

GENERAL SPECIFICATION

CORROSION

GS EP COR 202

Monitoring systems for cathodic protection of offshore structures
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05	10/2012	General revision
04	01/2011	Additional info about multicore cable and JB location
03	10/2008	Specification becomes limited to EP
02	10/2005	Change of title, transformation in Corporate General Specification and merger with GS COR 202
00	02/2001	First issue
Rev.	Date	Purpose of the revision

Owning entity: DEV/TEC	Managing entity: DEV/TEC/COR
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1. Scope

This document describes monitoring systems to be used for the cathodic protection of offshore structures, and specifies the quality, checking points and acceptance criteria governing their supply and installation.

These systems are designed to check the characteristics of the cathodic protection from the launching of the structure to the end of its life.

The precise description of monitoring system to be implemented for a given offshore structure shall be given in the Job Specification on the basis of the present General Specification. Complexity of the monitoring system will depend on various parameters such as importance and geometry of the structure and experience feed-back on the given offshore location. In all cases the full description of monitoring systems shall be approved by the Owner.

Typically, three levels of complexity of monitoring are considered:

- Zinc reference electrodes only
- Complete monitoring system: zinc reference electrodes and monitored anodes, to be installed typically on a jacket type structure
- Special monitoring system: zinc reference electrodes, monitored anodes and cathodic current measurement devices.

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
IEC 60079-7	Classification of hazardous areas
IEC 60243-1	Electrical strength of insulating materials – Test methods – Part 1 Tests at power frequencies
NF C 32-111	Rigid reticulated polyethylene insulated cables, series 1000 RGPV

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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 201	Supply of sacrificial anodes
GS EP COR 350	External protection of offshore and coastal structures and equipment by painting

3. Zinc reference electrodes

3.1 Composition

The chemical composition of the zinc alloy used for the reference electrodes shall comply with type Z2 as defined in [GS EP COR 201](#) paragraph 3.1.2.2.

3.2 Location

The minimum number of reference electrodes to be installed depends on the complexity of the structure, e.g. the number of submerged horizontal levels on a jacket that are below sea level. Their positions shall be defined in the cathodic protection job specification taking into account as a minimum, one reference electrode per level of jacket, and electrodes located in the vicinity of nodes, where the current demand is the highest.

These reference electrodes shall be connected to gathering boxes.

Alternatively, acoustic transmission of data using hydrophone may be proposed.

4. Complete monitoring system

4.1 Description of a set of complete monitoring system

The complete cathodic protection monitoring system shall comprise:

- For the submerged part:
 - Two monitored sacrificial anodes, isolated from the structure but connected to the structure through a calibrated shunt. The location of monitored anodes shall be approved by the Owner
 - A reference zinc electrode on each of the monitored anodes
 - A gathering box for all the measurement cables. This unit shall bear a reference zinc electrode
 - At least one reference zinc electrode on each level of the jacket, as far as possible from anodes
 - A multicore cable linking the gathering box to the connection unit.
- For the above-water part:

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- A connection unit located on the first level above sea level
- A measuring instrument located in the electrical rooms
- A multicore cable linking the connection unit to the measuring instrument.

4.2 Number of sets to install

- For sea depths between 0 and 60 m, the jacket should have one set of anodes with instrumentation (two anodes)
- For sea depths between 0 and 120 m, the jacket should have two sets of anodes with instrumentation
- For greater depths, the jacket should have one or more additional sets of anodes with instrumentation for each additional 60 m of sea depth.

4.3 Requirements for the components

4.3.1 Insulated sacrificial anodes

Two sacrificial anodes, taken at random from the batch of anodes provided for the protection of the structure, shall be installed as described in Appendix 1.

Each monitored anode shall have two insulating joints. One of the two shall be by-passed by a shunt for measuring the current output by the anode. The resistance of the shunt shall be no more than 2.5×10^{-3} ohms (0.5% accuracy from 0 to 30°C).

4.3.2 Zinc reference electrode

4.3.2.1 Composition

The chemical composition of the zinc alloy used for the reference electrodes shall comply with type Z2 as defined in **GS EP COR 201** paragraph 3.1.2.2.

4.3.2.2 Position

Reference electrodes on monitored anodes

The reference electrodes on these anodes shall be mounted as shown in Appendix 1 (detail 1).

Reference electrodes on the gathering box

A reference electrode shall be installed on the gathering box as shown in Appendix 2.

Reference electrodes on the structure

The minimum number of reference electrodes to be installed depends on the number of the jacket's submerged horizontal levels that are below sea level. Their positions shall be defined in the cathodic protection job specification and approved by the Owner.

These reference electrodes shall be connected to the nearest gathering box. The wiring diagram for these electrodes is given in Appendix 2. All reference electrodes shall be electrically insulated from the structure.

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4.3.3 Gathering box

This carbon steel gathering box shall be coated using system P08 of [GS EP COR 350](#). If made of stainless steel, it shall be coated using system P05 2nd of [GS EP COR 350](#).

The gathering box shall be mounted on a plate welded to the structure, mid-way from the monitored anodes.

Inside, it shall have a terminal block for connecting the two anodes and the reference electrodes, and cable entry glands. Wiring details are given in Appendix 2.

Note: When the cables have been connected to the terminal block, and the wiring and insulation have been checked, the unit shall be filled with epoxy resin on the construction site.

4.3.4 Resin

The epoxy resin shall meet the following specifications:

- Water absorption, 24 hours at 23°C, 3 mm thickness: 0.5%
- Transverse dielectric strength (3 mm thickness), minimum: 20 kV/mm according to [IEC 60243-1](#).

4.3.5 Multicore cable

A multicore cable, type U 1000 RGPV (hydrocarbon resistant and fire retardant) in accordance with [NF C 32-111](#), shall link the gathering box to the connection unit of the above-water level. The external diameter of the cable shall be minimum 18 mm.

4.3.6 Connection box

The multicore cables from the submerged part shall be terminated inside a connection box.

This shall be rated Eex"e" II B.T6, IP 667, according to [IEC 60079-7](#), for use in potentially explosive areas. The same applies for the terminal block and cable glands.

The unit shall be installed on the first floor above the first above-water level, after the jacket has been installed on site.

The unit's wiring principles are set out in Appendix 3 (one or two sets). The unit shall be of polycarbonate, or reinforced polyester. Metallic boxes are not acceptable.

4.3.7 Multicore cable

The cable linking the connection unit to the measuring instrument in the electrical plant rooms shall be type U 1000 RGPV in accordance with [NF C 32-111](#).

The cable shall have multicore conductors for each monitoring device. The external diameter of the cable shall be minimum 18 mm.

4.3.8 Measuring instrument

This shall be installed in an electrical room (or in the instrumentation room). It shall comprise a 19" x 6 U standard rack. The front of the instrument shall include a measuring device and a mimic.

4.3.8.1 Mimic

A switch shall be installed so that measurements can be taken from each of the sets. The switch controller shall be located on the front of the measuring instrument.

The reference electrodes located on the levels of the structure shall be connected directly to the mimic (regardless of the switch position).

A detailed list of each terminal and of relevant connections (shunt +/-, reference electrode on jacket, on gathering box, on anode, etc.) shall be clearly indicated in the box.

4.3.8.2 Measuring instruments

The measuring instruments shall include two digital voltmeters with high input impedance > 10 MΩ:

- 1 voltmeter - 200 mV - 2 000 points
- 1 voltmeter - 2 000 mV - 2 000 points.

The on/off switch shall control the digital voltmeters.

4.3.9 Cable protection

The cables shall be protected by carbon steel conduit (schedule 80), screw jointed:

- 1"1/2 diameter for the cables of the zinc reference electrodes located on the levels and for the cables linking the anodes to the gathering box
- 3" diameter for the 19-core cables linking the gathering box to the connection unit, located on the first above-water level.

The cable protection conduits shall be welded to the structure by steel plates measuring 100 x 50 x 7 mm:

- At one-metre intervals between +4 m and -5 m
- At two-meter intervals below -5 m.

In the above-water area, the multicore cable(s) shall be secured in such a way that they cannot slip inside the protective conduits (for example, by stainless steel draw tape).

5. Special monitoring system for cathodic current measurement

In addition to equipment described in 4, such a special monitoring system may comprise the following. Other alternative systems may be proposed for approval of the Owner.

5.1 Instrumented cathodes

The set of instrumented cathodes shall comprise two cathodes, the length of which being determined in accordance with the diameter of the pile, so that the unit surface area of a cathode is 1 m² to within ± 2%.

Only one side of the cathode is exposed to the seawater, the other one being suitably insulated as proposed in § 5.3 or equivalent insulation system to be approved by the Owner:

- the first cathode shall be coated with the same painting system as the jacket

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- the second cathode shall remain bare, and blasted to Sa 2 ½ just after to be mounted.

5.2 Equipment of cathodes

In the vicinity of each cathode, a zinc reference electrode shall be installed and connected to the terminal block of the connecting box by a 2 x 1.5 mm² cable U 1000 RGPV.

- Each cathode shall be connected to the structure by a calibrated shunt with a resistance of 10⁻² ohm (5 A/50 mV - 0.5% accuracy from 0 to 30°C). Each terminal of the shunt shall be connected by 2 x 1.5 mm² cable U1000 RGPV up to the gathering box. The shunt shall be installed in a box in the vicinity of the cathode, in which epoxy resin is poured after cables connections (§ 4.3.4).

The cathode/shunt/structure connecting cables shall have a cross-sectional area of minimum 1 x 25 mm².

5.3 Insulation between and fixing together of cathodes

Cathodes shall be insulated from the structure by a 25 mm thick neoprene plate bonded to the inner side of each cathode. Special care shall be taken in making cuts to allow the passage of the measurement cables, so that the measurement cables are not damaged when the jacket is installed.

6. Technical content of the bids

The technical bid shall include the characteristics and references of the various instruments and materials used, as listed below, when it applies:

- Voltmeter
- Stabilised PSU
- Mimic
- Resin
- Reference electrode
- Shunt characteristics
- Monitoring system Manufacturer
- Wiring diagrams
- Description of units (material, coating, size)
- Impressed current anode
- Current generator.

7. Inspections

7.1 Factory acceptance

Acceptance testing of all the various monitoring devices shall be carried out on the premises of the Supplier chosen by the Contractor, in the presence of a representative of the Owner.

7.1.1 Shunted anodes and measuring instrument

Each set shall be acceptance tested when finished (insulating seal resins poured inside the joint). It shall be submerged in a tank filled with 35 g/L NaCl salt water. The core of the anode on the shunt side shall be linked electrically to a frame ground (or to the tank itself if made of steel) via an ammeter.

The measurement cable for each anode shall be connected to the gathering box which shall in turn be linked to the measuring instrument (the electrical diagrams must be checked).

The following measurements shall be taken for each subsystem after calibrating the zinc electrodes regarding a saturated calomel electrode (SCE) provided with its certificate of calibration:

- Potential of anodes and zinc reference electrodes
- Resistance of shunt/sacrificial anode system and of shunts by direct measurement of the voltage across the terminals of the shunt, and by opposed current measurement
- Inspection of all insulating joints
- Verification of electrical connections (shunt cable color).

7.1.2 Zinc reference electrodes

Verification of the insulation resistance of the zinc relative to the electrode mounting shall be carried out.

Measurement of the potential of the zinc in 35 g/L salt water compared to a saturated calomel electrode (SCE). Measured potential shall be -1040 ± 10 mV/SCE.

Inspection of electrode identification details (number, cable length, level).

7.1.3 Documents to be submitted

- Drawings of all subsystems with details of insulating joints, cables and shunt values
- Wiring diagrams, layout and fixing drawings for the various boxes, and a plastic laminated drawing inside each box
- Wiring and dimension drawings of the measuring instrument, references and components
- Spare fuses (two sets)
- Acceptance test reports.

7.2 Acceptance testing on site

After assembly, all the following points shall be checked:

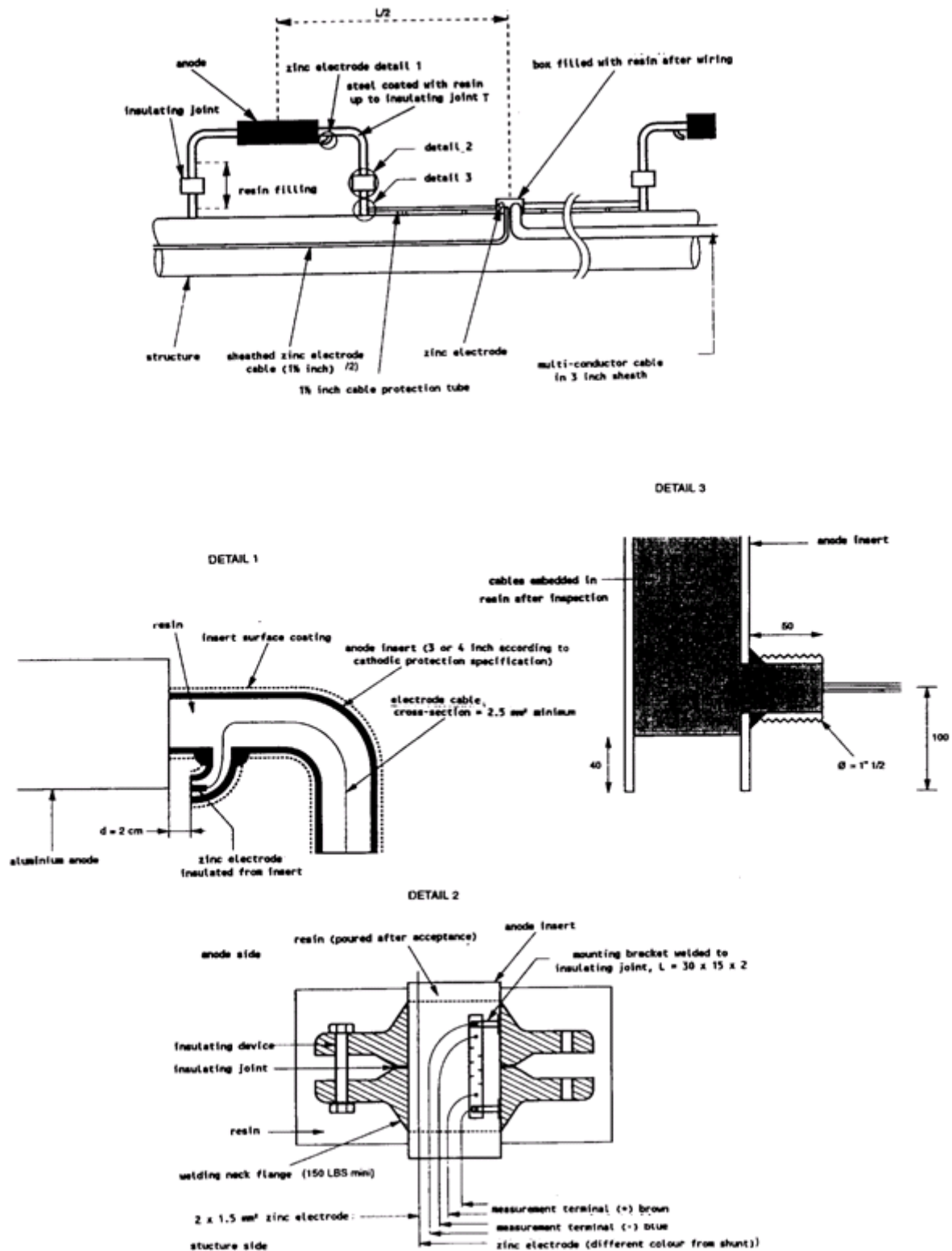
- Cable insulation
- Electrical continuity
- Wiring
- Fixing of cable supports

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- Reference electrode/structure insulation resistance
- Securing of the cable on the top level
- Verification of compliance of the positioning of the anodes with instrumentation and reference electrodes on the structure
- Documents to be submitted
- Drawing of conduits (position, assembly details and fixing details) for protecting cables
- Drawing of cable gathering boxes (materials, dimensions, type of cable glands)
- Drawing of the connection unit on the first above-water level
- Name of the Supplier of the monitoring device
- Exact positioning drawing of the anodes with instrumentation and the reference electrodes

Documents listed in section 7.1.3.

Appendix 1 Diagram of monitored anodes



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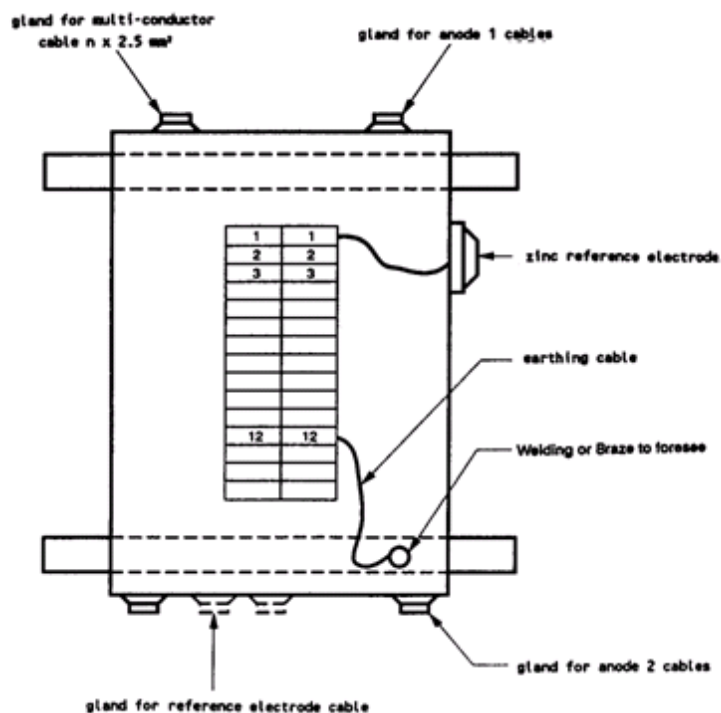
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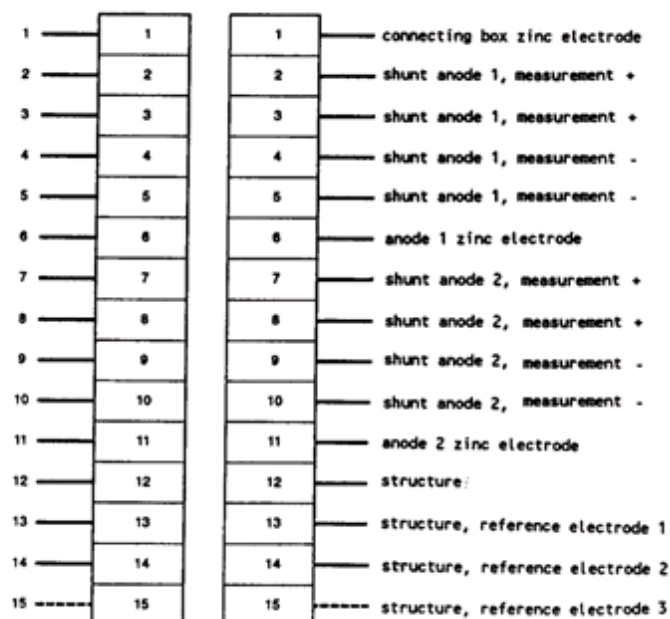
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Appendix 2

Appendix 2 Gathering box



reference of 19 x 2.5 mm² conductor cable



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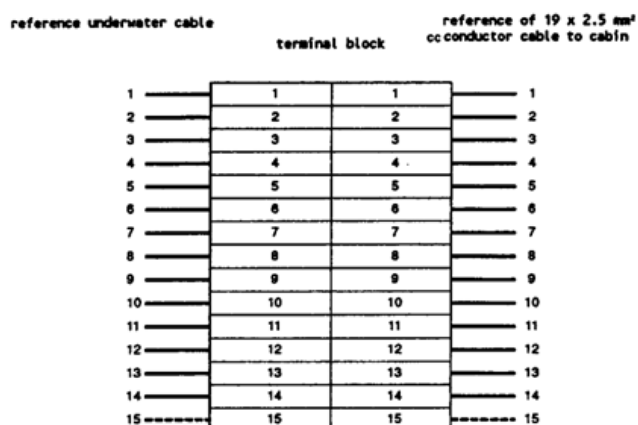
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Appendix 3

Appendix 3 Wiring diagrams of connection units

ONE SET



TWO SETS

