

GENERAL SPECIFICATION

SUBSEA SYSTEMS

GS EP SPS 035

Material specification for Duplex 22Cr and Super Duplex 25Cr Stainless Steel subsea equipments

01	05/2015	Organisation change – January 2015
00	09/2014	First issue
Rev.	Date	Purpose of the revision

Owning entity: DSO/TEC

Managing entity: DSO/TEC/SBS

Document update realised by
standards coordination
Reorganisation 2015

General Specification		GS EP SPS 035
Material specification for Duplex 22Cr and Super Duplex 25Cr Stainless Steel subsea equipments		
Rev.: 01	Effective date: 05/2015	Page: 2 of 24

Contents

1. Scope	4
2. Reference documents	4
3. QA/QC	6
3.1 General requirements	6
3.2 Inspection by the Company	6
4. Material and fabrication requirements	6
4.1 General requirements	6
4.2 Forged components	7
4.3 Pipes	7
4.4 Hot Isostatic Pressing (HIP)	8
4.5 Heat treatment	8
5. Testing	9
5.1 Lot definition	9
5.2 Sampling	10
5.3 Chemical composition	10
5.4 Mechanical properties	11
5.5 Metallurgical properties	12
5.6 Failure of tests - retests	13
6. Non-Destructive Examination	13
6.1 Non-Destructive Examination of pipes	14
6.2 Non-Destructive Examination of fittings, flanges, valve bodies and other components ..	15
7. Repair by welding	17
8. Finishing	17
9. Pickling and passivation	17
10. Positive Material Identification (PMI)	17
11. Marking	17

General Specification		GS EP SPS 035
Material specification for Duplex 22Cr and Super Duplex 25Cr Stainless Steel subsea equipments		
Rev.: 01	Effective date: 05/2015	Page: 3 of 24

12. Packing and handling	17
12.1 Packing and storage	17
12.2 Handling.....	18
13. Certificates.....	18
14. Documentation	18
14.1 Documentation to be approved prior to manufacture.....	18
14.2 Documentation to be delivered with the products	19
15. Requirements for Duplex Stainless Steels	20
15.1 General.....	20
15.2 Chemical composition	20
15.3 Mechanical properties	20
15.4 Pitting corrosion resistance	21
16. Requirements for Super Duplex Stainless Steels	22
16.1 General.....	22
16.2 Chemical composition	22
16.3 Mechanical properties	23
16.4 Pitting corrosion resistance	24

1. Scope

This specification covers the requirements for subsea equipment made in duplex 22Cr and super duplex 25Cr stainless steel for piping and pressure containing components. This specification covers seamless pipes, fittings (tees, elbows, reducers, sweepolets), flanges, valve bodies and other components either in the form of forged products or Hot Isostatic Pressed products.

The manufacturer of material to this specification shall as a minimum have an approved [NORSOK M-650](#) qualification and process for the relevant product form, size and grade. This approved manufacturing process shall be used in the manufacture of the relevant product to meet this specification.

Components for use in hydrogen sulfide service shall also conform to the requirements of [ISO 15156-3](#).

2. Reference documents

The reference documents listed below form an integral part of this General Specification.

External Documents

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the effective date of this document.

Reference	Title
API SPEC 6A	Specification for wellhead and Christmas tree equipment
ISO 10423	Petroleum and Natural Gas Industries - Drilling and Production Equipment - Wellhead and Christmas Tree Equipment
ASTM A182	Standard Specification for forged or rolled alloy and stainless steel pipe flanges, forged fittings, and valves and parts for high-temperature service
ASTM A370	Standard Test Methods and Definitions for Mechanical Testing of Steel Products
ASTM A380	Standard Practice for Cleaning, Descaling and Passivation of Stainless Steel parts, Equipment and Systems
ASTM A388/A388M	Standard Practice for ultrasonic examination of heavy steel forgings
ASTM A745	Standard Practice for Ultrasonic Examination of Austenitic Steel forgings
ASTM A789	Standard Specification for Seamless and Welded Ferritic/Austenitic Stainless Steel Tubing for General Service
ASTM A790	Standard Specification for Seamless and Welded Ferritic/Austenitic Stainless Steel Pipe

Material specification for Duplex 22Cr and Super Duplex 25Cr
Stainless Steel subsea equipments

Rev.: 01

Effective date: 05/2015

Page: 5 of 24

Reference	Title
ASTM A815/A815M	Wrought ferritic, ferritic-austenitic and martensitic stainless steel piping fittings
ASTM A923	Standard test methods for detecting detrimental intermetallic phase in duplex ferritic-austenitic stainless steels
ASTM A960/A960M	Standard specification for common requirements for wrought steel piping fittings
ASTM A988	Standard specification for Hot Isostatically Pressed stainless steel flanges, fittings, valves and parts for high temperature service
ASTM A991	Standard test method for conducting temperature uniformity surveys of furnaces used to heat treat steel products
ASTM A999/A999M	Standard specification for general requirements for alloy and stainless steel pipe
ASTM E165	Standard test method for liquid penetrant examination
ASTM E213	Standard practice for ultrasonic examination of metal pipe and tubing
ASTM E309	Standard practice for Eddy Current examination of steel tubular products using magnetic saturation
ASTM E384	Standard test method for Knoop and Vickers hardness of materials
ASTM E562	Standard test method for determining volume fraction by systematic manual point count
EN 10204	Metallic products - Types of inspection documents
ISO 148-1	Metallic materials - Charpy pendulum impact test - Part 1: Test method
ISO 15156-3	Petroleum and natural gas industries - Materials for use in H ₂ S-containing environments in oil and gas production - Part 3: Cracking-resistant CRAs (corrosion-resistant alloys) and other alloys
ISO 17025	General requirements for the competence of testing and calibration laboratories
ISO 6892-1	Metallic materials - Tensile testing - Part 1: Method of test at room temperature
ISO 9712	Qualification and certification of NDT personnel
NORSOK M-650	Qualification of manufacturers of special materials

General Specification		GS EP SPS 035
Material specification for Duplex 22Cr and Super Duplex 25Cr Stainless Steel subsea equipments		
Rev.: 01	Effective date: 05/2015	Page: 6 of 24

Total General Specifications

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published in the applicable yearly collection.

Reference	Title
Not applicable	

3. QA/QC

3.1 General requirements

Prior to the start of component manufacture, the Supplier shall prepare and submit to Company a written Inspection and Testing Plan (ITP) which describes the inspections to be performed during the supply of components at any stage. The ITP shall set forth "witness", "hold", "review" and "monitors" points for each party (Supplier, Contractor, Company and Third Party).

3.2 Inspection by the Company

All documentation as listed in paragraph 14.1 of this document shall have prior approval of the Company. All qualification tests shall take place under the supervision of the Inspector.

The Supplier shall notify the Inspector sufficiently in advance to enable him to be present at qualification tests and at all other tests or stages of manufacture subject to acceptance in accordance with this specification and ITP.

The Supplier shall ensure that the Inspector has full and free access to all parts of the Mill during all stages.

The Company reserves the right to re-check and verify tests carried out by the Supplier. For this purpose, the Company may request the delivery of samples or specimens for analysis in an independent laboratory selected by the Company.

4. Material and fabrication requirements

Manufacture shall not commence until the Company has reviewed and approved the Supplier Inspection and Test Plan (ITP) and the Manufacture Procedure Specification (MPS). The Manufacture Procedure Specification shall include all factors that influence the quality and reliability of the component.

4.1 General requirements

All fabrication and control operations shall be defined in the MPS established by the Supplier. This MPS shall be provided to the Company with the following information:

- Steel making, casting and refining methods
- Chemical composition
- Manufacturing process with forming method
- Heat treatment conditions (solution annealing)
- Destructive and non destructive testing

General Specification		GS EP SPS 035
Material specification for Duplex 22Cr and Super Duplex 25Cr Stainless Steel subsea equipments		
Rev.: 01	Effective date: 05/2015	Page: 7 of 24

- Pickling and passivation
- Marking
- Transportation protection.

The following requirements shall be followed:

- Duplex and super duplex stainless steels shall be melted using the basic electric-arc furnace followed by ladle refining and degassing using vacuum oxygen de-oxygenation (VOD) or argon oxygen de-oxidation (AOD)
- Duplex and super duplex stainless steels shall be Hot Isostatic Pressed (HIPed), forged, extruded, drawn or rolled
- Paint and markers containing zinc or chloride are prohibited
- Correction of deflection by flame straightening is prohibited
- The raw material supplier shall be indicated in the MPS or ITP
- All components shall be delivered in conformance with the requirements of the referenced standard and the requirements of the present specification.

[API SPEC 6A](#) or [ISO 10423](#) PSL3 requirements shall apply in addition to the requirements of this specification.

4.2 Forged components

Forged components shall be forged to shape. The minimum reduction ratio shall be 4:1.

The minimum reduction ratio does not apply to fittings made by forming seamless pipe.

Cold formed fittings are not permitted.

Forged bars with outside diameter more than 88.9 mm (3") are not permitted as per [ASTM A960/A960M](#) supplementary requirement S55.

Forged bars with outside diameter less than or equal to 88.9 mm (3") are allowed providing tests in both directions are acceptable (transverse and longitudinal directions).

Fittings machined from plates are not permitted.

For heavy wall components (with thickness ≥ 150 mm), pre-boring shall be carried out before heat treatment.

All the flanges shall be punched prior to heat treatment.

4.3 Pipes

4.3.1 Large bore piping

Seamless extruded pipes shall be used. As an option, trepanned forged pipes are also acceptable. Seam welded pipes shall not be used.

4.3.2 Small bore piping

Seamless extruded and cold drawn pipes shall be used. Both bright annealing heat treatment and continuous furnace annealing followed by pickling and passivation are acceptable.

4.4 Hot Isostatic Pressing (HIP)

Hot Isostatic Pressed (HIPed) duplex stainless steels components can be used and are recommended for their good resistance to HISC.

HIPed components shall be manufactured according to [ASTM A988](#) and this specification.

The density of the HIPed components shall be 100%.

4.5 Heat treatment

All components shall be delivered in the solution annealed (SA) water quenched condition.

Heat treatment shall be performed after all forming and straightening operations but before the final machining operations (if any).

The solution annealing temperature shall be performed in accordance with [ASTM A182](#) and [ASTM A815/A815M](#) for forged components, [ASTM A789](#) and [ASTM A790](#) for seamless pipes and with [ASTM A988](#) for HIPed products.

Close attention shall be given to the very important items listed below:

- The solution annealing temperature shall be maintained to allow sufficient soaking time at mid-thickness for heavy wall components and to parts located at the centre of the furnace
- In case of batch furnace heat treatment, the ramp-up shall not be more than 200°C/hour
- Quenching of duplex and super duplex stainless steels shall be sufficiently rapid to avoid the precipitation of detrimental phases
- The transfer time from the heat treatment furnace to the cooling media shall be less than 60 seconds and shall be recorded.

4.5.1 General requirements

The following requirements shall be followed:

- Heat treatment procedures shall be submitted to Company for approval
- Only furnace heat treatment shall be carried out. Induction heat treatment shall not be permitted
- Direct quenching after hot extrusion is permitted
- The furnace shall be either a continuous or batch-type furnace controlled within a range of $\pm 14^{\circ}\text{C}$ and equipped with recording pyrometers so that complete records of heat treatment are available
- A furnace loading sketch with photographs shall be submitted to Company
- Thermocouples shall be attached to the parts to be heat treated