



Exploration & Production

GENERAL SPECIFICATION

CORROSION

GS COR 162

Internal corrosion control in petroleum production installations

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1. Scope

This specification defines:

1. The functional requirements for performing an "internal corrosion risk assessment" for a production installation
2. The functional requirements for defining the "corrosion management" basis to be applied on the installation, as the result of the previous risk assessment.

This specification applies to all components of a production installation which are in contact with process fluids (produced and injected fluids). Unless otherwise specified, service and utility fluids are not relevant to this specification.

The "corrosion management" is one part of the complete "Integrity management", whereas Inspection activities are the complementary component. These Inspection activities are not part of this specification.

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
Not applicable	

Regulations

Reference	Title
Not applicable	

Codes

Reference	Title
Not applicable	

Other documents

Reference	Title
GM COR 004	Limiting flow velocity calculations
GM COR 007	Control of sand production and monitoring of sand erosion
GM COR 032	Microbiologically Induced Corrosion (MIC) risk assessment

Total General Specifications

Reference	Title
GS COR 161	Internal corrosion and erosion-corrosion monitoring: design and installation
GS COR 163	Application of chemical treatments for corrosion control
GS COR 170	Materials for sour service (upstream applications): Specification for design

3. Definitions

"Corrosion risk assessment": An evaluation of the likelihood and of the extent of corrosion damages of the installation if designed in the most standard material (usually carbon steel) and not subjected to any preventive action against corrosion.

"Corrosion management": The complete set of methods to be implemented for preventing the potential consequences of the predicted corrosion and for verifying the efficiency of these methods.

"Inhibitor availability": The proportion of time during which the inhibitor injection is applied to the equipment considered at an injection flow rate $\geq 80\%$ of the currently specified injection rate. Depending on the number and on the reliability of injection systems applied, inhibitor availability values of 95 to 98% are currently specified.

4. Internal corrosion risk assessment

When the COMPANY do not provide the corrosion risk assessment, the requirements included in this paragraph apply to the CONTRACTOR.

4.1 Corrosion risks to be assessed

1. Weight loss corrosion risks (uniform and localised) resulting from dissolved acid gases (CO_2 and H_2S)
2. Cracking corrosion risks resulting from the presence of H_2S (SSC, HIC and SOHIC)
3. Erosion-corrosion
4. Erosion by solid particles
5. Micro-biologically influenced corrosion (MIC)

6. Corrosion resulting from dissolved oxygen, if any (e.g. water injection)
7. Effect of any additional fluid either permanently or temporarily present (acid, sulfur, brine, amine, etc.).

4.2 Assessment methodologies

The assessment methodologies and criteria used for the evaluation which do not come from the COMPANY (General Specifications, COMPANY's evaluation tools or criteria) shall be submitted to the COMPANY's approval.

An indicative list of applicable internal tools and criteria are defined on Table 1. The use of other tools from open literature shall be submitted to COMPANY approval. GM COR documents are COMPANY'S technical documents. They will be supplied when necessary.

Table 1 - Applicable tools and criteria for corrosion risk assessment

Corrosion phenomenon	Calculation tools	Evaluation criteria	Comments
Sour service conditions		PH2S-pH Severity areas, as per GS COR 170	Similar to ISO 15156 criteria. Rough pH evaluation based on GS COR 170 criteria. Precise evaluation with CORPLUS
Weight loss corrosion (CO₂ only)	CORPLUS	Based on corrosion risks and calculated corrosion rates	Reference to be made to previous field experience, as much as available and documented, within Total or open literature.
Liquid erosion corrosion		Total Corrosion Technical Practice GM COR 004	Limiting flow velocities defined as per API RP 14 E, with various C factors, depending on fluid characteristics
Solid erosion-corrosion and erosion	SPPS	Total Corrosion Technical Practice GM COR 007	Provide an estimate of erosion rates in non-corrosive environments; Not directly relevant to erosion-corrosion in moderate erosive conditions, but can be used as a reference point.
MIC	None	Total Corrosion Technical Practice GM COR 032	
Corrosion by dissolved O₂		Max O ₂ content: 30 ppb in injected water	

A maximum use of previous field experience (either positive or negative) shall be made when assessing corrosion risks, in addition to the use of any predictive criteria.

4.3 Values of key parameters used for corrosion assessment

The necessary parameters for performing the risk assessments are dictated by the tools and criteria employed. Some values to be used for these parameters are given on Table 2.

Table 2 - Values to be used for assessing corrosion risks

Corrosion phenomenon	Parameter	Current value	Particular cases/Comments
SSC	Pressure	MAOP	Well equipment: MIN (Bubble P, Reservoir P), Liquid line (no gas): MAOP of upstream separator
	Temperature	Ambient	Bottom-hole liners: min possible T
	pH	Min calculated in situ pH	Gas-Condensate wells and P vessels: pH of condensed water Oil wells and liquid lines: pH of produced water
HIC	Pressure and pH	Same as SSC	
	Temperature	T max	
Weight loss corrosion (CO₂, H₂S)	Pressure	Nominal service pressure	Well equipment: MIN (Bubble P, Reservoir P), Liquid line (no gas): MAOP of upstream separator
	Temperature	From min to max flowing temperature	
	Water content	Max water-cut	
	Water composition	Representative water analysis, including organic compounds	
	Flow velocity	Max possible flow velocity	
Liquid erosion-corrosion	Pressure	Min service pressure	The worst Pressure (i.e. the lowest) and flow rate (i.e. the highest) not to be combined unrealistically, if not coincident. Only combine worst P and Flow rates possible at the same period in order to evaluate the worst flow velocity.
	Temperature	Max T	
	Flow rates	Max possible flow rates	
Solid erosion	P, T and Flow rates	Same as liquid erosion-corrosion	
	Sand produced	Max predictable flow rate and granulometry	
	Fluids density and viscosity	For each fluid	
MIC	Flow rates	Min flow rates	
	Water content	Max water-cut	
	Temperature	Min flowing temperature	

In case of significant variation of parameters along the lifetime of the installation, the evaluation shall be performed at several periods of this lifetime to take account of these variations. As much as possible, the values of the parameters shall be chosen as the most representative of each period of time.

4.4 Deliverables

Depending on their nature and on the evaluation criteria available, the corrosion risks can be assessed:

- Quantitatively, either as corrosion rates or lifetimes. The uncertainty on the delivered values shall be also provided
- In general categories (e.g. High, Medium, Low). In such case, the meaning of each category shall be described
- On a Yes/No basis, in case of risks associated with "threshold" criteria.

The assessment shall refer to the possibility that the equipment considered might lose its major functionality with regard to Safety, Environmental issues and Production capabilities during its expected lifetime.

5. Corrosion management

A complete "internal corrosion management" shall be defined for all production facilities involved.

The requirements included in this paragraph only apply to the CONTRACTOR if the "Internal corrosion management" is not already supplied by the COMPANY.

5.1 Methodology

The selection of "Corrosion management" methods shall be based on the results of the "corrosion assessment" evaluation. It shall be aimed at preventing corrosion failures susceptible to compromise the major functionality's of production facilities with regard to Safety, fluid containment and Production capabilities during their expected lifetime.

Methods selected for internal corrosion management may combine:

- The use of corrosion resistant materials (Corrosion resistant alloys, plastics and GRPs, cladding, etc.)
- Process equipment used for removing either the corrosive water, the main corrosive components or the favourable conditions for corrosion (Temperature, high flow rates, etc.)
 - Dehydration
 - CO₂ or H₂S removal
 - Cooling
 - Etc.
- Adequate design, particularly with regard to:
 - Allowable flow velocities, within limitations given in the "corrosion assessment" evaluation
 - Avoidance of water accumulation and trapping
 - Preventing air entries (blanketing, sealing, etc.).
- Corrosion allowances, organic coatings, cathodic protection
- Chemical treatments: inhibition, biocide, pH control, oxygen removal.

5.1.1 Material selection

Sour resistant materials are necessarily used as soon as sour conditions are encountered (severity areas 2 or 3). *Nota: This "sour resistant" material can be Carbon Steel, hence not necessarily resistant to weight loss corrosion phenomena.*

Corrosion resistant materials are selected when Carbon Steel integrity cannot be guaranteed, even with the application of additional preventive actions (such as inhibition, cathodic protection, etc.), or if these preventive actions are not applicable, more expensive or not safe enough with respect to Safety or Availability requirements.

Corrosion resistant alloys (CRA) are selected for assuring a complete resistance to the worst possible service conditions during the whole service life. All possible damaging effects from either external environmental conditions or temporary fluids/service conditions must be taken into account when selecting the material.

5.2 Deliverables

The "internal corrosion management" shall include, for all production facilities involved:

- The materials to be used
- The internal coating + cathodic protection to be applied, if needed
- The corrosion allowance
- The necessary injection facilities for Chemicals injection, including the required inhibitor availability, the flow rates indications needed for designing these facilities, and the location of the injection points
- The limiting flow velocity criteria to be applied to the various circuits
- Any other necessary condition needed for preventing corrosion (pigging, purging, blanketing, etc.)
- The corrosion monitoring tools to be installed (sampling points, fittings, probes, monitoring equipment)
- The list of reference documents to be applied (normative documents, standards and Recommended Practices, Total General Specifications).