

GENERAL SPECIFICATION

SUBSEA SYSTEMS

GS EP SPS 037

Welding of Duplex 22Cr and Super Duplex 25Cr Stainless Steel for subsea equipments

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1. Scope

This specification covers the requirements for the welding of subsea equipments made in Duplex (typically 22Cr - 05Ni) and Super Duplex (typically 25Cr - 07Ni) Stainless Steel.

This specification is to be considered as a supplement to either:

- [API SPEC 6A](#)
- [API SPEC 17D](#)

and their respective associated standards.

This specification applies to all welding activities on piping and pressure containing components including prefabrication and site activities of seamless pipes, fittings (tees, elbows, reducers, sweepolets), flanges and other equipment installed in the piping systems (bodies, valves, etc.) either in the form of forged products, seamless pipes or Hot Isostatic Pressed products.

Welds 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 17D	Design and Operation of Subsea Production Systems - Subsea Wellhead and Tree Equipment
API SPEC 6A	Specification for Wellhead and Christmas Tree Equipment
ASME BPVC Section IX	Qualification Standard for Welding and Brazing, Welders, Brazers, and Welding and Brazing Operators
ASME BPVC Section VIII Div 1	Rules for Construction of Pressure Vessels
ASTM A370	Standard Test Methods and Definitions for Mechanical Testing of Steel Products
ASTM A380/A380M	Standard Practice for Cleaning, Descaling and Passivation of Stainless Steel parts, Equipment and Systems
ASTM A923	Standard Test Methods for Detecting Detrimental Inter metallic Phase in Duplex Austenitic/Ferritic Stainless Steels
ASTM E384	Standard Test Method for Knoop and Vickers Hardness of Materials

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Reference	Title
ASTM E562	Standard Test Method for Determining Volume Fraction by Systematic Manual point Count
EN 10204	Metallic products - Types of inspection documents
EN 287-1	Qualification test of welders - Fusion welding - Part 1: Steels
ISO 11699-1	Non-destructive testing - Industrial radiographic film - Part 1: Classification of film for industrial radiography
ISO 14175	Welding consumables - Gases
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 15607	Specification and qualification of welding procedures for metallic materials - General rules
ISO 15609-1	Specification and qualification of welding procedures for metallic materials - Welding procedure specification - Part 1: Arc welding
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 19232-5	Non-destructive testing - Image quality of radiographs - Part 5: Determination of the image unsharpness value using duplex wire-type image quality indicators
ISO 3834-2	Quality requirements for fusion welding of metallic materials - Part 2: Comprehensive quality requirements
ISO 4136	Destructive tests on welds in metallic materials - Transverse tensile test
ISO 5173	Destructive tests on welds in metallic materials - Bend tests
ISO 9712	Non-destructive testing - Qualification and certification of NDT personnel
ISO/IEC 17025	General requirements for the competence of testing and calibration laboratories

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. General qualification fabrication and welding requirements

3.1 General

All welding and related activities shall comply with the requirements of [ISO 3834-2](#) and the additional requirements in this specification.

Manufacture shall not commence until the Company has reviewed and approved:

- Inspection Testing Plan (ITP)
- Welding Procedure Specification (WPS) and associated Welding Procedure Qualification Report (WPQR)
- And all requested documentation listed in Appendix 1 of this specification.

The Welding Procedure Specification shall include all factors which influence the quality and reliability of the components.

Materials shall be inspected after delivery on site. All damage shall be reported to the Company representative.

Correlation between marking on materials and materials certificates shall be checked by the Contractor, prior to fabrication.

Contact between stainless steel and carbon steel is prohibited.

The workshop, which shall be clean and free from oil and grease, shall be dedicated for fabrication of stainless steel only. The workshop shall be sufficiently draught free to ensure adequate gas shielding. A reception workshop certificate shall be filled-in before the start of fabrication and shall be periodically reviewed to follow the fabrication quality. A form of document is proposed in Appendix 2.

All the tools, except machining tools, shall not have been used on either carbon steel or any other grade of stainless steel. The following precautions shall be implemented:

- Grinding disks shall be free from iron and carbon
- Wire brushes shall be stainless steel
- Earth connection of welding and cutting equipment shall be stainless steel
- Cutting shall be carried out only by plasma or by mechanical sawing¹.

¹ Chloride content in machining oil shall be limited to 1.0 ppm.

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In case of condensation on materials, humidity shall be eliminated by using hot air blowers and/or by controlled induction heating. To prevent any oxidation the use of air/gas torch is prohibited.

Oil, moisture, rust, scale, paint or other foreign matter shall be removed from the weld surface and at least 50 mm of adjacent base metal prior welding.

Contamination of surface, weld bevel and surrounding areas with low melting point metals such as Copper, Zinc, etc., are not acceptable.

Inner and outer surface of weld preparation shall be:

- Thoroughly cleaned by wire brushing using a stainless steel wire brush
- Followed by de-greasing with solvent free from chloride and in accordance with local health and safety regulations.

Paint and markers containing zinc or chloride are prohibited.

Stringer beads shall be used. Minor arc oscillation to ensure side wall fusion is permitted.

Correction of deflection by flame straightening is prohibited.

Grinding of all start/stop is required.

The bevels shall be prepared by machining¹, but a preparation by automatic plasma cutting is acceptable. The heat affected zone shall then be removed by grinding.

Company shall be notified for all welding procedure qualifications and mechanical testing performances and also for starting of welding production. These Welding Procedure Qualifications shall be performed in the Workshop facilities (and sub-vendor facilities).

3.2 Shielding and backing gas protection

All gas shall be certified to [ISO 14175](#) with the following additional requirements described in sub-paragraph 3.2.3.

All gas shall be identified in both the WPS and WPQR by manufacturer and trade name.

3.2.1 Shielding gas

The shielding gas shall be 100% Argon or Argon + 2% Nitrogen minimum.

Shielding gases shall not contain Hydrogen.

3.2.2 Backing gas protection

The back purge shall be made with 100% Argon or 100% Nitrogen or Argon + 2% Nitrogen minimum.

The oxygen content of the backing gas shall be measured with digital monitoring equipment which indicates values in ppm units.

The oxygen level in the backing gas protection shall be less than 500 ppm.

The addition of hydrogen in shielding and backing gas is prohibited.

Backing gas protection during qualification tests as well as during fabrication must be maintained until completion of the first four passes or a minimum of 5 mm of deposited weld metal.

The oxygen level in the backing gas protection shall be checked and recorded in ppm units during the qualification tests until the end of weld performance.

During the fabrication, the oxygen level shall be checked and continuously recorded in ppm units until completion of the first four passes or of 5 mm of deposited metal.

In production, the oxygen level shall be in accordance with the level obtained during the qualification tests. The oxygen level taken as a reference for the qualification and fabrication will be the oxygen level measured at the start of the qualification weld.

The internal checking point of oxygen level shall be located in the upper quadrant (12 o'clock position) of the pipe, unless proven technically impossible.

Before production start, the Contractor shall send to the Company, for approval, the back purging and oxygen level measurement methods to be applied.

3.2.3 Gas composition

Gas composition shall be as defined hereunder:

- Dew point shall not be higher than -50°C
- Purity of the gas (Argon, Nitrogen, Argon + 2% Nitrogen minimum) > 99.999%
- H₂O < 10 ppm
- O₂ < 10 ppm
- CO₂ < 10 ppm
- Hydrocarbon < 5 ppm.

4. Welding documents

4.1 General

Welding procedures without filler metal are prohibited.

4.2 Welding Book

Prior to fabrication, a welding book shall be submitted to the Company for review.

The welding book including repair procedures shall be submitted as soon as possible after the award of work prior to any fabrication or any parts and sufficiently ahead of the actual welding for the review of the Company.

The welding book shall be fully transmitted each time a new revision is issued.

4.3 Welding Procedure Specifications (WPS)

Welding procedure specifications shall be established for all welding and shall follow [ISO 15607](#) requirements.

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Only the Company signed WPS shall be used for fabrication.

Applicable welding procedure specifications shall indicate the diameter and thickness range as appropriate.

A welding procedure is defined as the method and sequences to be adopted to achieve a satisfactory welded joint when carried out by a competent workman under the expected conditions of manufacture.

All welding procedures submitted to the Company shall include the actual welding details including all of the essential and non-essential variables and in particular the weld preparation and the bead sequence.

The actual job welding parameters shall be within the range used for the procedure qualification.

Weld procedures shall state the actual consumable or flux trade name and type as well as the code designation.

The welding procedure shall be issued on [ASME BPVC Section IX form QW 482](#) or equivalent such as [ISO 15609-1 Annex A](#).

4.4 Welding Procedure Qualification Record (WPQR)

All welding procedures shall be qualified in accordance with the requirements of [ISO 15614-1](#) or equivalent and the requirements given in this specification.

Previous welding qualifications shall not be accepted, and all welding procedures shall be qualified for the job concerned unless previously agreed by the Company.

Welding qualifications shall be performed on the actual site of production welding.

4.4.1 Welding essential variables

The following additional changes in the qualified procedure shall also require re-qualification of the procedure:

General

- For super duplex stainless steel, UNS number shall be considered as an essential variable.
- Change from one UNS number to another will require a new weld procedure qualification.
- Any change in company which performed the qualification test or site where the qualification test weld was produced.
- Welding procedure qualification with a duplex stainless steel base metal does not qualify welding procedure on super duplex stainless steel and vice versa.
- If any essential variable is exceeding its qualified range, during production welding then, relevant weld shall be cut-out and base metal shall be re-bevelled.

4.4.1.1 Base material

- Any change in wall thickness beyond the qualified ranges given below:

	Test weld thickness - mm	Qualified Thickness range - mm	Qualified OD range - mm
Butt welds	$t \leq 5$ $t > 5$	t to $1.25 t$ $0.75 t$ to $1.25 t$	0.5D to 2D

Where:

t = nominal wall thickness

D = Outside Diameter

- All the weld test coupons shall be taken from the concerned job bulk.

4.4.1.2 Welding consumables and gas

- Any change in welding consumable brand name.
- Any change in batch of welding consumable.
- Any change in nominal composition of shielding gas or backing gas.

4.4.1.3 Welding position

- Welding direction downhill to uphill and vice versa.
- Any change in welding position beyond the position range given below shall be re-qualified:

Pipe / fitting position	
Test weld	Qualified
5G	Horizontal $\pm 15^\circ$
2G	Vertical $\pm 15^\circ$
Any other position (6G...)	Qualified position $\pm 15^\circ$
2G + 5G	Do not qualify 6G position

4.4.1.4 Welding technique

- Any increase or decrease of the heat input greater than 10% of that used in the qualification.
- Any increase of maximum interpass temperature.
- Any change in flow rate beyond $\pm 10\%$.