

GENERAL SPECIFICATION

CORROSION

GS EP COR 002

Corrosion control on production facilities: Field operations
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05	10/2012	Major changes and additions on the Corrosion Management strategy. Definition of the minimal content of the "Corrosion Management during Field operations" document.
04	01/2011	General review - Definition of the Corrosion Management document - Inclusion of a paragraph on the organisation of Corrosion management
03	10/2009	Reinforcement of Corrosion monitoring requirements. Biocide treatment specifications adjusted to their content in active components
02	10/2008	Additional tables: corrosion treatment of closed loop cooling water and hot water. Inclusion of specific pH stabilisation conditions for Sour TEG units. Requirement for a pluri-annual painting plan and a formal paint survey as part of the Painting maintenance Plan, in Appendix - Table 3.8
00	10/2005	First issue
Rev.	Date	Purpose of the revision

Owning entity: DEV/TEC

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1. Scope

This document is related to Corrosion Control on Production Facilities. It is applicable to field operation activities, from production start-up to field abandonment (design and construction activities being covered in other specifications, based on the same corrosion control considerations).

This document specifies the main activities of Corrosion entities in charge of field operations in operating subsidiaries, based on a defined Corrosion Management strategy. It also specifies practical methodologies and requirements for:

- Performing internal corrosion assessments on operated facilities
- Defining corrosion mitigation and corrosion monitoring programs
- Applying these programs during normal field operations
- Running exceptional operations with no adverse corrosion impact.

Preliminary remarks: Due to the wide variety of parameters and solutions applicable to corrosion control, this document not only includes general specifications but also some indicative or applicative tables to be used within defined application limits. *Some comments and explanations are also given in italics, with no prescriptive value.*

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
Not applicable	

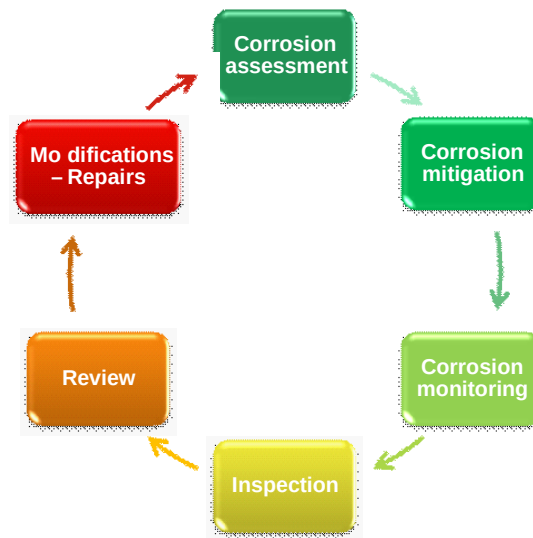
Total General Specifications

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 001	Corrosion control on production facilities: Design and construction
GS EP COR 451	Corrosion and Coatings Integrity Inventory for Offshore Installations

3. Definitions

Corrosion management: The overall Corrosion Management process for any production facility is summarized in the following loop, which is applicable both during design and construction and during Production:



Preventive actions for corrosion mitigation, *i.e. all actions undertaken during operation to control the corrosion of susceptible materials and equipment* include, but shall not be limited to:

- Metallic and non-metallic material selection
- Chemical treatments dedicated to corrosion mitigation: Corrosion inhibition, biocide treatments, oxygen scavenging, chlorination, pH stabilisation
- Physical treatments applicable to corrosion mitigation: Dehydration, de-oxygenation, H₂S and/or CO₂ removal, operational pigging, etc.
- Cathodic protection
- Painting and coating
- Thermal insulation and fire-proofing materials, with respect to their potential impact on external corrosion.

Corrosion Monitoring activities, *i.e. all actions regularly undertaken to verify the implementation and efficiency of preventive actions* include, but shall not be limited to:

- Follow-up of chemicals injection rates
- Follow-up of Cathodic protection equipment
- Potential and current measurements for cathodic protection
- Coupons and corrosion probes
- Chemical analyses (inhibitor, iron, oxygen, pH)

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- Bacterial counts (kits, bioprobes, etc.)
- Hydrogen probes
- Ultra-sonic mats, Field signature Monitoring (FSM).

4. The "Corrosion management during field operations" document

It is the responsibility of the entity in charge of Corrosion Control of a subsidiary to put in place a corrosion management strategy and to formalize it in a "Corrosion management during field operations" document.

This document is the "mother document" specifying how corrosion is managed within the subsidiary throughout the production period. It defines the organization and the technical bases used to control corrosion on all facilities. It supports application documents which are established (per area and/or per assets/ facilities) to assure the proper implementation of the strategy. A minimal content of this document and an indicative list of application documents are given in appendix 1.

The next paragraphs define the main requirements related to this corrosion management during field operations, essentially on corrosion assessment, corrosion mitigation, corrosion monitoring and review tasks. Inspection and maintenance activities are not covered apart for their strict corrosion part as they are dealt with in other documents.

4.1 Organisation

The corrosion management document shall define, if not already done in an upper level document, the organisation in charge of corrosion control of the facilities during field operation:

- Tasks to be managed, i.e.:
 - Periodic corrosion assessment
 - Corrosion mitigation programs and implementation
 - Corrosion monitoring programs and implementation
 - Review of inspection programs and results, in close relationship with the inspection entity
 - Exceptional operations with a possible corrosion impact.
- Responsibilities, accountabilities, interfaces between entities in charge
- Human resources
- Qualification and training

4.2 Corrosion register

A formal Corrosion register shall be established and regularly up-dated.

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The Corrosion Register is generally a part of a wider "Plant Asset Register" managed by the Inspection entity. It contains the necessary information and documentation on all the equipment involved in corrosion management activities during field operations:

- Construction materials,
- Other mitigation solutions applied during the design and construction, with all necessary characteristics,
- All equipment available for chemicals' injection
- All equipment available for corrosion monitoring.

4.3 Corrosion assessment during operations

A Corrosion assessment shall be established and regularly up-dated to:

- 1. Evaluate the need for applying new preventive solutions or improving the solutions in place as well as to set the efficiency target of these solutions**
- 2. As part of any RBI evaluation for preparing inspection programs. *Corrosion Assessments are currently included in RBI evaluation tools.***

The corrosion assessment aims at evaluating whether corrosion is well controlled or not and at which rate it is likely to proceed, in case of insufficient control.

It shall be used for revising corrosion mitigation, corrosion monitoring, and inspection programs, and is a key input for the definition of planned maintenance & repairs.

The deliverables of this Corrosion Assessment are in two parts:

1. The Natural Corrosion Likelihood, i.e. without any applied mitigation: This Natural Corrosion Likelihood is particularly used to define whether additional mitigation solutions are needed or not and to evaluate how quick problems might be experienced if such mitigation was not applied or inefficient.
2. The final Corrosion Likelihood, which also accounts for:
 - The efficiency of preventive solutions used, if any
 - The corrosion monitoring and inspection results.
 - The last known or expected condition of the equipment considered (extent of corrosion damages if any, repairs, etc.)

Note: For new facilities, the Natural corrosion assessment during field operations is based on similar tools and methodologies as those used during design (cf. **GS EP COR 001**). The First Natural Corrosion Likelihood evaluation is the one elaborated within the Project phase.

Corrosion Assessments shall be regularly revised, and as a minimum in case of:

- Any significant change in operating conditions, such as but not limited to:
 - Start-up of a new field using existing facilities or equipment
 - Implementation of a new process unit which modifies the service conditions of existing facilities or equipment
 - A change in production rates by more than 50%.

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- Unexpected corrosion events likely to re-occur at other locations and not covered by existing corrosion assessment results,
- Corrosion monitoring results regularly in contradiction with the corrosion assessment.

4.4 Corrosion mitigation

A Corrosion Mitigation Program shall be established and regularly updated. This program shall specify all necessary actions to be undertaken during operational life to prevent corrosion failures of any important equipment before its expected end of service.

The bases of internal corrosion and its mitigation shall be defined in the "Corrosion Management document for all production and injection facilities.

"Corrosion Mitigation Programs" shall include all relevant solutions as described in § 3. A typical structure to be followed is shown in Appendix 2.

For any preventive action of the corrosion mitigation program, the following shall, as a minimum, be specified:

- The method to be used
- The location where it will be used
- The equipment to be used
- The requirements for use (dose rates, potential values, flow rates, etc.)
- The quantitative efficiency levels targets
- The relevant application procedures.

The corrosion mitigation program shall be formally delivered to all entities in charge of its implementation, together with all relevant procedures needed to allow its correct application.

The availability of the necessary material and human resources for the implementation of the corrosion mitigation program shall be verified.

The Corrosion mitigation program shall be updated regularly, and as a minimum:

- Every year
- For physical and chemical treatments: when production rates are changed by more than $\pm 25\%$, or new fields or new process facilities are added
- When corrosion monitoring results are regularly in contradiction with expectations, or quickly drifting from previous average values
- When inspection results are in contradiction with expectations, based on the supposed performance of preventive actions.

The bases for a typical corrosion mitigation program are given in Appendix 3 for:

- Table 3.1: Corrosion inhibition of oil and gas production facilities
- Table 3.2: Biocide treatment of oil and gas facilities

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- Table 3.3: pH stabilisation of MEG/DEG fluids used as hydrate inhibitors and for TEG dehydration units
- Table 3.4: Corrosion treatment of water injection facilities
- Table 3.5: Corrosion treatment of closed loop cooling water facilities
- Table 3.6: Corrosion treatment of pressurised hot water facilities
- Table 3.7: Operational pigging of pipelines for corrosion prevention (excluding intelligent pigging inspection)
- Table 3.8: Painting maintenance.

4.5 Corrosion monitoring

A corrosion monitoring program shall be established and regularly updated, aiming at either:

- 1. Verifying the effective use and the performance of preventive actions, if any,**
- 2. Verifying that corrosion likelihood remains below the maximal acceptable level, when no preventive action is deemed necessary.**

A formal corrosion monitoring program shall be established as a minimum for physical and chemical treatments, and for cathodic protection (internal and external).

Corrosion monitoring results shall be regularly gathered, analysed (on a monthly basis) and kept over the whole operational life time of the facilities considered.

Note: Corrosion monitoring is different from inspection. It aims at evaluating the performance of preventive actions within short time delays (days to months depending on the technique) but without any direct indication of the physical condition of the equipment considered. Inspection is focused on the corrosion status of equipment on a longer term basis (months to years).

The monitoring program shall cover all relevant production and injection facilities. A typical list of monitoring techniques is given in Appendix 4, Table 4.1.

Among the various preventive actions undertaken, corrosion monitoring activities will be focused on cathodic protection and physical and chemical treatments, whereas painting-coating and corrosion resistant materials are mostly covered by Inspection programs.

The Corrosion Monitoring program is a formal document defining all activities and measurements to be handled to cover the objectives listed here above.

For each measurement/ activity the following shall be included, as a minimum:

- The monitoring technique used
- The location where it is used
- The relevant application procedure
- The measurement frequency
- The entity in charge of the activity,

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- The threshold acceptance values.
- The actions to be undertaken when threshold values are exceeded,

All application procedures necessary to the satisfactory application of the corrosion monitoring program must also be made available to the entities in charge.

The Corrosion monitoring program is regularly up-dated, as a minimum when:

- New facilities are installed or existing facilities are closed,
- Process modifications are made, which may modify the corrosiveness of the fluids which are monitored or the efficiency of the applied mitigation,
- Changes are made on the applied mitigation programs,
- Corrosion monitoring or inspection results are regularly in contradiction with expectations,

As long as chemicals treatments are concerned, the corrosion monitoring program shall include:

- The verification of injection specifications (flow rates, dose rates, continuity or frequency and duration), based on typical guidelines indicated in Appendix 4, Table 4.2
- Indicative parameters related to treatments' efficiency, as per reference documents (coupons, probes, titrations, bacterial counts, etc.). A sound corrosion monitoring program requires combining several monitoring techniques in parallel.

4.6 Inspection activities related to corrosion control

The corrosion entity in charge shall

- **Maintain a permanent and close relationship with the inspection department, with systematic and mutual exchange of information on significant corrosion events experienced, inspection results involving corrosion damages, poor corrosion monitoring results, etc.**
- **Be involved in the definition of RBI type inspection programs for the Corrosion Likelihood evaluation of the concerned equipment.**

Be involved in the implementation of inspection programs where corrosion is the essential reason for inspection, particularly when the objective of the inspection is to establish the painting maintenance program.

For RBI programs, the Corrosion entity is in charge of validating the Corrosion Likelihood evaluation used in the RBI tool. This evaluation shall be consistent with the Corrosion Assessment defined in § 4.3.

The Corrosion entity shall check that the planned inspection programs are adequate with respect to corrosion assessment and corrosion threats, and consistent with any additional information regarding corrosion events, corrosion monitoring results, etc.

Inspection results shall be reviewed with respect to their possible impact on any other equipment potentially subjected to similar corrosion damages.