



Exploration & Production

GENERAL SPECIFICATION

CORROSION

GS EP COR 104

**Material Selection and Corrosion control for Sea
Water Lift Pump and Water Discharge Caissons**

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1. Scope

This document defines the general technical requirements for the specification of internal and external protection systems against corrosion for the following:

- Sea water lift pump and fire water pump caissons including pump strings
- Discharge (also referred to as “dump”) caissons for offshore use which include raw sea water, de-aerated sea water, produced water, open drain and sewage caissons.

The purpose of the specification is to define:

- The internal corrosion protection requirements for lift pump caissons
- The internal corrosion protection requirements for discharge caissons
- The external coating requirements all types of caissons
- The corrosion protection requirements for internal pump strings including the connection pipework commonly referred to as the “rising main, or “pump risers”.

Specific applications such as “drilling cuttings” caissons which have particular requirements for erosion service are outside the scope of this standard.

Similarly J- tubes are outside the scope of this document.

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
Not applicable	

Professional Documents

Reference	Title
DNV-RP-B401	Cathodic protection design

Regulations

Reference	Title
Not applicable	



Codes

Reference	Title
Not applicable	

Other documents

Reference	Title
Not applicable	

Total General Specifications

Reference	Title
GS EP COR 100	Design of cathodic protection of offshore structures
GS EP COR 350	External protection of offshore and coastal structures and equipment by painting
GS EP COR 352	Internal protection of equipment by painting
GS EP COR 355	External protection of piping and equipment by thermal spray coating

3. Introduction

In many operating facilities offshore, serious corrosion has occurred in both sea water lift caissons and also various water discharge caissons. The impact on production and safety can be significant and the cost of repair is usually very high.

Traditionally, caissons have been treated as open ended pieces of pipe with external corrosion protection provided by typical structural steel external paint with or without internal coating.

For critical applications where there is a high consequence of failure, specific corrosion mitigation measures are required for internal and external corrosion protection of caissons.

Consequently, this General Specification aims to assess internal and external caisson corrosion protection on an individual basis rather than have a systematic approach to corrosion protection of these items.

4. Criticality assessment

During the engineering phase CONTRACTOR shall perform a qualitative criticality assessment of all sea water lift and water discharge caissons in terms of probability and consequence of failure. This shall also consider the potential impact of a corrosion-fatigue failure in service e.g. potential dropped object protection.

4.1 Sea water lift caissons

For sea water lift caissons, serious **internal** corrosion failures leading to parting of the caisson shall be considered and reviewed during design for the following locations:

- Perforation of caissons due to serious corrosion of carbon steel adjacent to the pump location itself
- Perforation of the caissons at centraliser locations adjacent to the rising main between the pump body and the splash zone.

Such events can lead to loss of production and high cost to replace or repair in operation and each application shall be assessed in terms of consequence of failure.

4.2 Discharge, Sea Water, Produced Water, Open Drain, and Sewage Caissons

4.2.1 Sea Water Discharge Caissons

Perforation due to **internal corrosion** of internally coated carbon steel sea water discharge caissons leads to production losses as interruption of sea water discharge can lead to shutdown of some process units.

4.2.2 Produced water Caissons, Oily water Caissons

Similarly, produced water caissons perforation and parting due to serious corrosion of carbon steel in the splash zone occurs due to the combination of **internal and external corrosion**. The root cause for internal corrosion is the mixing of de-oxygenated, hot, high velocity produced water (which may also contain residual amounts of CO₂) and cold oxygenated static sea water.

Below the splash zone, external corrosion is not a concern since cathodic protection is effective. Similarly, internal corrosion problems in this submerged zone are much less severe than in the splash zone since flow conditions are quasi-static and conventional coatings as identified in **GS EP COR 352** are effective.

In the atmospheric zone of the caisson, internal and external corrosion can be managed by conventional coating systems specified in accordance with **GS EP COR 350** and **GS EP COR 352**.

4.2.3 Open Drain / Sewage Caissons

Open drain/sewage caissons have also been a source of problems but this is usually when no internal corrosion mitigation measures have been specified.

For all discharge caissons the consequences of failure shall be assessed in design and reflected in the materials selected for each application.

5. Design of Sea water lift caissons

5.1 Materials selection

5.1.1 Glass reinforced epoxy GRE

For sea water lift caissons, non metallic composites shall be considered in the first case as the best solution as this material is immune to internal and external corrosion in sea water.



The mechanical characteristics of the caisson shall however be assessed, particularly with respect to fatigue performance and potential impact damage of GRE.

5.1.2 CRA

For sea water lift caissons the caisson in the vicinity of the pump string can be specified in a corrosion resistant alloy such as 25 Cr duplex stainless steel or internally alloy 625 clad carbon steel. A 6.0 metre long flanged spool is usually sufficient to eliminate the internal caisson corrosion problem at this location. However the high risk of galvanic corrosion at the carbon steel/CRA interface, particularly for the internally coated carbon steel caisson case shall be considered and this option is therefore not generally recommended. A fully internally clad alloy 625 option (or similar nickel alloy) can be considered for applications with a very high consequence of failure.

5.1.3 Carbon steel

This remains often the standard choice for sea water lift caissons and provided a substantial corrosion allowance is used (minimum of 6 mm) and measures are implemented to mitigate internal and external corrosion, this remains an acceptable option for applications where GRE is not a suitable in terms of mechanical strength.

5.2 Coatings

5.2.1 Internal coating of carbon steel sea water lift caissons and pump string/rising main

The pump string shall be coated with a glass flake epoxy coating system or a polyolefin wrap system. To leave the internal pump string uncoated is not an acceptable option due to the high risk of galvanic corrosion.

All internal surfaces of sea water lift caissons shall be coated including all welds and coating systems shall be selected to accommodate this requirement for all welds including field welds. The sizing of the caisson shall take into account this requirement also.

Glass flake epoxies (system P07 Second of **GS EP COR 350**) rather than conventional epoxies shall be used to increase the mechanical resistance and durability of caisson internal coatings. All coating works shall be compliant with COMPANY General Specification **GS EP COR 352**.

5.2.2 Uncoated internal sea water lift caisson and coated pump string/rising main

For this option the number of sacrificial anodes required on the pump will be substantial due to the large surface area of carbon steel to be protected. However in cases where the cathodic protection system does not provide sufficient current, then the worst case is general corrosion over a large area rather than localised corrosion at a region of coating breakdown as would be the case for the internally coated option. Consequently, a 10 mm corrosion allowance shall be specified for this situation.

5.2.3 External coating

In order to increase the durability of external coatings, glass flake epoxy coating systems shall be specified in accordance with **GS EP COR 350** paint system P07 Second for temperature less than 80°C.

Above the maximum operating temperature of 80°C, coating systems based on vinyl esters shall be used in accordance with **GS EP COR 352** system P102.



Alternatively for external surfaces, thermally sprayed aluminium coating systems (TSA) can be specified in accordance with **GS EP COR 355**.

Cathodic protection requirements shall be as defined in **GS EP COR 100** for category 4 coatings for submerged service.

Coating breakdown factors and cathodic protection current density requirements for TSA shall be addressed on an individual basis and submitted to COMPANY for approval.

5.3 Internal cathodic protection of Sea Water Lift Pump Caissons

5.3.1 General

The following criteria shall be used for the pump caisson cathodic protection design.

- Mean current density in pump area: 300 mA/m² to achieve protection potential criteria.
- Mean current density above and below pump: 100 mA/m² to achieve protection potential criteria.
- Design life 5 years minimum or as specified in the Project Particular Specification depending on pump removal frequency.

Additionally, the caisson shall be sized to ensure the clearance between pump body and internal casing shall be 150 mm to reduce the resistance path for effective corrosion protection.

The suitability of the specified current densities shall be demonstrated by cathodic protection modelling for each application using COMPANY approved cathodic protection software.

5.3.2 Cathodic protection of internally Bare Caissons

This is considered an acceptable cathodic protection option provided it is possible to physically locate sufficient anodes on the pump string to cathodically protect the caisson.

5.3.3 Cathodic protection of internally coated caisson

In centraliser areas the coating breakdown figures should take account of the coating potentially being completely removed at the centraliser contact points.

5.4 Internal Cathodic protection monitoring

A fixed potential monitoring system using zinc reference electrodes shall be installed and located at critical areas within the caisson. A typical assembly consists of Zinc reference electrodes spliced and encapsulated into a single core 16 mm² screened cable which is of a sufficient length to be connected to a monitoring panel at deck level.

6. Design of disposal caissons

6.1 General

For these caissons there is no accelerating effect of galvanic corrosion between carbon steel and CRA pump components and so the material selection options usually involve GRE or carbon steel with a corrosion allowance and corrosion mitigation.



6.2 Materials selection

6.2.1 Glass reinforced epoxy (GRE)

For sea water and produced water dump caissons non metallic composites shall be considered as the best solution to prevent both internal and external corrosion.

However mechanical characteristics need to be assessed particularly with respect to fatigue performance and potential impact damage of GRE prior to final selection.

6.2.2 Corrosion resistant alloys (CRA)

For sea water discharge caissons the choice of a metallic corrosion resistant alloy may be justified for situations where consequence of failure can have very high potential production losses or environmental impact.

For sea water, 25%Cr superduplex stainless steel can be specified provided the service temperature is below of 30°C. Alternative CRA alloys such as high molybdenum content nickel alloys installed as welded liners in the splash zone may be considered **in extreme cases** in which failure has very high consequence.

6.2.3 Carbon steel

When GRE is not a suitable material selection option with respect to mechanical resistance carbon steel remains an acceptable choice for discharge caissons provided a substantial corrosion allowance (minimum of 10 mm) and suitable coating systems are used.

6.3 Internal coating of carbon steel discharge caissons

In order to increase the durability of internal coatings in carbon steel particularly in splash zones it is necessary to specify improved internal coatings for all caissons based on glass flake epoxies rather than specify conventional epoxies only. Consequently internal coating systems shall be specified in accordance with **GS EP COR 350** paint system P07 Second. The system selected shall be demonstrated to be capable of successful application on the complete internal caisson surface including welds using semi-automatic paint spraying equipment without solvent retention or blockage due to the viscous nature of the product.

Sacrificial anodes shall also be specified for the design life and current density requirements defined in **GS EP COR 100** if space allows. Category 4 coating breakdown factors shall be used.

6.4 External coating of carbon steel discharge caissons

In order to increase the durability of external coatings of carbon steel, external glass flake epoxy coating systems shall be specified in accordance with **GS EP COR 350** paint system P07 Second for temperature less than 80°C.

Above maximum operating temperatures of 80°C coating systems based on vinyl esters shall be used in accordance with **GS EP COR 352** system P102.

Alternatively for external surfaces, thermally sprayed aluminium coating systems (TSA) can be specified in accordance with **GS EP COR 355**.



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Cathodic protection requirements shall be as defined in **GS EP COR 100** for category 4 coatings for submerged service.

Coating breakdown factors and cathodic protection requirements for TSA shall address on an individual project basis and submitted for COMPANY approval.