

GENERAL SPECIFICATION

CORROSION

GS EP COR 502

Control by electrical measurements of cathodic protection of submerged pipelines

05	08/2012	General clarifications
03	10/2005	Addition of "EP" root to GS identification
02	09/2003	Change of Group name and logo
01	10/2002	Remote electrode method added - Requirement of Certification for specialised personnel
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1. Scope

This specification describes the requirements for inspecting the efficiency of cathodic protection of underwater pipelines during subsea inspections:

- Either during inspections carried out in order to check the pipe after laying
- Or during later periodic inspections.

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
Not applicable	

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

Survey of cathodic protection efficiency of sea-lines shall be carried out exclusively by competent specialised personnel. The qualification of each of the specialists working for such a job shall be demonstrated to the Owner before commencement of the job. Therefore the verification of the formal Certification of the individuals shall be carried out as follows:

- Measurements to be carried out by level 2 certified personnel
- Selection of measurement methods, analysis and verification of results and validation of report to be carried out by level 3 certified personnel

Accepted Certification schemes are AFNOR Compétence (Seawater Application Sector), APCE (Seawater Application Sector), Institute of Corrosion, NACE International. Any other Certification scheme should be approved by the Owner.

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Any use of non certified personnel for cathodic protection measurement shall be subject to the approval of the Owner on a case by case basis (demonstration of competence through detailed curriculum vitae and description of experience).

4. Measurements to be carried out

The Contractor shall perform measurements of the metal/electrolyte potentials along the entire sealine to check the protection level according to the position and the efficiency of the cathodic protection system – sections 5.1, 5.2 or 5.4.

As complementary measurements, the operation of each anode shall be checked by measuring near-line potential gradient in order to estimate the anode current output, and determine their degree of consumption (for protection by sacrificial anodes) – section 5.3.

The methods which shall be applied are defined in chapter 5.

5. Inspection methods

Unless otherwise specified by the Owner, the three methods described in Sections 5.1, 5.2 and 5.3 or the three methods described in section 5.2, 5.3 and 5.4 shall be used in parallel to meet the objectives set above. Such method should be performed by divers, by Remote Operated Vehicle (ROV) or directly from a boat, depending on the feasibility. It shall be noted nonetheless that ROV cannot operate between seawater surface and -20 m approximately. Consequently, such depths shall be investigated by other means (divers or boat).

No other method shall be used unless previously examined and approved by the Owner.

5.1 Continuous true potential measurement (by unwound cable)

In this method, the potential profile of the steel along the entire pipeline is recorded by moving a reference electrode vertically above and as near as possible to it, the reference electrode being connected through a voltmeter (negative terminal) by an insulated connecting wire, unwound as travel proceeds, to the body of the riser (inlet or outlet end) of the pipeline inspected.

If justified by the length of the pipeline, and subject to approval by the Owner, direct intermediate connections with the sea-line or an anode can be made.

The vehicle moving the reference electrode shall be equipped with a video camera for visual inspection of its position, or with a positioning system designed to follow the line even if it is buried.

The potential profile shall include the total length of the pipeline.

5.2 Direct local potential measurements

In addition to the measurement system described in Section 5.1 or 5.4, measurements by direct contact shall be taken on accessible areas of the pipeline (anodes, coating defects, welded joints, etc.). These local measurements serve to check/calibrate the validity of the continuous true potential measurements. These measurements shall be taken at 500 m intervals along the entire sea line, with mandatory measurement at the foot of the risers and at all salient points (tees).

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Unless otherwise authorized, no more than half of the local measurements shall be taken on anodes.

The distance between the reference electrode and the measurement point shall be kept to a minimum in order to reduce the error caused by the ohmic drop in the electrolyte. This is essential for measurements on anodes; a distance less than 10 cm is required. This is normally ensured by the design of the reference electrode. If this is not obtained, a correction calculation is necessary.

5.3 Continuous near-line potential gradient measurement

This method involves recording the potential difference measured between several reference electrodes, moved together along the sea line and as near as possible to it.

The measurements may be used in real time or off-line to determine the location and the current output of the anodes (for protection by sacrificial anodes).

The use of this method should also serve to detect serious coating defects.

Video camera and accurate positioning systems shall be used to enable monitoring of the sea line even if it is buried, and to provide very accurate positioning data for mathematical analysis of the measurements.

The travel speed of the measurement system above the sea line shall be adjusted to the data recording frequency to ensure a proper evaluation of the peaks found, especially when crossing anodes. A slower speed above the anodes shall only be allowed if proof is obtained that all the anodes are visible.

The minimum spacing between the measurement points is 20 cm.

The anode current output shall be evaluated from the knowledge of the peaks, using a computation method previously approved by the Owner.

The final report shall indicate all the anode current outputs. If the anode dimensions are provided by the Owner, the report shall also give the estimated lifetimes of the anodes based on a linear extrapolation of their consumption over time.

5.4 Continuous potential measurements by remote electrode

This method records the potential difference between two reference electrodes all along the pipeline. The recording shall be carried out continuously.

The first electrode shall be located in a vertical position and near the pipeline, driven by a vehicle fitted with a video camera and a positioning device that permits to visualize and/or to follow the pipeline even if it is buried.

The second electrode shall be located near the sea surface in shallow water and/or at a minimum distance of 30 m from any other structure to be in an area where there is no electrical influence that could alter its potential. The distance between the two electrodes shall also be 30 m minimum in order to consider the electrode at "infinite" so that the remote electrode is not directly influenced by the field created by the pipeline's anodes.

Periodically (at least one time per 500 m) direct measurements in accordance with Section 5.2 shall be carried out. The final profile reconstituted of the pipeline potential given in the final report shall show these measurements so as to judge the drift observed. Potentials measured

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close to platforms located at the ends of the sea-line shall be used only with an extreme precaution to calibrate the profile because the electrical field at these areas is too complex.

6. Measurement equipment

Ag-AgCl/seawater measurement electrodes shall be used for the measurements, calibrated against a saturated calomel electrode. The potential difference between the two electrodes shall be between 0 and +10 mV with the negative (-) terminal of the voltmeter connected to the saturated calomel electrode.

If two or more electrodes are used, the drift of potential difference between them shall be less than 5 mV. These calibrations shall be performed at mobilization time, before and after each serie of measurements during dives.

The recording and computation equipment shall be approved by the Owner and checked periodically (especially by calibration using standard cells).

7. Measurement validation and interpretation

7.1 On site measurement validation

A preliminary report giving the raw results shall be submitted to the Owner before demobilisation to confirm the agreement of the measurements with those specified in the Contract and their validity.

In case of non-conformity (especially missing measurements) or unexplainable results, the Contractor shall complete or correct the inspection carried out.

7.2 Acceptance criteria for inspection after pipe-laying

In case of inspection performed in order to check the pipeline after the laying operation, the pipe-laying Contractor shall carry out corrective actions as dictated by the measurement results.

These actions are linked to non-conformities regarding either the coating (degradation of the factory coating, poor field joint coating, poor repairs) or the cathodic protection (faulty anodes).

The measurements carried out in accordance with this specification shall take into account the following criteria:

7.2.1 Potential

A potential variation of more than 20 mV over a length less than 2 m, **outside the location of any anode**, indicates a significant coating defect and shall be considered as a non-conformity.

7.2.2 Anode current output

The absence of a peak at a location where there should be an anode can be interpreted in two ways:

- Negligible current due to absence of coating defects. In this case, the potential in the vicinity of the anode should be close to that of the anode (less than 20 mV difference)
- Missing or poor anode connection. In this case, this point should be checked to evaluate the non-conformity further.

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An anode current output which is higher than the average of the other anodes indicates the presence of significant coating defects in the vicinity of that anode. A special survey of the defects shall be carried out if the measured current output is equal to twice the average anode current on the inspected pipeline. If the difference between the potential at this point and the average potential nearby is more than 20 mV, the defect shall be considered as a non-conformity.

7.3 Treatment of non-conformities

In the absence of particular contractual clauses, the non-conformities defined in Section 5.2 shall be subject to a repair by the installation of additional sacrificial anodes.

The repair procedure shall be submitted to the Owner for approval.

8. Contractor's obligations

8.1 Contents of the tender file

The Contractor shall submit a file to the Owner containing:

- Details of the proposed inspection methods
- A description of the material, technical and human resources (Certification of personnel) required for implementing these methods and for quality control (instrument calibration)
- The minimum spacing between discontinuous measurements (unwound cable method)
- A document describing the presentation of the results in the final inspection report.

All Sub-contractors, if any, shall be subject to the approval of the Owner.

The equipment proposed by the Contractor to perform the tests shall be approved by the Owner.

The Contractor shall demonstrate that he has all the equipment with certificates of calibration available at the time of inspection.

8.2 Before starting operations

The Contractor shall demonstrate during mobilisation that the required material and human resources are available and comply with the present requirements and that all the measurement and data processing systems are in working order and have been thoroughly checked and calibrated (especially measurement electrodes, voltmeters, recorders, microcomputers, etc.).

8.3 Spares Parts

Sub-contractor shall have available offshore, as the minimum, the following spare parts:

- 1 sub-surface transmitter
- 1 complete multi-electrode probe (including cells Ag/AgCl type)
- 1 remote reference electrode (Ag/AgCl type)
- 3 calomel cells for calibration (with calibration certificates)

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- 1 zinc block (with certificate)
- 1 voltmeter (with calibration certificate)
- Filling solutions for electrodes.

8.4 Personnel Mobilization

Sub-contractor shall mobilize the following personnel on board survey vessel:

- Two (2) Operators for CP measurements
- One (1) CP Engineer for data processing on board survey vessel.

8.5 Documentation

A draft of the CP survey final report presenting all the measurements taken (including the potential and field gradient charts), an easily legible summary of the results as well as the conclusions / interpretations on CP survey results, shall be submitted to the Owner before demobilization. The objective being to ensure that all necessary CP data have been collected and scope of survey have been completed before demobilization starts.

The draft report shall as well as the final CP survey report shall be submitted to Owner no later than one month after demobilization.

The following information will be required:

- Reference electrodes calibration records
- Cathodic Potential measurements
- Field Gradient: potential profile
- Position and condition of anodes recorded
- A description of any painting / coating defects and their effect on the Cathodic Protection of the equipment
- A discussion/evaluation of the anode activity and of its consumption. The current output shall be calculated for each anode
- Position of contact reading. This should be recorded in relation to structure, position on structure and ROV orientation
- Recording of video pictures.