



Exploration & Production

GENERAL SPECIFICATION

CORROSION

GS COR 161

**Internal corrosion and erosion-corrosion monitoring:
design and installation**

02	10/04	General review - introduction of monitoring of erosion-corrosion, summary table for requirements
01	11/03	Change of Group name and logo
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Rev.	Date	Notes



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1. Scope

The present specification defines the minimal requirements applicable to:

- The selection of internal corrosion and erosion-corrosion monitoring systems
- The installation and start-up of the equipment.

The present specification is applicable to the surface installations for oil and gas production. It does not apply to external corrosion monitoring of pipes or downhole equipment.

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
Not applicable	

Total General Specifications

Reference	Title
GS COR 162	Internal corrosion control in petroleum production installation

3. Aims

3.1 The corrosion-erosion monitoring plan

A corrosion/erosion-corrosion monitoring plan is established for all facilities likely to be subjected to corrosion or erosion/ corrosion failures over their planned service life. The monitoring plan is established to fulfil the main following objectives:

- Controlling/ verifying the corrosive behaviour of produced fluids, when no preventive action is implemented (such as corrosion inhibition, biocide treatment, pH stabilisation),
- Verifying the practical application and efficiency of preventive treatments, when they are applied.

The monitoring plan shall consist of:

Selection of viable monitoring methods with regard to the objectives indicated here above,

- The nature and severity of expected corrosion/erosion-corrosion
- The areas of highest risk
- The selected corrosion/erosion-corrosion prevention methods.
- The operating conditions.
- Drawing up of a coherent plan based on the reliability and limits of the monitoring methods applicable to the cases under study
- Special construction requirements for corrosion/erosion-corrosion monitoring, such as fitting, special piping devices, etc.
- List of equipment, spare parts and products needed for two years of operation
- Operating and maintenance instructions and, if necessary, methods of sampling and chemical analysis
- Result interpretation guide.

The Engineering COMPANY shall be responsible for compiling this corrosion/erosion-corrosion monitoring plan.

3.2 Corrosion monitoring

In oil and gas production, none of the available corrosion monitoring method alone can supply all the data needed to achieve the aims cited above. The corrosion monitoring plan shall include a combination of several methods.

For each monitoring point it shall be defined whether it is aimed at controlling the corrosive behaviour of the produced fluid or at verifying the application/efficiency of anti-corrosion treatments.

For both objectives, the applicable methods are:

- corrosion samples: corrosion coupons (CC), bioprobes and spool pieces
- corrosion probes: conventional electrical resistance probes (ERP), linear polarisation resistance probes (LPR), hydrogen probes (HP), high sensitivity probes ("CEION" type)
- bacterial activity (bioprobes)
- sampling points (SP), chemical analyses, etc.

Corrosion monitoring system shall be based on, but not limited to, typical corrosion monitoring requirements (applicable methods and effluents to be monitored) as summarized on table 1 of this specification.

Any new available method able to provide similar or superior result (particularly in term of reliability and easy operability) shall be evaluated and proposed to the OWNER's approval as an alternate solution.

Non intrusive monitoring systems (i.e. not requiring the use of HP retrievers) shall particularly be considered for high pressure or hardly accessible conditions.

3.3 Erosion-corrosion monitoring

Erosion-corrosion monitoring shall be carried out when the nature of the fluid is such as wear and wall thickness loss by mechanical damage are expected (unpredicted sand production, high flow velocities ...). It is not intended to give quantitative measurements on sand production (amount of sand in the stream) which is not in the present specification's scope.

Erosion-corrosion monitoring shall be performed by means of either intrusive or non intrusive methods, such as:

- Erosion-corrosion probes (intrusive)
- FSM : Field Signature Method (non intrusive)
- Acoustic methods (non intrusive)
- Ultrasonic methods: permanent UT-mats, monitors (non intrusive). UT mats can also be used instead of CC/ERP for corrosion monitoring purpose when the area to be monitored is not easily accessible during retrieval operations.

UT-mats have temperature limitations and shall not be used over 90°C.

Non intrusive methods shall be given particular attention for high pressure or hardly accessible conditions.

4. General installation instructions

4.1 Mounting capabilities

So as not to disrupt exploitation, intrusive coupons and probes shall be mounted and removed at the operating pressure and temperature.

Intrusive probes and coupons installed on lines subject to pigging are flush-mounted.

A 2" access fitting system shall be used for intrusive probes. However, 1" access fittings are allowed for systems with operating pressure less than 5 bars. The type of fitting to be used among the two main types currently available on the market (mechanical or hydraulic retrieval

type) must be clarified with the OWNER. The coupons and probes shall be inserted or removed using a special tool (retriever). The access fittings for an installation shall be standardised and compatible with other access fitting on the market so that just one type of probes and retriever are needed.

4.2 Access fitting location

The access fittings shall be positioned with a 2 m clearance to allow an easy access and a safe manoeuvrability of the retriever tool during the whole installation/removal operation.

In addition, fittings should be located in pipework situated at floor level or immediately adjacent to permanent walkways. If not possible, an access shall be created from the floor.

Monitoring points dedicated to corrosivity measurements shall be installed upstream corrosion inhibitor and biocide injection points (if any). Conversely, monitoring points aimed at verifying the treatment efficiency shall be located downstream the injection points, at a sufficient distance for assuring an effective mixture, i.e 10 m for straight pipe section and 5m as a minimum if mixing devices are present (2 tees or elbows, diameter change...)

For access fittings equipped with intrusive monitoring device installed in pairs, there should be a minimum distance of 1 meter between each fitting.

When sand production is expected, the 12" position shall be preferred to avoid sand accumulation in the access fittings and coupon/probe damage during retrieval operations.

4.3 Sensitive element position

4.3.1 Corrosion monitoring

For intrusive probes and coupons, the sensitive element shall be in contact with the water in liquid phase. It is, therefore, to be positioned in the installation in relation to the fluid flow conditions in normal production.

4.3.1.1 Gas circuits

"Gas circuits" are intended as circuits where the gas phase occupies the main volume at the monitoring location.

The sensitive element shall always be positioned at the bottom line. The access fitting at 6 o'clock position is the base solution. The 12 o'clock position can be used if easier access and manoeuvrability. In this case, probe holder length shall be adjusted to place the sensitive element at 5 mm above the pipe bottom line. This solution shall be limited to diameters of 8" and less and to moderate and stabilised flowing conditions not likely to break the extended probe holder (Gas velocity < 10 m/s, no slug flow).

If there is a low quantity of water as well as in case of gas-condensate fluid, the sensitive element shall be of the flush-mounted type.

If the water is in the form of mist, the position of the element is unimportant, but it shall be of the protruding type. In case coupons are used, a second disc coupon can be installed in flush position.

4.3.1.2 Liquid hydrocarbon circuits

"Liquid hydrocarbon circuits" are intended as circuits where the liquid phase occupies the main volume at the monitoring location.

The sensitive element is to be positioned at the bottom line. As long as the diameter is 12" or less the base position of the access fitting is 12 o'clock, with a probe holder adjusted to place the sensitive element at 5 mm above the pipe bottom line.

The 6 o'clock position is used for:

- higher diameters than 12",
- Flush-mounted elements, required if BSW is durably lower than 10%, or if flow velocities are so high that there is a risk for the protruding element to be upset or damaged.
- Segregated flow regime, whatever the water-cut.
- Bioprobes (as flush-mounted elements)

Protruding sensitive elements are selected for coupons and probes unless indicated here above.

4.3.1.3 Water circuits

The position of the sensitive element is unimportant, but it shall be of the protruding type.

Bioprobes shall be of the flush type in the 6 o'clock position.

4.3.2 Erosion-corrosion monitoring

When probes are used for erosion-corrosion purpose, the probes shall be positioned relatively to the flow so that the solids bearing portion of the production stream be in contact with the sensitive element.

4.4 Choice of probe type and model

The choice of probe type and model shall be a function of:

- The composition of the effluent
- The operating pressure
- The flow rate and flow regime.

At each location at least two types of monitoring systems (coupons and probes) shall be used.

Loop type resistance probes shall not be used on facilities handling production fluids. They shall only be tubular element type or flush type. Loop element type probes are suitable for monophasic fluids on utilities (TEG, hot water, cooling water,...).

Linear polarisation probes shall not be used in environments with a resistivity lower than 10^{-5} ohm-cm. They shall not be used on gas lines.

The hydrogen probes shall always be of the non intrusive (patch probe). They shall only be used for environments containing H_2S .

The bioprobes shall be installed in flush position and they should be Robbins Device type. On water injection circuits, side stream systems with permanent flow shall be preferred.

Coupons can be strip type or ladder type or flush disc type.

Water sampling points are located at the bottom line position.

4.5 Choice of fixed and portable instruments

For each type of monitoring technique, the COMPANY shall define the type of monitoring equipment to be installed, among the following possibilities:

- Periodic measurement, using a portable measuring device
- Automatic periodic measurement with an autonomous measuring device (usually battery powered) installed near the monitoring point
- Automatic periodic measurement with data transmission to a centralised collecting system located in the Control Room or any equivalent location.

The portable equipment shall be able to read and store data from LPR and Resistance probes and transfer the corrosion data to a PC.

Data recovery from autonomous measuring devices shall be made by a remote data collector able to transfer the data to a PC.

4.6 Equipment list

The full equipment list shall be divided into four separate sections.

- **Section 1:** retriever tool and monitoring to be mounted on the installations, including probes, coupons, coupon holders, etc. and a two year supply of spare parts.
- **Section 2:** special equipment for installing the probes and coupons, sampling facilities, etc. This equipment includes access fittings, shut-off valves, spools, etc.
- **Section 3:** portable or fixed measuring equipment, such as portable measuring devices, remote data collectors, computers and necessary software for data processing, pH-meters, etc., and the necessary accessories including adapters, safety barriers, etc.
- **Section 4:** equipment and chemical products for the production laboratory for corrosion monitoring.

5. Operating manual

The operating manual includes operating instructions, measuring and analysis frequencies, sampling and analysing methods, special precautions regarding the storage, insertion and withdrawal of probes and coupons, instructions for the preparation and cleaning of probes and coupons before insertion and after withdrawal, coupon weighing instructions, etc. All these regulations shall be given in detail in the monitoring file which shall be handed over to the user at the time of starting up.

The Engineering COMPANY shall be responsible for drawing up this file.



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Key corrosion monitoring Points

EQUIPEMENT TO BE MONITORED		FLUID	MONITORING DEVICE	MONITORING LOCATION	COMMENTS
Pipelines	Unprocessed Fluids: Trunklines and long onshore Flowlines (> 1km)	Multiphase (inhibited)	CC + ERP + SP Bioprobe	Inlet and outlet Outlet	
	Processed Fluids	Oil (stabilized) export	CC + ERP + SP	Inlet	Usually not required, only upon specific request.
		Dry gas export	CC + ERP	Inlet	Usually not required, only upon specific request.
		Wet gas	CC + ERP + SP	Inlet and outlet	
		condensate, oil water	CC + ERP + SP Bioprobe	Inlet and outlet	
		Gas condensate	CC + ERP + SP	Inlet and outlet	
	Injection	Water injection (SW)	CC + LPR + bioprobe	Injection wells manifold inlet	
	Production	Produced water (PW)	CC + ERP + bioprobe	Inlet and outlet	
Separation Process	1 st stage separator	Produced water	CC + ERP + SP	Water outlet of separator	
	Crude desalter	Produced water	CC + ERP + SP	Water outlet of desalter	
Water injection process	Filtration	Injection water	SP	Downstream filters, outlet of each filter	For bacterial monitoring purpose
	Deaeration	Injection water	CC + ERP or LPR + bioprobe + SP	Deaeration tower outlet, upstream HP pump	Bioprobe to be placed upstream biocide injection point
Gas process	Hydrate control	MEG	CC+ ERP SP	HP section downstream flash drum Lean and rich MEG	
	Dehydration	TEG	SP	Lean and rich TEG	
Utilities	Cooling/Heating medium	Water	CC + ERP + SP	Hot section	1" access fittings to be used