



Exploration & Production

## GENERAL SPECIFICATION

### CORROSION

#### GS COR 204

**Supply of a device for checking cathodic protection characteristics of a jacket**

|      |       |                               |
|------|-------|-------------------------------|
|      |       |                               |
|      |       |                               |
| 01   | 09/03 | Change of Group name and logo |
| 00   | 02/01 | First issue                   |
| Rev. | Date  | Notes                         |



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## 1. Scope

This document describes a cathodic protection monitoring system (monitored anodes and instrumented cathodes) for offshore platforms, and indicates the quality, inspection and acceptance criteria requirements applicable to its supply and its assembly.

This system is designed to check the characteristics of the cathodic protection from the launching of the jacket.

## 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                                                                                        |
|-------------|----------------------------------------------------------------------------------------------|
| PrEN 12496  | Sacrificial anode for cathodic protection in sea water                                       |
| ISO 62-1980 | Water absorption of resin plastics                                                           |
| IEC 243     | Determination of electric strength of solid insulating materials                             |
| NFC 32-311  | Rigid, reticulated polyethylene insulated cables, series 1000 RG PFV                         |
| IEC 79-7    | Increased safety "e"                                                                         |
| IEC 502     | Energy transport cables with solid extruded insulation for rated voltages from 1 kV to 30 kV |

### 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 201 | Supply of sacrificial anodes                                |
| GS COR 350 | External protection of structures and equipment by painting |

## 3. Description of components of the measurement system

### 3.1 For the underwater part

One set comprises:

- Two aluminium sacrificial anodes. Each anode is insulated from the structure by two insulating joints. One of the insulating joints is short-circuited by a shunt with a perfectly known resistance (Appendix 2)
- A zinc reference electrode near each of these anodes
- An impressed-current anode of the platinum-plated titanium type, placed under each of these sacrificial anodes (Appendix 2)
- Four steel plates of known surface area, called "instrumented cathodes" and insulated from each other. One of these plates is welded to the structure. It maintains the other three and also supports the connecting box. Each of these plates has one zinc reference electrode (Appendix 3)
- A zinc reference electrode on each level of the jacket
- Four zinc reference electrodes. They are fixed to the cable protection tube between anodes and connecting box
- A watertight connecting box for all the cables (anodes, electrodes, shunts, etc.)
- A multi-conductor cable linking the connecting box to the junction box placed on the first above-water level.

### 3.2 For the above-water part

- A watertight junction box placed on the first above-water level, containing two recorders designed to monitor all the measurements during the first few months after the jacket is launched
- A measurement unit in the technical rooms (instruments, etc.) located on the deck
- A multi-conductor cable linking the junction box to the measurement unit.

## 4. Definition of supply

### 4.1 Underwater part

#### 4.1.1 Reference electrodes

The chemical composition of the zinc alloy used for the reference electrode shall comply with type Z2 as defined in [prEN 12496](#).

The description of the electrodes for the levels is given in Appendix 6 - diagram 6A.

For the anodes, cathodes and connecting box, it is given in Appendix 6 - diagrams 6B and 6C.

#### 4.1.2 Monitored anodes

These shall be taken from the batch of anodes intended for protection of the structure.

Each anode shall be provided with series 300 RF insulating joints. One of these joints shall be short-circuited by a shunt resistance of  $2.5 \cdot 10^{-3}$  ohms equipped with four  $2.5 \text{ mm}^2$  U 1000 RGPV cables. Two of them (measurement cables) shall be used to measure the current output of the anode. The other two cables (power cables) shall be used to check the resistance of the shunt by the "current opposition" method.

In addition to the above equipment, each anode shall receive:

- A zinc reference electrode equipped with a  $2 \times 1.5 \text{ mm}^2$  U 1000 RGPV cable placed 2 cm from the anode and electrically insulated from it
- An impressed-current anode of platinum-plated titanium, 1 inch diameter and 450 mm active length, with an output of 10 A, mounted in parallel with the sacrificial anode and equipped with a  $2 \times 2.5 \text{ mm}^2$  section cable 1000 RGPV (Appendix 2).

Between each monitored anode and the connecting box, two zinc reference electrodes, each equipped with a  $2 \times 1.5 \text{ mm}^2$  cable U 1000 RGPV and electrically insulated from the structure, shall be positioned as follows (Appendix 3):

- The first 20 cm from the bottom of the anode
- The second midway between the previous anode and the monitored cathode.

The cable shall be run inside the insert, and the insulation after installation shall be executed as described in Appendix 2.

#### 4.1.3 Instrumented cathodes

The set of Instrumented cathodes shall comprise four steel plates (three cathodes and one support plate) the length of which shall be determined in accordance with the diameter of the pile, so that the unit surface area of a cathode is  $1 \text{ m}^2$  to within  $\pm 2\%$ . After painting of the cathode bolting plates, the bare steel surface area must be measured with an accuracy of  $\pm 0.2\%$ .

The inner side of the three cathodes and the plates must be coated according to system P08.

##### 4.1.3.1 Equipment of cathodes No. 1 and 3

At the centre of each cathode, a zinc reference electrode shall be connected to the terminal block of the connecting box by a  $2 \times 1.5 \text{ mm}^2$  cable U 1000 RGPV (Appendix 4).

- Cathode No. 1 shall be connected to the structure by a shunt with resistance of  $10^{-2}$  ohm (5 A/50 mV)
- Cathode No. 3 shall be connected to the structure by a shunt with resistance of  $5 \cdot 10^{-2}$  ohm (1 A/50 mV).

The cathode/shunt/structure connecting cables shall have a cross-sectional area of 25 mm<sup>2</sup>.

#### 4.1.3.2 Equipment of cathode No. 2

- A zinc reference electrode shall be connected by a 2 x 1.5 mm<sup>2</sup> cable U 1000 RGPV to the terminal block of the connecting box
- Two 2.5 mm<sup>2</sup> cables welded to the inner side of the plate and connected separately to the terminal block of the connecting box (Appendix 4).

#### 4.1.3.3 Equipment of the support plate

This cathode, welded on its four sides to the structure, shall be designed to:

- Maintain the other three on the cord and eliminate any risk of sliding during pile driving
- Support the cable connecting box.

#### 4.1.3.4 Insulation between and fixing together of cathodes

Cathodes No. 1, 2 and 3 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 (Appendix 4 and Appendix 5).

The cathodes shall be insulated from each other by a plastic insulating plate, of sufficient thickness to ensure proper fixing of the assembly by clamping. The threaded rods shall be of glass reinforced epoxy, and the nuts and washers shall be of insulating material.

#### 4.1.4 Connecting box

The connecting box shall be made of steel plate at least 6 mm thick, with inside dimensions of 400 x 400 mm, welded to the centre of cathode No. 4 and coated according to system P08.

The cable protection sheaths shall project from the sides of the box, and be fixed by welding to the outer sides of the box.

This watertight box shall receive the insulated terminal block to which all the cables are connected (Appendix 7). The 2.5 mm<sup>2</sup> "earthing" cables of the shunts of cathodes 1 and 3, and the earth cable of the support plate, shall each be connected to a bracket welded to an inner side of the box.

A zinc reference electrode equipped with a 2 x 1.5 mm<sup>2</sup> cable shall be fixed to one of the outer sides of the box. After inspection of the connections and acceptance by the OWNER, the box shall be filled with epoxy resin or equivalent, meeting the following requirements:

- Water absorption, 24 h at 23°C, thickness 3 mm: 0.5%
- Minimum transverse electric strength (thickness 3 mm): 20 kV/mm.

#### 4.1.5 Multi-conductor cable

This cable, of type U 1000 RGPV, 37 x 2.5 mm<sup>2</sup>, shall connect the connecting box to the junction box.

The numbering of the strands shall be identical to that of the cables of the monitoring system connected in the connecting box.

### 4.2 Above-water part

#### 4.2.1 Junction box, wiring

- The junction box shall be made of steel coated according to system P09 and of safety type EEx "e" or "d" for use in explosive areas. The same shall apply to the terminal blocks and cable glands
- It shall withstand submersion and be made watertight to enable operation of the measurement acquisition system as soon as the jacket is launched and throughout the pile-driving phase
- The box shall be positioned to provide ready access
- Its dimensions shall be such that it can accommodate:
  - The connecting terminal block(s), multi-conductor cable(s) of the underwater part, and connecting cables with the measurement unit in the technical rooms
  - The provisional measurement acquisition system.
- The wiring arrangement shall be the same as that of the connecting box
- The cable connecting the junction box to the measurement unit shall be of type U 1000 R02V.

#### 4.2.2 Provisional measurement acquisition system

A solid state memory recorder or equivalent with twenty inputs shall be assigned to each monitoring set. This must be rated to store all the parameters for three months at a rate of one measurement every 2 h. This means a minimum storage capacity of 25.000 data items including the date and time. The acquisition system must allow the data to be uploaded to an IBM-compatible microcomputer. To save memory, this must be placed on standby until the submersion of the structure, and data acquisition must be initiated by the passage of current in the anode shunt.

As soon as the jacket is launched, the following data shall be recorded per set of measurements.

| Type of measurement         | Number of variables                    | Number of inputs on recorder |
|-----------------------------|----------------------------------------|------------------------------|
| Anode output                | 2                                      | 4                            |
| Current density on cathodes | 2                                      | 4                            |
| Anode potential             | 2                                      | 2                            |
| Potential between anodes    | 4                                      | 4                            |
| Cathode potential           | 3                                      | 3                            |
| Level potential             | 2 (or 3 depending on number of levels) | 2 or 3                       |
| <b>Total</b>                | <b>15 or 16</b>                        | <b>19 or 20</b>              |

### 4.3 Measurement unit

The measurement unit shall be located in the technical rooms (instruments, etc.) and consist of:

- A 19" x 10U rack comprising:
  - A mimic panel
  - A d.c. generator
  - Measurement equipment (voltmeters, shunts).
- A 19" x 3U rack placed above the previous rack, where the recorder(s) recovered in the junction box after the deck is installed shall be positioned: this rack must be equipped with a pre-wired telescopic slider system so that the recorders can be installed easily.

#### 4.3.1 Mimic panel

The panel is described in Appendix 1.

The following indications must appear on the front panel:

- Reference of each measurement point (electrodes, cathodes, etc.)
- Rating of each shunt.

#### 4.3.2 Current generator

The current generator shall be a stabilised power supply powered at 220 V, 50 Hz and capable of generating a d.c. current adjustable from 0 to 20 A. The output voltage shall be adjustable from 0 to 15 V. The stability of the output must be less than 30 mV for a load variation of 0 to 100%, and a mains variation of  $\pm 10\%$ . The residual ripple shall be less than 5 mV. The generator shall have two outputs on 10 A/100 mV shunt. The different protection fuses shall be accessible from the front of the panel.

#### 4.3.3 Measuring instruments

The digital voltmeters shall have a high input impedance ( $> 1$  Megohm):

- 2 voltmeters, 0 to 200 mV, accuracy  $10^{-2}$  mV
- 1 voltmeter, 0 to 2 V, accuracy  $10^{-1}$  mV.

#### 4.3.4 Recorder(s)

The recorder(s) must be connected so as to allow continuous recording of the data listed in Section 4.2.2. The location must allow easy replacement of the memory cards.

## 5. Arrangement and installation

### 5.1 Number of reference electrodes on the structure

One zinc electrode shall be fixed to each underwater level of the jacket. It must be perfectly insulated from the structure, and positioned at a point as far as possible from the aluminium sacrificial anodes (Appendix 6).

### 5.2 Number of sets of monitored anodes and instrumented cathodes

For depths between 0 and 60 m, one set shall be provided.

For depths between 60 and 120 m, two sets shall be provided.

One set for each additional depth interval of 60 m may also be provided.

### 5.3 Position and spacing

For a jacket equipped with two monitoring sets, these sets shall be installed on the same cord. In all cases, the arrangement and layout shall be such that each set is located between two levels. The orientation of the monitored anodes with respect to the front plane shall be identical to that of the other anodes of the pile concerned (at 45 degrees towards the interior with respect to the plane of the jacket faces).

For each monitoring set, the spacing between each anode (measured from the centre of the anodes) shall be such that it corresponds to the design criteria (current density and rated current of an anode) (Appendix 3).

#### Example:

- Design current density: 100 mA/m<sup>2</sup>
- Nominal current output: 4 A
- Area between middle of each monitored anode: 40 m<sup>2</sup>

### 5.4 Cable protection

In the underwater zone, the cables shall be protected by carbon steel (schedule 80) screw-jointed tubes, with the following diameters:

- 1 ½ inches for the cables of the zinc reference electrodes of the different levels
- 2 ½ inches for the cables of the monitored anodes
- 3 ½ inches for the multi-conductor cables.

The protective tubes shall be welded to the structure by steel brackets measuring 100 x 50 x 7 mm:

- Every 1 m between the +4 and -5 m levels
- Every 2 m below -5 m.

In addition, in the above-water zone, the 37 x 2.5 mm<sup>2</sup> cable(s) shall be attached so that they cannot slide in the protective tubes, with self-tightening threads of 316L steel.

Internal fixing systems shall also be provided for multi-conductor cables at each level in order to reduce the total weight of the cable during jacket launching.

## 6. Quality assurance procedures

### 6.1 Design

Before the start of the fabrication, a Quality Plan must be drawn up, detailing all the procurement, fabrication, checking and inspections procedures.

These shall be described in "detailed procedures".

### 6.2 Materials

The technical part shall give the characteristics and references of the various items and materials listed below:

- Voltmeter
- Stabilised power supply
- Recorder
- Resin
- Reference electrode
- Characteristics of shunts
- Wiring diagram (connecting box, junction box and measurement unit)
- Description of connecting and junction boxes (material, coating, dimensions)
- Cable characteristics
- Description of cathodes (dimensions, insulation, attachments).

### 6.3 In-plant acceptance

Acceptance of the system and the different inspections shall be performed in the plant of the SUPPLIER selected by the CONTRACTOR, attended by the OWNER'S representative.

Set of monitored anodes, cathodes and measurement unit. Each set shall undergo acceptance testing when completed (resin of insulating joints poured). It shall be immersed in a tank filled with salt water containing about 30 g/l NaCl. The anode core shall be electrically connected to a metal frame (or to the tank if it is made of uncoated steel) via an ammeter.

The measurement cables of each anode shall be connected directly to the measurement unit (the circuit diagrams shall be checked first).

The following measurements shall be taken for each subassembly after checking the insulation and calibrating the zinc electrodes relative to the Ag/AgCl/sea water electrode (open-circuit potential  $-1050 \pm 20$  mV):

- Potential of anodes with respect to Ag/AgCl/sea water electrode

- Measurement of the resistance of the shunt/sacrificial anode combination, shunt/cathode combination, and shunts, by direct measurement of the voltage across the shunt terminals and by measurement using the opposition method
- Checking out operation of the impressed-current anodes from 0 to 10 A (in increments of 1 A)
- Testing the mimic panel by operating the two impressed-current anodes simultaneously
- Checking out operation of the data acquisition units.

The following documents shall be supplied:

- Detailed drawings of assemblies with details of insulating joints, impressed-current anodes, instrumented cathodes, various cables, and values of shunts
- Wiring, dimensional and fixing diagrams of all connecting and junction boxes (a plastic laminated wiring diagram shall be fixed inside each box)
- Cable lengths
- Wiring and dimensional drawings of the measurement unit, and references of its components
- List of spare parts
- Acceptance reports.

#### 6.4 On-site acceptance

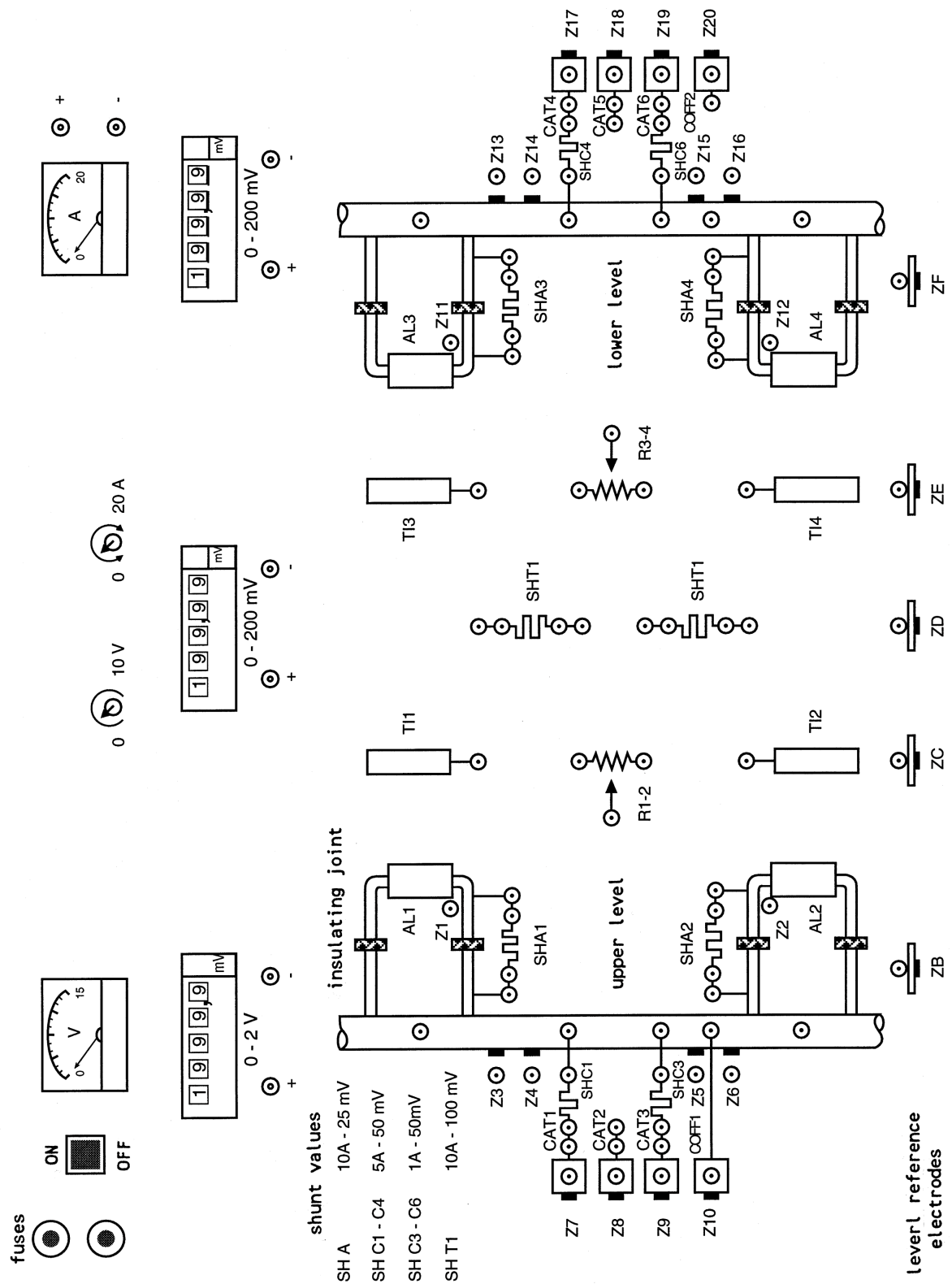
All the following points shall be checked after assembly:

- Conformity of wiring
- Insulation of cables
- Electrical continuity
- Cable support fixing
- Insulation of reference electrodes from the structure
- Insulation of instrumented cathodes between each other and from the structure
- Fastening of cables to the above-water level
- Conformity of positioning of monitored anodes and instrumented cathodes and reference electrodes.

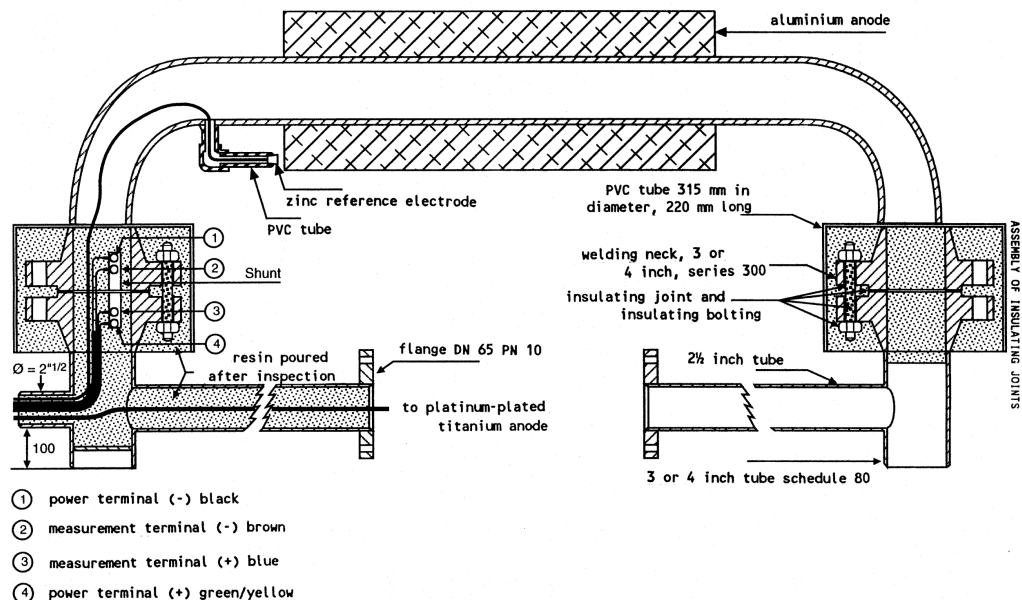
The following documents shall be supplied:

- Drawing of cable protection tubes (position, assembly and fixing details)
- Drawing of cable connecting boxes (materials, dimensions)
- Drawing of junction box for above-water level (materials, dimensions, glands)
- Drawing of exact positioning of the monitored anodes and instrumented cathodes and of the reference electrodes
- Documents listed in Section 6.3.

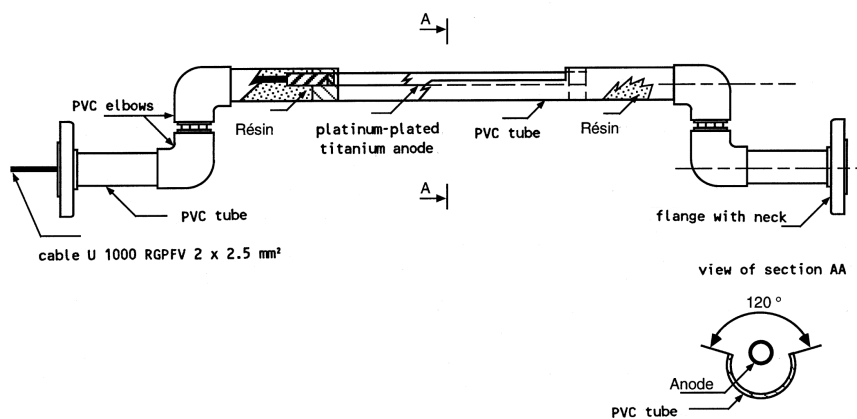
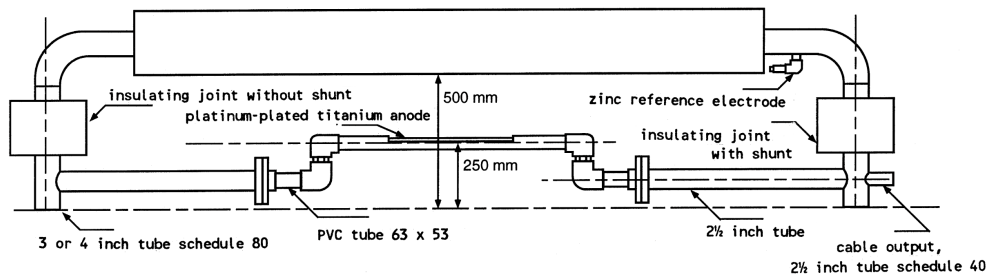
## Appendix 1 Mimic panel



## Appendix 2 Assembly of insulating joints and platinum-plated titanium anode on sacrificial anode



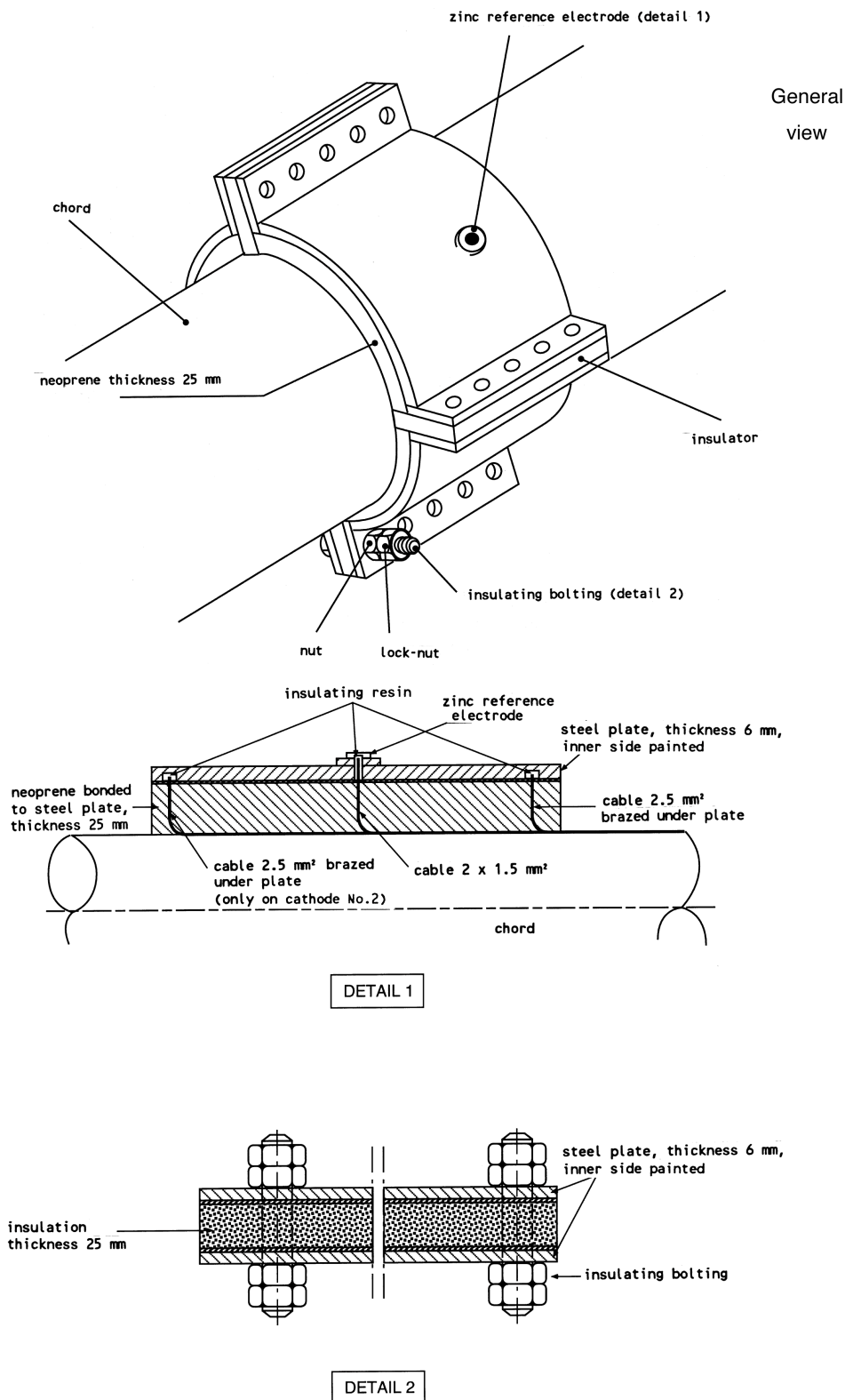
### Assembly of insulating joints



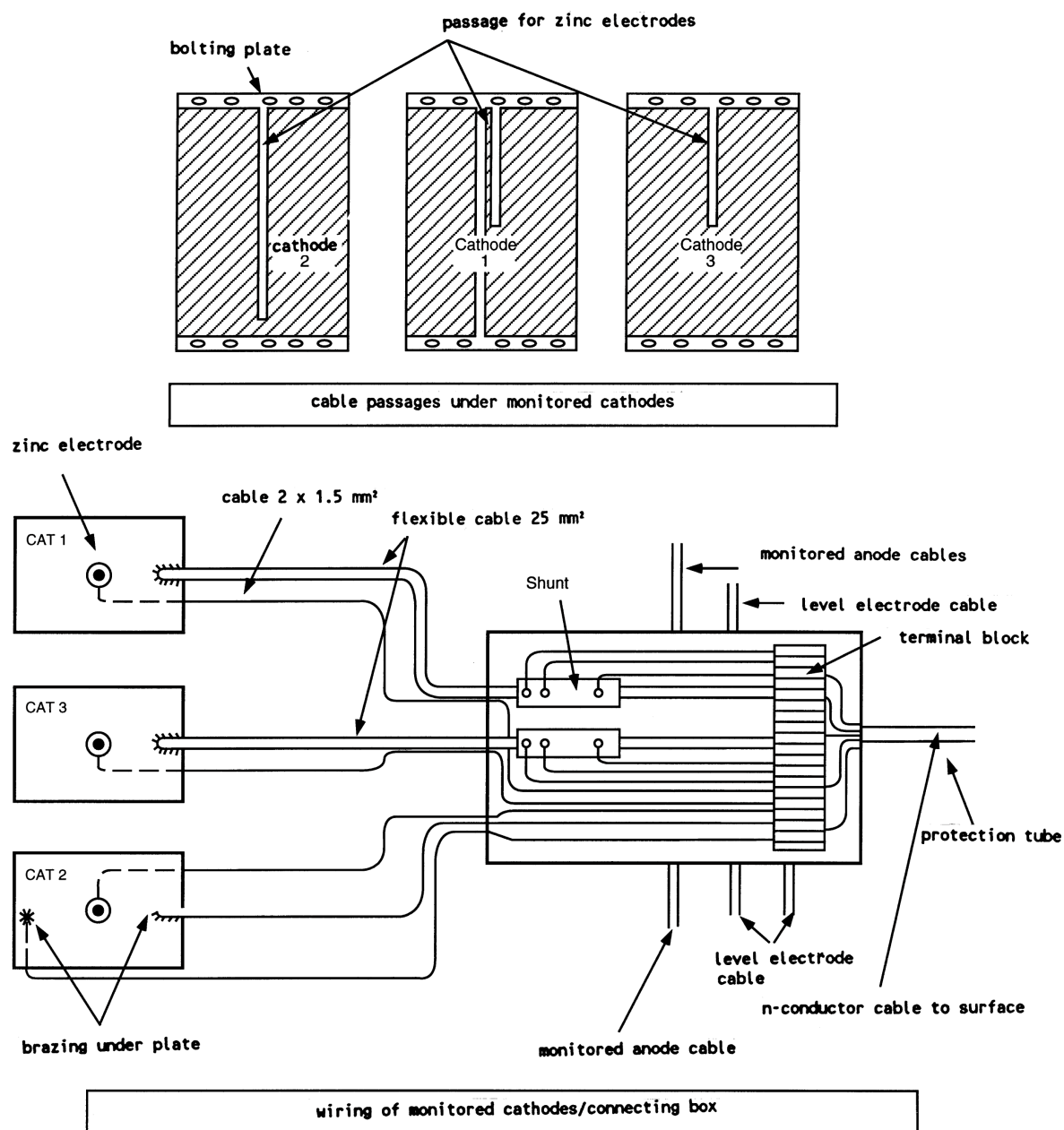
### Assembly of platinum-plated titanium anode



## Appendix 4 Instrumented cathode - General view - Details

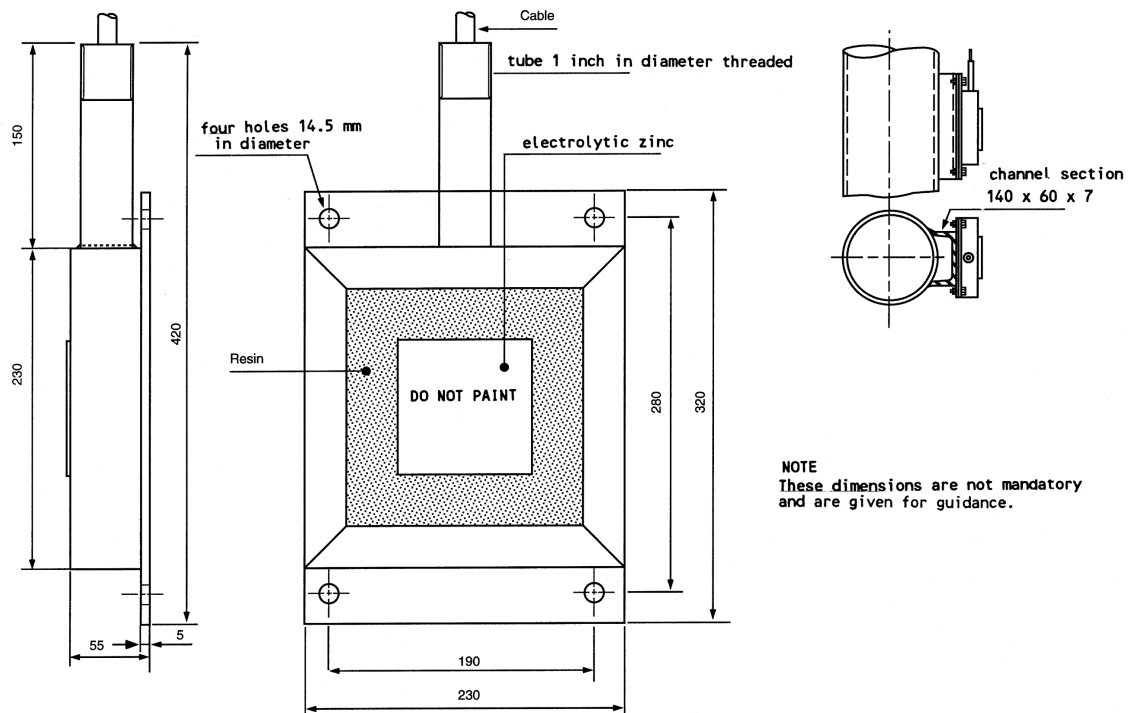


## Appendix 5 Instrumented cathode - Cable runs

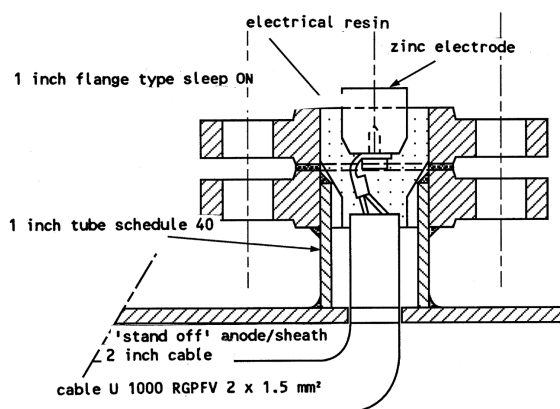


## Appendix 6 Zinc reference electrodes

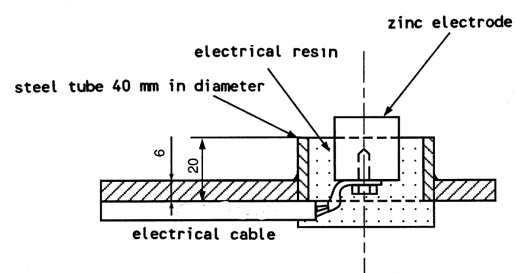
8a - Level reference electrode



8b - Reference electrode for monitored cathodes and connecting box



8c - Reference electrode between anodes and on anodes



## Appendix 7 Wiring general diagram

