples shall be taken in the transverse direction as far as size permits. If there is no single identifiable axis, specimens shall meet the energy values for longitudinal direction or alternatively three sets of orthogonal samples with three samples each shall be tested. All the sets shall satisfy the acceptance criteria for transverse direction.<br>The minimum absorbed energy for full size specimens shall be 41 J average and 33 J single in the transverse direction and 81 J average and 65 J single when testing in the longitudinal direction is carried out.<br>The impact test specimens shall be taken from mid-thickness position.<br>Reduction factors for sub-size specimens shall be: 7,5 mm - 5/6 and 5 mm - 2/3. |
| ***Hardness testing*** | Hardness testing shall be performed in accordance with the requirements in ASTM A370 on two forgings per lot. When only one part is produced, this part shall be hardness tested as required. The maximum hardness shall be 22 HRC from three readings per part. |
| ***Non-destructive testing*** | VT shall be carried out on each forging in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing.<br>All forgings shall be 100 % tested after final machining by the magnetic particle method in accordance with ASME BPVC V article 7. All accessible internal and external surfaces shall be examined. Acceptance criteria shall be ASME BPVC VIII Div. 1 Appendix 6.<br>Ultrasonic testing shall apply to all forgings with greatest cross section thickness exceeding 50 mm. The testing shall be carried out to ASTM A388/A388M and dedicated procedure with scanning plan. Supplementary requirement S1 shall apply.<br>Acceptance criteria:<br>— no single indication exceeding reference distance amplitude curve;<br>— no multiple indications exceeding 50 % of reference distance amplitude curve is allowed. Multiple indications are defined as two or more indications (each exceeding 50 % of the reference distance amplitude curve) within 13 mm of each other in any direction. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements:<br>The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS.<br>Ni < 1,0 % |

[a] The supplementary suffix “S” shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Marking*** | The forgings shall be marked to ensure full traceability to melt and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1, unless specified otherwise by the purchaser.<br>The inspection documents shall include the following information:<br>— Steel manufacturer, melting and refining practice;<br>— Heat treatment condition (for tempered condition, tempering temperature and holding time). |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. C231 / C231S[a]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Impact tested carbon steel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Seamless pipes** | API Spec 5L | X60N, X60Q, X60QO, X65Q, X65QO (SMLS) | PSL2 | |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Manufacturing*** | Seamless pipe (SMLS) according to the product standard | | | |
| ***Chemical composition*** | The chemical composition in API Spec 5L shall apply for all thicknesses. | | | |
| ***Heat treatment*** | For pipes delivered in quenched and tempered condition the minimum tempering temperature shall be 630 °C. | | | |
| ***Impact testing/ Toughness testing*** | Charpy V-notch testing according to ASTM A370 at - 46 °C is required for nominal thickness ≥ 6 mm.<br>Where pipe dimension does not allow testing in the transverse direction, the specimen shall be oriented in longitudinal direction.<br>The minimum absorbed energy for full size specimens shall be 41J average of three specimens and 33J single value in the transverse direction and 81J average of three specimens and 65J single value in the longitudinal direction.<br>Reduction factors for sub-size specimens shall be: 7,5 mm - 5/6 and 5 mm - 2/3. | | | |
| ***Hardness testing*** | Hardness testing of pipe body shall be performed on one pipe per lot in accordance with API Spec 5L, 46th Edition Annex J.<br>The maximum hardness shall be 22 HRC or 250 HV10. | | | |
| ***Non-destructive testing*** | The pipe shall undergo testing and pass acceptance criteria according to ASME BPVC VIII Div. 3 KE-240. | | | |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a,] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements:<br>The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS. | | | |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The material certificate shall be issued in accordance with ISO 10474 / EN 10204 type 3.1, confirm compliance with this specification, and include the following information: | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| | — melting and refining practice;<br>— heat treatment condition (for QT condition, austenitisation and tempering temperature and quenching medium);<br>— NDT standard and acceptance criteria. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. C233 /C233S[a] / C233SH[b]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Impact tested carbon steel*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Wrought fittings** | ASTM A860/A860M | WHPHY 60, WPHY 65 | Seamless or welded | ASTM A960/A960M S53, S57, S69 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Chemical composition*** | A product chemical analysis shall be taken per melt of material.<br>The steel shall be made according to a fine grain and inclusion control practice.<br>The heat analysis shall be modified as follows:<br>C ≤ 0,16 %, P ≤ 0,020 %, (Nb+Ti+V) ≤ 0,10 %; | | | |
| ***Heat treatment*** | During the heat treatment process, fittings shall be placed in such a way as to ensure free circulation around each fitting including any quenching operation.<br>For products delivered in the tempered condition, the minimum tempering temperature shall be 630 °C. | | | |
| ***Test sampling*** | Samples for production testing shall realistically reflect the properties in the actual parts.<br>Test sampling shall be made from an actual fitting, from a prolongation thereof, or if not possible, a length of starting material that has been heat treated in the same heat treatment load as the fittings it represents. | | | |
| ***Extent of testing*** | Impact and hardness testing shall be carried out for each heat and heat treatment load. | | | |
| ***Tensile testing*** | Maximum yield to tensile ratio, $R_{p0,2}/R_M \leq 0,93$. | | | |
| ***Impact testing/ Toughness testing*** | Impact testing is required for thickness ≥ 6 mm; for fittings with a weld end, the weld end thickness shall govern.<br>Test specimens shall be oriented in the transverse direction or alternatively in both transverse and longitudinal direction as far as size permits. Acceptance criteria for transverse direction is minimum 41 J average and 33 J single. Acceptance criteria for longitudinal direction is minimum 81 J average and 65 J single.<br>Reduction factors for sub-size specimens shall be: 7,5 mm - 5/6 and 5 mm - 2/3.<br>The impact test specimens shall be taken from mid-thickness position. | | | |
| ***Hardness testing*** | ASTM A960/A960M supplementary requirement S57 shall apply with the following requirements: hardness testing shall be carried out on a minimum two fittings, including parent material, weld and HAZ, for each test lot. | | | |
| ***Non-destructive testing*** | *Ultrasonic testing*<br>Ultrasonic testing shall apply to all fittings with greatest cross section thickness exceeding 50 mm. The testing shall be carried out to ASTM A388/A388M and dedicated procedure with scanning plan. Supplementary requirement S1 shall apply.<br>Acceptance criteria: | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service, but excluding HIC testing and UT examination.

[b] The supplementary suffix "SH" shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

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| | — no single indication exceeding reference distance amplitude curve;<br>— no multiple indications exceeding 50 % of reference distance amplitude curve is allowed. Multiple indications are defined as two or more indications (each exceeding 50 % of the reference distance amplitude curve) within 13 mm of each other in any direction.<br>*Magnetic particle testing*<br>ASTM A960/A960M supplementary requirement S53 and S69 shall apply. 100 % magnetic particle testing shall be carried out in accordance with ASME BPVC V, Article 7. Acceptance criteria shall be according to ASME BPVC VIII, Div. 1, Appendix 6. All accessible internal and external surfaces shall be examined. Testing shall be carried out after machining if applicable. Non-machined surfaces shall be cleaned prior to testing. |
| ***Repair of defects*** | Weld repair of the base material is not permitted.<br>Repairs to weld metal are acceptable in accordance with the standard specification and shall meet the chemistry requirements of the original manufacturing weld. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When suffix S is specified is specified the following requirements apply:<br>— The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS.<br>— Chemical composition:<br>— S ≤ 0,010 % for fittings made from seamless pipe;<br>— S ≤ 0,003 % for welded fittings made from flat-rolled parts;<br>— S ≤ 0,020 % for fittings made from forging;<br>— Ni < 1,0 % for the weld metal.<br>— Hardness testing:<br>For fittings, in addition to the hardness testing requirement in the MDS, welding procedure qualification testing for manufacturing and any repair welding shall meet the requirements of ISO 15156-2 / ANSI/NACE MR0175 using Vickers method, with a maximum hardness of 250 HV.<br>When suffix SH is specified is specified the following requirements apply:<br>— HIC testing in accordance with NACE TM0284, using Test Solution A shall apply.<br>— Acceptance criteria per specimen shall be CLR ≤ 15 %, CTR ≤ 5 %, CSR ≤ 2 %.<br>— Maximum individual crack length shall be reported for each section.<br>— UT testing of flat-rolled product before manufacture:<br>ASTM A578/A578M S1, S2.1 shall apply. |
| ***Marking*** | The fittings shall be marked to ensure full traceability to melt and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— Heat treatment condition (for tempered condition, tempering temperature). |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service, but excluding HIC testing and UT examination.

[b] The supplementary suffix "SH" shall be used to designate a material delivered in accordance with the MDS including the additional supplementary requirements for sour service plus HIC testing and UT examination.

| Material Data Sheet | MDS No. C234 / C234S[a] | | | Rev. 1 |
|---|---|---|---|---|
| *TYPE OF MATERIAL: Impact tested carbon steel* | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Forgings** | ASTM A694/A694M | F60, F65 | | ASTM A961/A961M S55 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Chemical composition*** | The steel shall be made according to a fine grain and inclusion control practice.<br>C ≤ 0,20 %, S ≤0,020 %, P ≤ 0,025 %, Ti ≤ 0,05 %, Nb ≤ 0,04 %, (V+Nb+Ti) ≤ 0,10 %, CE ≤ 0,43 % | | | |
| ***Heat treatment*** | For products delivered in the quenched and tempered condition the minimum tempering temperature shall be 630 °C.<br>Forgings shall be placed in such a way that free circulation around each forging is ensured during the heat treatment process, including quenching. | | | |
| ***Test sampling*** | Test sampling shall be made from an actual forging or from a prolongation thereof.<br>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. | | | |
| ***Extent of testing*** | Impact test, tensile test and hardness test shall be carried out for each heat, nominal thickness and heat treatment load.<br>The testing shall be carried out representing the part with heaviest wall thickness within the heat treatment load.<br>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. A test lot shall not exceed 2 000 kg for forgings with as forged weight ≤ 50 kg , and 5 000 kg for forgings with as forged weight > 50 kg. | | | |
| ***Impact testing/ Toughness testing*** | Impact testing shall be carried out at −46 °C. One set of three samples shall be tested. Test samples shall be taken in the transverse direction as far as size permits. If there is no single identifiable axis, specimens shall meet the energy values for longitudinal direction or alternatively three sets of orthogonal samples with three samples each shall be tested. All the sets shall satisfy the acceptance criteria for transverse direction.<br>The minimum absorbed energy for full size specimens shall be 41 J average and 33 J single in the transverse direction and 81 J average and 65 J single when testing in the longitudinal direction is carried out.<br>The impact test specimens shall be taken from mid-thickness position.<br>Reduction factors for sub-size specimens shall be: 7,5 mm - 5/6 and 5 mm - 2/3. | | | |
| ***Tensile testing*** | Yield to tensile ratio, $R_{t0,5}/R_M$ shall be maximum 0,90.<br>Reduction of area shall be minimum 35 %. | | | |
| ***Metallographic testing*** | Metallographic testing shall be taken from the same locations as the tensile tests. Magnification shall be both 200× and 500×. The prior austenite grain size shall be determined in accordance with ASTM E112. The prior austenite grain size shall be 5 or finer. No banding of microstructure is permitted. | | | |
| ***Hardness testing*** | Hardness testing shall be performed in accordance with the requirements in ASTM A370 on two forgings per lot. When only one part is produced, this part shall be hardness tested as required. The maximum hardness shall be 22 HRC from three readings per part. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Non-destructive testing*** | VT shall be carried out on each forging in accordance with the product standard. The testing shall be performed after machining, if applicable, and non-machined surfaces shall be cleaned prior to the testing.<br>All forgings shall be 100 % tested after final machining by the magnetic particle method in accordance with ASME BPVC V article 7. All accessible internal and external surfaces shall be examined. Acceptance criteria shall be in accordance with ASME BPVC VIII Div. 1 Appendix 6.<br>Ultrasonic testing shall apply to all forgings with greatest cross section thickness exceeding 50 mm. The testing shall be carried out to ASTM A388/A388M and dedicated procedure with scanning plan. Supplementary requirement S1 shall apply.<br>Acceptance criteria:<br>— no single indication exceeding reference distance amplitude curve;<br>— no multiple indications exceeding 50 % of reference distance amplitude curve is allowed. Multiple indications are defined as two or more indications (each exceeding 50 % of the reference distance amplitude curve) within 13 mm of each other in any direction. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements:<br>The material shall be traceable in accordance with ISO 15156-2 / ANSI/NACE MR0175 and this MDS.<br>Ni < 1,0 % |
| ***Marking*** | The forgings shall be marked to ensure full traceability to melt and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1, unless specified otherwise by the purchaser.<br>The inspection documents shall include the following information:<br>— Steel manufacturer, melting and refining practice;<br>— Heat treatment condition (for tempered condition, tempering temperature and holding time). |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. D111 / D111S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL:*** **Ferritic-Austenitic stainless steel type 22Cr duplex** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Seamless pipes** | ASTM A790/A790M | UNS S31803, UNS S32205 | - | - |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Qualification*** | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| ***Metal making*** | The melt shall be refined by AOD or equivalent method. | | | |
| ***Chemical composition*** | UNS S31803: N = 0,14 % - 0,20 % | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Heat treatment*** | The pipes shall be solution annealed followed by rapid cooling.<br>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 rapid cooling. |
| ***Test sampling*** | Where pipe dimension does not allow taking test specimens in transverse direction specimens shall be taken in longitudinal direction. |
| ***Extent of testing*** | One tensile, one set of impact tests, corrosion test and one micrographic examination including ferrite measurements shall be carried out for each heat and heat treatment lot. |
| ***Impact testing/ Toughness testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall conform with ISO 17781 QL I for testing in the transverse and longitudinal direction.<br>NOTE Impact testing is only applicable for wall thickness ≥ 6 mm and when the pipe dimension allows extraction of a test sample. |
| ***Corrosion testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781. |
| ***Micrographic Examination*** | The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781. |
| ***Non-destructive testing*** | The pipe shall undergo testing and pass acceptance criteria according to ASME BPVC VIII Div. 3 KE-240. |
| ***Repair of defects*** | Weld repair is not permitted. |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: |
| | *Hardness testing*<br>Hardness testing shall be performed in accordance with the requirements in ASTM A370 / ASTM A1058 on one length of pipe per lot. The maximum hardness shall be 28HRC from three readings taken in close proximity. |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. |
| ***Surface treatment and finish*** | Finished pipes shall be white pickled or bright annealed. Machined surfaces do not require pickling. |
| ***Marking*** | The pipes shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be issued in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— The MPS identification or the MPCR/QTR number used;<br>— Steel manufacturer;<br>— Solution annealing temperature, holding time and cooling medium (holding time is not applicable for pipes produced hot finished and direct quenched). |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. D112 / D112S** [a] | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Ferritic-Austenitic stainless steel type 22Cr duplex*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| **Welded pipes** | ASTM A928/A928M | UNS S31803, UNS S32205 | Class 1, 3 and 4 | ASTM A928/A928M S3, S4 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Qualification*** | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| ***Metal making*** | The melt shall be refined by AOD or equivalent method. | | | |
| ***Chemical composition*** | UNS S31803: N = 0,14 % - 0,20 % | | | |
| ***Welding*** | The WPS shall be qualified in accordance with ISO 15614-1 or ASME BPVC IX, shall include the same examinations as for the production testing and shall fulfil the acceptance criteria of ISO 17781. 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. | | | |
| ***Heat treatment*** | The pipes shall be solution annealed followed by rapid cooling.<br>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 rapid cooling. | | | |
| ***Impact testing/ Toughness testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall conform with ISO 17781 QL I.CVN test specimens may be oriented in longitudinal direction when combination of OD, ID and wall thickness does not allow orienting the test specimen in transverse direction. | | | |
| ***Corrosion testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781. | | | |
| ***Micrographic Examination*** | Supplementary requirement S4 shall apply as modified by this MDS.<br>The sampling of test specimens, testing methodology and acceptance criteria for microstructural examination including ferrite measurements shall be in accordance with ISO 17781. | | | |
| ***Extent of testing*** | One tensile, one set of impact tests, corrosion test, and one micrographic examination including ferrite measurement shall be carried out for each heat and heat treatment lot.<br>A lot of pipe is defined as the quantity of product not exceeding the lot definition in the standard and from the same heat, same processing conditions including weld procedure and same heat treatment load. For continuous furnaces, the lot definition shall conform with the product standards. | | | |
| ***Non-destructive testing*** | The pipe shall undergo testing and pass acceptance criteria according to ASME BPVC VIII Div. 3 KE-240.<br>Supplementary requirement S3, penetrant testing, according to ASME BPVC V Article 6 shall apply to 100 % of the weld area of 10 % of the pipes (same test lot as defined for mechanical testing) delivered.<br>The testing shall be carried out after calibration and pickling.<br>Acceptance criteria shall be to ASME BPVC VIII, Div. 1 Appendix 8. | | | |
| ***Repair of defects*** | Weld repair of base material is not permitted.<br>For repair of welds, the requirements for production welding above shall apply to the repair WPS. Repair welds shall be heat treated as per the original production weld. | | | |
| ***Sour service (additional metallurgical, manufacturing, testing and certification requirements)*** [a] | When sour service requirements are specified by the purchaser, the material shall conform to the requirements of the ISO 15156 series / ANSI/NACE MR0175 and the following additional requirements: | | | |
| | The material shall be traceable in accordance with ISO 15156-3 / ANSI/NACE MR0175 and this MDS. | | | |
| ***Surface treatment and finish*** | Finished pipes shall be white pickled or bright annealed. Machined surfaces do not require pickling. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

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| ***Marking*** | The pipes shall be marked to ensure full traceability to heat and heat treatment lot. |
| ***Certification*** | The material manufacturer shall have a quality system in place (e.g. ISO 9001) accepted by the purchaser.<br>The inspection documents shall be in accordance with ISO 10474 / EN 10204 type 3.1 and shall confirm compliance with this specification.<br>The inspection documents shall include the following information:<br>— MPS identification or MPCR/QTR number used;<br>— Manufacturer of the starting material;<br>— Solution annealing temperature, holding time and quench medium. |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.

| **Material Data Sheet** | **MDS No. D113 / D113S [a]** | | | **Rev. 1** |
|---|---|---|---|---|
| ***TYPE OF MATERIAL: Ferritic-Austenitic stainless steel type 22Cr duplex*** | | | | |
| ***PRODUCT FORM*** | ***STANDARD*** | ***GRADE*** | ***ACCEPTANCE CLASS*** | ***SUPPLEMENTARY REQUIREMENT*** |
| **Wrought fittings** | ASTM A815/A815M | UNS S31803, UNS S32205 | WP-S or WP-WX | ASTM A815/A815M S2, S7<br>ASTM A388/A388M S1 |
| ***Scope*** | This MDS defines applicable options and/or requirements that supplement or amend the referenced standard specification. | | | |
| ***Qualification*** | Manufacturers and the manufacturing process shall be qualified in accordance with ISO 17782 or NORSOK M-650. The qualification testing shall meet the requirements of this MDS. | | | |
| ***Metal making*** | The melt shall be refined by AOD or equivalent method. | | | |
| ***Chemical composition*** | UNS S31803: N = 0,14 % - 0,20 % | | | |
| ***Welding*** | The WPS shall be qualified in accordance with ISO 15614-1 or ASME BPVC IX , shall include the same examinations as for the base material and shall meet the acceptance criteria of ISO 17781. 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. | | | |
| ***Heat treatment*** | The fittings shall be solution annealed followed by water/liquid quenching.<br>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. | | | |
| ***Test sampling*** | Test sampling shall be made from an actual fitting, from a prolongation thereof, or if not possible, a length of starting material that has been heat treated in the same heat treatment load as the fittings it represents. | | | |
| ***Tensile testing*** | Supplementary requirement S2 shall apply. | | | |
| ***Impact testing/ Toughness testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall conform with ISO 17781 QL I.<br>CVN test specimens may be oriented in longitudinal direction when combination of OD, ID and wall thickness does not allow orienting the test specimen in transverse direction. | | | |
| ***Corrosion testing*** | The sampling of test specimens, testing methodology and acceptance criteria shall be in accordance with ISO 17781. | | | |

[a] The supplementary suffix "S" shall be used to designate a material delivered in accordance with the MDS plus the additional supplementary requirements for sour service.