



Exploration & Production

GENERAL SPECIFICATION

PIPING VALVES VESSELS

GS EP PVV 614

Welding of duplex and superduplex stainless steel

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1. Scope

This specification summarises basic requirements for fabrication and welding of duplex (typically 22 Cr - 05 Ni) and superduplex (typically 25 Cr - 07 Ni) stainless steel pressure vessels and piping networks.

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

- Pressure vessel code (ASME or **BSI PD 5500**)
- **ASME B31-3** and **API RP 14E** for piping

and their respective associated standards.

This specification applies to all welding activities on pressure vessels and piping including prefabrication, site and field installation of tubes, fittings, flanges and other equipment installed in the piping systems (valves, etc.).

2. Reference documents

The reference documents listed below form an integral part of this General Specification. Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and supplements, is the latest revision published at the EFFECTIVE DATE of the CONTRACT.

Standards

Reference	Title
ASTM E 562	Standard Test Method for Determining Volume Fraction by Systematic Manual point Count
ASTM E 1815	Standard Test Method for Classification of Film Systems for Industrial Radiography
ASTM G 48	Standard Test Methods for Pitting and Crevice Corrosion Resistance of Stainless Steels and Related Alloys by Use of Ferric Chloride Solution
EN 287	Approval testing of welders - Fusion welding
EN 288	Specification and Approval of Welding Procedures for Metallic Materials
EN 473	General principles for qualification and certification of NDT personnel
EN 584-1	Non destructive testing - Industrial radiographic film - Part 1: Classification of film systems for industrial radiography
EN ISO 15614	Specification and qualification of welding procedures for metallic materials. Welding procedure test
ISO 5579	Non-destructive testing - Radiographic examination of metallic materials by X-rays and gamma rays - Basic rules
NACE MR0175/ISO 15156	Materials for use in H ₂ S-containing environments in oil and gas production

Professional Documents

Reference	Title
API RP 14E	Design and Installation of Offshore Production Platform Piping Systems
SNT-TC-1A	American Society for Non-destructive Testing Recommended Practice

Regulations

Reference	Title
Not applicable	

Codes

Reference	Title
ASME B31.3	Process piping
ASME Section V	Non Destructive Methods of Examination
ASME Section VIII	Boiler and Pressure Vessel Code
ASME Section IX	Qualification Standard for Welding and Brazing, Welders, Brazers, and Welding and Brazing Operators
BSI PD 5500	Specification for unfired fusion welded pressure vessels

Other documents

Reference	Title
Not applicable	

Total General Specifications

Reference	Title
GS EP COR 560	Physical and chemical treatment of hydrostatic test water
GS EP PVV 112	Piping material classes
GS EP PVV 171	Steel piping fabrication
GS EP PVV 175	Cleaning of piping and vessels
GS EP PVV 211	Design and fabrication of pressure vessels according to ASME VIII

Reference	Title
GS EP PVV 212	Design and fabrication of pressure vessels according to BSI PD 5500
GS EP PVV 619	Piping or pressure vessel components in duplex and superduplex stainless steel

3. General qualification fabrication and welding requirements

3.1 General

Manufacture shall not commence until the COMPANY has reviewed and approved the Contractor's Quality Plan and the Manufacture and Inspection Procedure Specification. The Manufacturing and Inspection Procedure Specification shall include all factors which influence the quality and reliability of the piping.

The CONTRACTOR shall transmit all fabrication procedures to the COMPANY for review. A tentative list of documents is defined in Appendix 1 of this specification.

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 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
- Brush 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.

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.

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

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 deflexion 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 welding procedure qualification 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 Backing gas protection

The back purge shall be made with argon or appropriate mixture approved by the COMPANY before starting qualification tests.

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

Backing gas protection during qualification tests as well as during fabrication must be maintained until completion of the first fourth 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 fourth 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.

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

Before production start, the CONTRACTOR shall send to the COMPANY, for approval, back purging and oxygen level measurement methods to be applied. This proposed method could be continuous or discontinuous with a minimum frequency to be agreed by the COMPANY.

Backing gas composition shall be as defined hereunder:

- Ar > 99,999%
- H₂O < 10 ppm
- O₂ < 10 ppm
- CO₂ < 10 ppm

- HC < 5 ppm
- N₂ < 40 ppm

4. Welding documents

4.1 General

Welds shall have a minimum of two (2) passes whatever are the welding process and the weld geometry.

Welding procedures without filler metal are prohibited.

4.2 Welding Book

Prior fabrication of piping components, 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 and sufficiently ahead of the actual welding for the review of the COMPANY.

Only the COMPANY signed WPS shall be used for fabrication.

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

4.3 Welding Procedure Specifications (WPS)

Applicable welding procedure specifications shall make reference to the relevant piping classes and 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 Section IX](#) form QW 482 or equivalent.

4.4 Welding Procedure Qualification Record (WPQR)

All welding procedures shall be qualified in accordance with the requirements of [ASME Section IX](#) form QW 482 or equivalent. 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 procedure qualification with a duplex stainless steel base metal does not qualify welding procedure on superduplex stainless steel and converse.

For superduplex 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.

4.4.1 General

The weld procedure qualification program shall include the following essential variables and range:

- Heat input: any increase the heat input greater than 10% of that used in the qualification
- Welding process or any change in welding process for any pass
- Weld consumable (electrode, wire or flux) including changing from one brand name to another
- Change of flux (if any) in GTAW process.

Sufficient advance notice should be given to allow the COMPANY representative or an Inspection Authority recognized by the COMPANY to witness here above operations.

- Welding of the test ring
- Non destructive examination
- Chemical, Mechanical and corrosion testing

After those WPQR and associated WPS shall be send to Company for approval.

In addition to the requirements of [ASME Section IX](#) or [EN 288](#), each welding procedure qualification shall include the tests detailed here below. Location of specimens is defined in Figure 1. Tests shall be made not less than twenty four hours after the total completion of the weld.

If any test result is not acceptable, resetting on double quantity of originally required test samples shall be done. If the result is acceptable on all test pieces from resetting, the relevant test weld is accepted. Conversely if any additional test result fails, the test weld is considered as not acceptable.

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

4.4.2 Guide bend test

Transverse bend test shall consist of two face bends and two root bends for wall thickness < 10 mm, and four side bends for wall thickness $\geq$ 10 mm. The jig diameter shall be four times the wall thickness of the test plate. Acceptance criteria shall be in accordance with relevant chapter of [ASME Section IX](#) or [EN 288](#).

4.4.3 Impact test

Impact tests shall be carried out either at the temperature stated below (for piping), or at the temperature defined for the specific job based on the design temperature (whichever is the lower).

Three sets of three Charpy-V specimens shall be tested at minus 46°C for duplex steel and minus 20°C for superduplex steel. One set shall be located in the weld metal and two sets shall be located in the heat affected zone (FL + 2 mm; FL + 5 mm). In case of wall thickness greater than 20 mm, three sets shall be taken off the external surface and three sets shall be taken off the internal surface. The acceptance criteria for 10 x 10 mm specimens shall be as follow:

- Average for three specimens: 40 joules
- Individual value: 28 joules.