



Exploration & Production

GENERAL SPECIFICATION

CORROSION

GS EP COR 401

Installation of anodes on submerged pipelines

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07	01/2011	Modification in bracelet anode type
06	10/2009	Test of electrical continuity before recoating
05	10/2008	Specification becomes limited to EP
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1. Scope

The Standard Specification sets out the technical requirements governing the installation of sacrificial anode bracelets designed to provide submerged pipelines with cathodic protection, with or without concrete weight coating.

The anode bracelets are installed from a laying barge or at an on-shore site.

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
BS 4515	Welding of steel pipelines on land and offshore
ISO 8501-1	Preparation of steel substrates before application of paints and related products - Visual assessment of surface cleanliness - Part 1: Rust grades and preparation grades of uncoated steel substrates and of steel substrates after overall removal of previous coatings

Professional Documents

Reference	Title
Not applicable	

Regulations

Reference	Title
Not applicable	

Codes

Reference	Title
Not applicable	

Other documents

Reference	Title
Not applicable	



Total General Specifications

Reference	Title
GS EP COR 102	Design of cathodic protection of sealine by sacrificial anodes
GS EP COR 201	Supply of sacrificial anodes
GS EP PLR 420	Site welding of carbon steel pipelines to API 1104 and DNV-OS-F101 (sweet service)
GS EP PLR 421	Site welding of carbon steel pipelines to API 1104 and DNV-OS-F101 (mild, intermediate and severe sour service)

3. Shape, dimensions and number of sacrificial anode bracelets

The quality, inspection and warranty requirements governing the supply of sacrificial anode bracelets are defined in [GS EP COR 201](#).

The Job Specification drawn up for each pipeline shall define the dimensions, weight, design and number of bracelets to be installed in compliance with [GS EP COR 102](#).

The two documents mentioned above, and this document shall be an integral part of any call for tenders for the supply and installation of sacrificial anode bracelets.

4. Installation of the bracelets

4.1 Bracelets positioning

4.1.1 On concreted pipelines

Sacrificial bracelet anodes shall be positioned in the middle of the concreted line pipes, or as a minimum at 3 m from the ends.

The Contractor shall provide a section free from concreted and without protruding reinforcing rods to prevent any contact with the bracelets to be installed.

4.1.2 On non concreted pipelines

On non concreted pipelines, bracelet anodes shall be positioned at the end of the line pipes, minimum 0.250 m from the end, outside of the butt jointing zone.

4.2 Assembly of bracelet anodes

Bracelet anodes shall be welded or clamped on and bolted to the sea lines providing that the Contractor demonstrates the anodes will not move during installation.

Any other assembly shall be submitted to Company for approval.

4.2.1 Assembly of half-shell anode bracelets

Before assembly, care shall be taken to ensure that the bracelet is squeezed and tightened over the pipeline external diameter.

The half-bracelets shall be assembled by bolting or by arc welding the transverse cores (Example of Appendix 1) in order to securely fix the anode to the pipe.

4.2.1.1 Bolting assembly

For bolting assembly of half-shells, the minimum recommended bolt torque shall be defined by the Contractor.

During the installation, it shall be checked systematically using a torque wrench.

Additionally, a welding point shall be carried out on each bolt to secure the assembly once the bolts are tightened.

Prior to installation, a shear test shall be carried out by Contractor to demonstrate the mechanical strength of the anode on the pipe.

The axial load to be applied to the anode over the pipeline shall be higher than the one expected in the stinger.

This test shall demonstrate that the anodes will not move during the pipe laying. If the test results are not satisfactory, the anode core/pad shall be welded to the pipeline to secure the assembly.

4.2.1.2 Welding assembly

Fillet welds between anode cores should be in agreement with § 8.5 of [GS EP PLR 420](#).

If the half-shell assembly requires a welding to the pipe, the welder and the relevant welding procedure shall be qualified as per the [GS EP PLR 420](#) (sweet service) or [GS EP PLR 421](#) (sour service).

4.2.2 Assembly of segmented anode bracelets

The half-bracelets are assembled by bolting, in pairs, in accordance with the drawing in Appendix 2.

This method of fixing may provide mechanical strength, but demonstration shall be carried out by the Contractor that the anodes will not move during installation (shear tests - § 4.2.1.1).

Note: For any bolted assembly, the electrical continuity between anode and pipeline shall be carried out by cables.

4.2.3 Assembly on concreted sea line

The assembly of half-shells or segmented anodes on a concreted sea line will entail particular specifications.

Where anodes are located in mid line pipe, the concrete Contractor shall execute a groove in the concrete such that **the meshed reinforcing steel rods cannot under any circumstances come into contact with the core of the anodes**.

This groove shall be as long as the overall length of the bracelet, plus two times 5 cm as a minimum.

After installation, these gaps on each side the anode shall be filled in by a rigid appropriated compound previously qualified by Company (epoxy resin, solid PU, guniting concrete, etc.).

4.3 Anode to pipeline electrical connections

The anodes to pipeline electrical connections are done either by welding of anode pads or through cables.

4.3.1 Welding of anode pads

Welding of anode pads is the preferred method for establishing electrical contact between the sacrificial anode and the sea line.

It shall be mandatory for deep sea pipelines and risers.

The lugs serving for electrical contact shall be positioned and shaped to achieve good contact with the pipe from which the coating has been stripped locally. This positioning shall take into account the presence or not of doubler plate (see § 10.20 of [GS EP PLR 420](#) or [GS EP PLR 421](#)).

The welders and welding procedures shall be qualified as per [GS EP PLR 420](#) (sweet service) or [GS EP PLR 421](#) (sour service).

4.3.2 Electrical connection through cables

In some cases defined here after, electrical connection between anode pads and pipe through cables may be accepted by the Owner for conventional depths, provided that the following requirements are fulfilled:

- 2 cables are used per anode
- Cables are protected from mechanical damage by adequate location and/or mastic infill in case of concrete weight coated pipelines
- Connection of cables to steel pipe is carried out either through a doubler plate (steel grade $\geq$ X60) or directly (steel grade $<$ X60), in full compliance with General Specifications [GS EP PLR 420](#) or [GS EP PLR 421](#)
- The cable connection process shall be qualified in accordance with General Specifications [GS EP PLR 420](#) or [GS EP PLR 421](#) prior to installation. Pin brazing by electrical discharge method is recommended for offshore and onshore connections, while cable connections by aluminothermy are only accepted at onshore site.

The kind of cable connections that may be accepted according to the type of installation (S-Lay, J-Lay and reel-lay) and the pipeline steel grade are clearly defined in § 10.20 of the General Specification [GS EP PLR 420](#).

For sour service pipelines, connections shall exclusively be done through doubler plates, as per the General Specification [GS EP PLR 421](#).

4.3.3 Other connection

Any other anodes to sea line connection shall be qualified prior to be proposed by the Contractor.

The Contractor shall provide all necessary information and a specific procedure.

A specific qualification test in presence of Company specialist shall be performed to validate the electrical connection.



4.4 Specific requirements for anode installation

4.4.1 Connection qualification requirements

In all cases where welding of anode pads or welding of doubler plates is applied, a fully qualified procedure is required in accordance with the requirement defined for the main pipe welding (GS EP PLR 420 or GS EP PLR 421).

In all cases where any pin brazing method or aluminothermy method is applied, a fully qualified procedure shall be required in accordance with BS 4515 and GS EP PLR 420 or GS EP PLR 421.

4.4.2 Welding qualification

All welding operations must be carried out by qualified welders according to a previously qualified procedure in full compliance with the GS EP PLR 420 or GS EP PLR 421.

The procedure submitted to the Owner for approval, shall specify:

- Preparation of the joints
- Execution of the joints
- Quality of welds/inspections.

Interconnecting plates shall be welded by continuous fillet welds around the entire periphery of each plate.

4.4.3 Preparation to anode connection

Before executing welds or pin brazing, the coating must be entirely removed at the point where the fixing lugs or flaps (shaped for welding) are to be fitted (according to the type of bracelet to be installed), or where the cable is to be connected.

To minimize damage to the coating, the reconstructed bracelet shall be offered up to the line pipe, in the welding position, to define the exact position where the connection to the pipe will be carried out.

The stripped areas shall be about 50 mm beyond the metallic elements to be connected.

4.4.4 Coating repairs

At the locations where the anode installation has created damage to the pipeline coating, coating repair shall be done.

Once fitted and welded, the bare surface of anode cores and/or fixing lugs shall be minimized by application of a suitable coating.

The surface shall be brushed clean prior to coating to grade of cleanliness ST 3 as specified in ISO 8501-1.

The coating product which shall be compatible with the parent coating, shall be applied immediately after the surface preparation.

Two components epoxy coating or resin (Pitch), or elastomer-based mastic shall be used to coat all metallic bare surfaces.

In the case of concreted line pipe, the reinforcing steel rods visible on either side of the groove shall be insulated (ref § 4.2.3).



5. Checking and inspection

5.1 Electrical continuity

The electrical continuity between anode and the sealine shall be checked after the connection.

The measured resistance between anode and the pipeline shall be less than 0.1 Ω .

5.2 Cable connection

The integrity of the cable connection between the anode and the sealine shall be checked by hand-pulling the cable.

No loose connection shall be accepted.

5.3 Coating inspection

After anode installation and electrical connection to the pipeline, the repaired pipeline coating shall be visually inspected and show no defect.

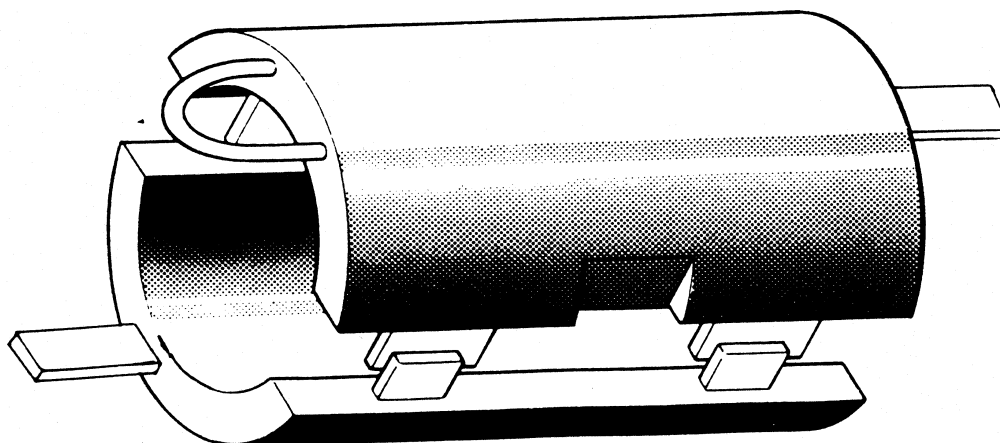
All visible parts of anode cores and/or fixing lugs shall also have no bare steel.

5.4 Electrical discontinuity between anodes and concrete rebars

On concreted pipelines, the electrical discontinuity between the anodes and the concrete rebars shall be checked after anode installation.

An electrical resistance of 1 M Ω or higher must be measured to guarantee there is no contact.

Appendix 1 Example of an half-shell anode bracelet



Appendix 2 Drawing of segmented anode bracelet

