

GENERAL SPECIFICATION

CORROSION

GS EP COR 402

Design of Jacket Cathodic Protection Retrofit Systems
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1. Scope

This document defines the minimum requirements for the design, calculation methods, selection of equipment and alloy materials, installation and commissioning for retrofitting of external cathodic protection on offshore fixed structures (platforms, wharfs, piers, jetties, piles, subsea templates and wells).

Cathodic protection retrofitting shall be implemented using galvanic (or sacrificial) anodes.

This document also gives the rules for anode distribution.

The requirements of the present document supersede those of reference documents, which shall be used in addition when necessary. Recommendations from EN standards or [DNV-RP-B401](#) related to fix or floating offshore structures and to harbour installations shall be followed where they are not conflicting with those of the present document.

This General Specification shall be used for retrofitting cathodic protection on existing structures which are already polarized. It shall never be used for providing cathodic protection to new structures to be installed offshore, as those shall be provided with their own integrated cathodic protection system.

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
DNV-RP-B401	Cathodic Protection Design
EN 12495	Cathodic protection for fixed steel offshore structures
ISO 15589-2	Petroleum and natural gas industries - Cathodic protection for pipeline transportation systems – Part 2: Offshore Pipelines

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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
GS EP COR 100	Design of cathodic protection of offshore structures
GS EP COR 201	Supply of sacrificial anodes
GS EP COR 350	External protection of offshore and coastal structures and equipment by painting
GS EP COR 501	Control of cathodic protection of submerged fixed structures
GS EP EXP 311	Plant integrity – Minimum inspection requirements
GS EP SPS 029	Metallic Materials for Subsea Production Facilities

3. Qualification and Certification of Cathodic Protection specialists responsible for the design

Design of cathodic protection retrofitting systems to be installed on offshore structures shall be carried out exclusively by competent specialised personnel. The qualification of each of the specialists working for such design shall be demonstrated to Company before commencement of the WORK.

Requirements for personnel qualification are given in [GS EP COR 100](#) chapter 3.

4. Preliminary assumptions

4.1 Definition of zones

The zones are defined in the [EN 12495](#) with the following deviations:

- Atmospheric (emerged) zone: for a platform, this zone is defined in [GS EP COR 350](#) as: Area between the crest level of the 50 year wave superimposed on the maximum surge height plus the normal Mean Height Water Springs (MHWS) and the top of the structure.
- Splash zone: Between the crest level of the 100 year wave superimposed on the maximum surge height plus the normal Mean Height Water Springs (MHWS) and 3 m below the Lowest Astronomical Tide (LAT), whichever is the greater.
- Mud line (immersed) zone: for a platform, area from the bottom of the jacket to 2 m above the stability floor.
- Buried zones: for a platform, part of piles and conductor pipes under the bottom of the jacket and buried in the seabed.

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4.2 Risers - Insulating joints - Appurtenances

Theoretically, the initial design of the original cathodic protection system should be compliant with the general provisions of General Specification [GS EP COR 100](#).

If this is not the case however, the person in charge of cathodic protection retrofit design shall clearly identify the differences in the Particular Project Specification so that they can be catered for in the final design.

4.3 Painting-Coating

Theoretically, the initial painting of the installation should be compliant with General Specification [GS EP COR 350](#).

If this is not the case however, the person in charge of cathodic protection retrofit design shall clearly identify the differences in the Particular Project Specification so that they can be catered for in the final design.

5. Calculation of cathodic protection

5.1 Protection criteria

For carbon steel, the potential achieved on the structure shall be:

- More negative than -800 mV/Ag-AgCl-sea water in **aerated** seawater or buried parts
- More negative than -900 mV/Ag-AgCl-sea water in a seawater environment with a high content of sulphate reducing bacteria and for the underside of the mud mats
- For carbon steel with SMYS greater than or equal to 550 MPa, the potential shall remain more positive than -1100 mV/Ag-AgCl-sea water.

For other materials, potential requirements shall be in accordance with [ISO 15589-2](#) Table 1 and material requirements shall be in accordance with [GS EP SPS 029](#) § 6 to avoid hydrogen embrittlement.

5.2 Current density

Jacket cathodic protection system retrofit shall be performed before depolarization of the structure.

Inspection and cathodic protection monitoring results together with the estimated lifetime of the installation shall be used to evaluate the need for retrofitting. In general the retrofitting shall be done when the potential is gradually becoming more positive as a function of time. Retrofitting shall be done in good time prior to the potential reaches -800 mV/Ag-AgCl-seawater. No retrofitting shall be done when the potential is more negative than -900 mV/Ag-AgCl-seawater.

The current density to be applied for the retrofit of the cathodic protection of bare steel shall be equal to the mean (maintenance) current density given for submerged zone in the [DNV-RP-B401](#) (January 2010), Annex A – Table 10-2, according to the 'climatic region' and depths.

For buried zone, this current density shall be 20 mA/m².

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The final (repolarisation) current density to be applied for the cathodic protection of submerged carbon steels shall also be as per [DNV-RP-B401](#) (January 2010), Annex A – Table 10-1. Current densities at the end of life are used to verify that the chosen anodes are capable of supplying the additional current required to re-polarise the structure, if necessary.

Current densities shall be increased by 10 % in the splash zone.

Current densities for the mud line zone shall be the same as for the submerged zone.

For equipment such as risers operating at elevated temperatures, current densities shall be increased by 1 mA per °C above 25°C.

Current drain to wells is 6 A per well for the remaining lifetime of the platform, except if otherwise specified.

These values may be modified in the Project Particular Specification if justified by actual site conditions and after Company Approval.

5.3 Resistivity

The resistivity of seawater as a function of geographic location should be as given in General Specification [GS EP COR 100](#) chapter 5.3. If more accurate resistivity values are measured in the vicinity of the structure and documented, they may be used after Company Approval.

5.4 Surfaces to be protected

The surface to be protected shall be divided in different zones (splash zone, submerged zone, mud line zone and buried zone). Cathodic protection for each of these zones shall be calculated separately.

The jacket shall also be divided into different zones (levels) as a function of depth. Calculations shall be carried out for each level separately.

Calculations shall include any other metallic surface electrically continuous with the jacket, unless they are already protected with their own, fit for purpose, cathodic protection system.

5.5 Coating breakdown factors

The coating breakdown factors shall be based on the recommendations given in General Specification [GS EP COR 100](#) chapter 5.5.

They shall take into account the age of the structure at the retrofit time and the extended service life.

6. Sacrificial anode systems

Indium activated aluminium alloy anodes shall be used, although special precautions must be taken for structures sensitive to hydrogen embrittlement following the requirements of the [GS EP SPS 029](#).

Compositions, quality requirements and control of the aluminium alloy anodes are given in General Specification [GS EP COR 201](#).

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6.1 Characteristics of the sacrificial alloy

Cathodic protection calculations shall take into account the potential and practical consumption (m) values guaranteed by the anode Supplier and verified during the qualification procedure. If the values are unknown at the time of calculation, a conservative value shall be chosen. These values are given in chapter 6.2 in [GS EP COR 100](#).

6.2 Utilisation factor u

The utilisation factor which shall apply can be found in chapter 6.3 in [GS EP COR 100](#).

6.3 Calculation of cathodic protection

As indicated in Section 5.1, the calculation is based on the current requirement (I_t) at mid-life (maintenance) or the quantity of anodes in order to have the required current at final condition.

The current requirement (I_t) for the entire structure is the sum of currents for individual parts for:

- Uncoated surfaces
- Coated surfaces
- Buried surfaces.

The calculation of sacrificial anodes for cathodic protection retrofitting follows the same principle as for offshore structures as described in General Specification [GS EP COR 100](#).

6.4 Installation and location of anodes

Stand-off anodes shall be used. Minimum requirements are given in [GS EP COR 201](#).

The anodes shall be installed on frames made of composite materials or carbon steel painted according to system P08 of General Specification [GS EP COR 350](#).

Frames shall be designed in such a way that silting is not possible and that the distance between anodes is minimum 1 m to limit the interference between them.

Frames shall be electrically connected to the structure via at least two electrical cables, the section of which shall be high enough to limit the voltage drop and not to reduce anodes current output (20 to 30 mV drop maximum in cables - minimum cable section 1 x 70 mm²). Cables shall be multicore armoured suitable for submerged exposure in seawater, type XLPE/PVC/SWA/PVC or equivalent).

The cable should be connected on the emerged (atmospheric zone) part of the structure in order to allow the monitoring of the CP current from anodes during operation. However, in case of excessive cable lengths due to the depth of the platform, direct connection of cables to the structure is allowed using retrofit clamps, providing specific qualification of the connection is previously carried out.

The cables shall be routed from bottom to top in a composite pipe attached on the existing jacket structure. Cables shall also be protected on the seabed. In any case, cable protection shall be approved by Company.

For platforms installed in deeper water (typically more than 40 m), it may be necessary to install a few anodes on the first immersed level of the jacket. This shall be evaluated through a CP modeling study unless a previous retrofit in the same conditions demonstrates that the anode

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sleds at the bottom provide satisfactory CP potentials at upper levels. In this case, anodes shall be installed according to General Specification **GS EP COR 201**.

6.5 Distribution of anodes

The total anode number shall be evenly distributed on each frame.

The number of supporting anode frames shall be as a minimum, equal to the number of sides of the jacket.

Distribution of the frames shall be according to the available space around the platforms and taking into account existing structures. Care shall be given to restricted zones (sealines, boat landings, etc.) to avoid any future damaging of the anode frame or connecting cables

7. Verification of the protection level

7.1 Commissioning

Just before the retrofit (or connection of frames cables to the structure), CP potentials shall be measured according to the principles given in **GS EP COR 501**.

After anode frame connection, CP potentials shall be measured using the same method as above. CP current flowing in the cables connected to the emerged part of the structure shall also be recorded within the first hours after the connection.

In the first three to six months of operation after commissioning of the retrofit system, a series of measurements shall be performed, according to the principles given in **GS EP COR 501** in order to demonstrate the effectiveness of the retrofitted cathodic protection system. In addition, the amount of current and the direction of current flow in the cables fixed on the structure shall be monitored and recorded to confirm the functioning of anode sleds.

7.2 Routine monitoring

The subsequent schedule of routine inspections shall be drawn up by Contractor at the request of Company, in accordance with the **GS EP EXP 311**. The suitability of the chosen anode sizes, dimensions and number must be verified during the entire life of the structure.

When fixed monitoring system is installed on structures, measurements should be done on a monthly basis in order to follow the evolution of CP as a function time (these measurements can be used to anticipate any decrease in protection level as well as to anticipate anode lifetime and when to retrofit).

In between scheduled subsea surveys, measurements by so-called drop-cell can also be done in order to evaluate the global potential. The need for this shall be evaluated on a case by case basis.

The verification of potential is described in **GS EP COR 501**.

8. Quality assurance procedures

All requirements detailed in General Specification **GS EP COR 100** shall fully apply for design, construction, and commissioning of cathodic protection retrofit systems.