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TECHNICAL SPECIFICATION

HIGH PRESSURE (HP) TRANSMISSION SYSTEMS

INSTALLATION OF CATHODIC PROTECTION SYSTEM

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1. INTRODUCTION

The installation of the Cathodic Protection System will be in compliance with this specification, the Study of the Cathodic Protection System, which shall be carried out by EPC Contractor during the detail engineering phase, the Standard drawings for Cathodic Protection System, as well as the applicable codes and standards referred to in paragraph 3.2 here in.

2. SCOPE AND OBJECTIVES

This Specification covers the construction procedures and working techniques to be followed by the Contractor for the proper installation of the Cathodic Protection System of the High Pressure N.G. Pipeline.

The exact implementation of this specification will ensure that the installed Cathodic Protection System will be reliable and properly functioned with maintainability.

3. REFERENCES

3.1 Reference Documents

DSF-SPC-CPR-001: Cathodic Protection Anode Material.

DSF-SPC-CPR-002: Cathodic Protection Transformer Rectifier Cabinets at Anode Beds.

DSF-SPC-CPR-003: Cathodic Protection Polarization Probe, Reference Electrode and ER Coupon.

DSF-SPC-CPR-004: Electrical Resistance Welding "Pin Brazing".

DSF-SPC-CPR-006: Cathodic Protection Commissioning and Start-up.

DSF-SPC-CPR-007: Marker and Measuring Posts.

DSF-SPC-CPR-008: Precautions Against Proximity Effects during the Construction Phase.

DSF-SPC-CIV-004: Measuring-up and as Built Documentation.

DSF-SPC-CIV-014: Reinstatement.

DSF-SPC-PIP-013: Corrosion Protection of Field Joints & Uncoated Pipeline Components.

DSF-SPC-PIP-016: Crossings.

STD-4-43-19: Cathodic Protection for Pipelines - Concrete Piers for P.P.C. KWh Meter and T/R Cabinet.

STD-00-78-01: Cathodic Protection for Pipelines - Transformer Rectifier Cabinet.

STD-3-78-02: Cathodic Protection for Pipelines - Installation of Transformer / Rectifier Cabinet.

STD-00-78-04: Cathodic Protection for Pipelines - Location of Reference Electrode.

STD-00-78-05: Cathodic Protection for Pipelines - Anode Bed Installation for Impressed Current Horizontal Anodes.

STD-00-78-06: Cathodic Protection for Pipelines - Anode Bed Installation for Impressed Current Vertical Anodes.

STD-00-78-07: Cathodic Protection for Pipelines - Anode Bed Installation for Sacrificial Anodes.

STD-00-78-15: Cathodic Protection for Pipelines - Measuring Posts K3S.

STD-00-78-16: Cathodic Protection for Pipelines - Measuring Posts K3J, K3G / A & B.

STD-00-78-18: Cathodic Protection for Pipelines - Measuring Posts K4J, K4G / A & B.

STD-00-78-29: Cathodic Protection for Pipelines - Cable Laying in Casing Pipe.

3.2 Reference Codes and Standards

EN 12068: Cathodic Protection, External organic coatings for the corrosion protection of buried or immersed steel pipelines used in conjunction with cathodic protection, tapes and shrinkable materials

EN 12954: General principles of cathodic protection of buried or immersed onshore metallic structures.

ISO 15589-1: Petroleum, petrochemical and natural gas industries — Cathodic protection of pipeline systems — Part 1: On-land pipelines.

ELOT EN 13509: Cathodic Protection Measurements Techniques.

EN ISO 18086: Corrosion of metals and alloys - Determination of AC corrosion - Protection criteria.

ELOT EN 50122: Railway applications - Fixed installations - Electrical safety, earthing and bonding.

ISO 21857: Petroleum, petrochemical and natural gas industries — Prevention of corrosion on pipeline systems influenced by stray currents.

EN 50443: Effects of electromagnetic interference on pipelines caused by high voltage A.C. electric traction systems and / or high voltage A.C. power supply systems.

AfK Recommendation No. 3: Measures for the installation and operation of pipelines in the vicinity of three-phase high voltage systems and single line traction systems.

ISO 15589-1: Petroleum & Natural Gas Industries – Cathodic Protection of Pipeline Transportation Systems. On-land Pipelines.

IEC 60502-1: Power Cables with extruded insulation and their accessories – Cables for rated voltages of 1KV.

4. ACRONYMS

CP	Cathodic Protection.
EN	European Norms.
ELOT	Hellenic Organization for Standardization.
NG	Natural Gas
T/R	Transformer Rectifier

5. GENERAL

Before starting of trenching and excavation for the installation of the cathodic protection, the Contractor shall obtain all the necessary licenses and information regarding the exact location of existing facilities which may be affected during the works. The Contractor is responsible for all the damages committed to such structures.

The reinstatement of the working zone after the completion of the works, shall be performed in accordance with Technical Specification DSF-SPC-CIV-014 “Reinstatement”.

During construction, all works, that will take place next to High Tension Lines, in areas where the Proximity Effects Study evaluates high values of induced voltages and the already installed pipeline sections are long, will be performed with all the necessary protective measures, in order to avoid the personnel to get in contact with any induced voltages in the pipeline.

These measures include, but not limited to, wearing of plastic boots and gloves, earthing of the pipeline etc.

All the temporary earthings shall be removed shortly after the completion of the construction works. The works in the vicinity of the already installed pipeline shall be performed with care, in order to avoid any destruction either of the pipe's coating or of the pipe.

6. CATHODIC PROTECTION STATIONS

Each CP - section shall include one CP - station, with magnetite impressed current anodes. The CP - station shall be installed at locations that meet the following requirements:

- Low soil resistivity for the anode bed (e.g. high water table).
- Minimum distance 100 m between anode bed and pipeline and other metallic structures (secondary structures).
- Distance between the CP - station and the pipeline axis shall not be more than 3.0 m.
- Access to PPC low voltage distribution network.
- Access road.

The CP - station includes a Transformer/Rectifier cabinet, which supplies the cathodic protection current to the pipeline, an impressed current anode bed with magnetite anodes and a reference electrode.

7. CABLES

7.1 General

The cables to be used will follow the requirements of IEC 60502-1. All cables running out of the pipeline's route will be installed underground. Cables with metal sheathing or armouring are not permitted.

All underground cables shall be placed at least 1.00 m deep, laid at a layer of sand of 15 cm. The cables shall be covered by a layer of sand 20 cm height and will be marked with warning tape.

The tape shall be made from yellow PVC or PE, approximately 40 mm wide, and a text (15 mm wide) per approximately 1 m written on "ΠΡΟΣΟΧΗ ΚΑΛΩΔΙΑ ΔΕΣΦΑ ΤΗΛ. 2130884000". The tape shall be placed approximately 0.8 m below ground level.

Cable connections to pipes shall be made by "Pin Brazing" in accordance with Technical Specification DSF-SPC-CPR-004" Electrical Resistance Welding Pin Brazing".

All welded areas shall be carefully insulated in accordance with Technical Specification DSF-SPC-PIP-013 "Corrosion Protection of Field Joints and Uncoated Pipeline Components".

All welds shall be performed and approved before backfilling.

Cable laying in casing pipe shall be as shown on the relevant Standard Drawing.

The positions of all underground cable connections to pipes shall be measured-up in accordance with Technical Specification DSF-SPC-CIV-004 "Measuring Up and As Built Documentation".

During the installation of cables connected to a transmission line on which dangerous induced voltages may occur, insulating mats shall be used as per Technical Specification DSF-SPC-CPR-008 "Precautions Against Proximity Effects during the Construction Phase".

7.2 Measuring Cables

All measuring cables shall be of type J1VV-U (NYY-O) 2x2.5 mm^2 in accordance with IEC 60502-1.

Cable connections in measuring posts shall be constructed with terminal lugs. Terminals will be marked with the color coding as indicated on the relevant standard drawings. All color marking is related to ascending km distance and shall be followed strictly.

When the measuring cable runs parallel with the pipeline, the cable shall be placed on the upper side of the pipe, where it shall be laid tension- free with slack and fastened to the pipe with tape every 2 m.

In order to avoid any damage of cable during the backfilling, the cable shall run from the pipeline connection point to the measuring post through the bottom of the pipeline trench.

Where measuring posts are placed beside the pipeline, the cable shall be laid at right angles from the pipe to the measuring posts.

If the cable is not mounted in a post at the same time as the cable laying, the cable ends shall be insulated carefully with insulating tape and shall be color coded in accordance with the relevant standard drawings and shall be carefully protected from damages.

The cables shall be fixed to a temporary wooden marker post. A temporary sign snail indicates location of the post in accordance with the progressive km distance of the pipeline, type of the measuring post and location of the pipe related with the post.

7.3 Other Cables

Anode feeder cables J1VV-U (NYY-O) 4x6 mm^2 between transformer rectifier cabinet and anode bed shall be insulation tested with a megger before connection to the anodes.

Cable sleeves shall be used for the connection to the anode cables, in accordance with relevant Standard Drawings. After the insulation test and the approval of the connection by the Engineer and/or the Client's Representative, sleeves shall be sealed by casting.

Cathode cables J1VV-U (NYY-O) 4x6mm^2 between transformer rectifier cabinet and pipeline shall be connected to the pipeline by "Pin Brazing".

All other cable connections shall be established as described in the detailed project.

PVC cables must not be laid at temperatures below 0°C, without having been preheated.

8. MEASURING POSTS

8.1 General

In order the Cathodic Protection System to be sufficient, a number of Measuring Posts shall be installed alongside the pipeline's routing.

The following types of measuring posts can be used:

- Type K1: Potential measurements on pipeline.
- Type K3: Potential and current measurements on pipeline.

• Type K4: Potential and current measurements on pipeline. Potential measuring on casing pipe. Resistance measuring between pipeline and casing pipe.

• Type K5: Interference measurements for secondary constructions. Connections of two CP installations across a resistance in the measuring post. Potential measuring on pipeline and secondary structures. Voltage drop measuring between pipeline and secondary structures. Resistance measuring between pipeline and secondary structure.

• Type K5X: Potential measurements and measurements of resistance between pipe and foreign steel pipes. Connections of two CP installations across a resistance in the measuring post.

Note: The M.P. will be identified as type K5X where "X" is the number of foreign steel pipes.

• Type K6: Potential measurements on both sides of insulating joint. Voltage drop measuring over insulating joint. Resistance measuring of insulating joint. Current measuring across the insulating joint if the insulating joint is bonded.

• Type K8: Potential measurements on both sides of insulating joint. Voltage drop measuring over insulating joints. Resistance measuring of insulating joints. Current measuring across insulating joints, if the insulating joints are bonded.

• Type K9: "On" potential measurements without voltage-drop.

• Type K1G, K3G

and K4G: Measurements as above (for types K1, K3 and K4) and earthing of the pipeline through a voltage arrester.

- Type K3S: Potential measurements, line current measurements and permanent connection with a sacrificial anode.

For measuring posts types K3 and K4, the sign A or B indicates the location of the line current measurements cables in respect of the post.

Where the study of Proximity Effects requires earthing of the pipeline through special AC mitigation devices (AC-couplings DC-decoupling devices), the stay-wire shall be connected to Measuring Posts type K1, K3, K4 called K1G, K3G, K4G respectively.

In Measuring Post type K3S the sacrificial anodes shall be installed as indicated in the relevant Standard Drawings.

For line current measuring posts, type K3 and K4, there must not be any valves within the 50 m measuring section. The length and wall thickness of the pipe sections, in the 50 m pipe section, shall be recorded in accordance with relevant sections.

8.2 Installation

The Measuring Posts shall be installed at a location next to the pipeline with free access.

To ensure an effective monitoring of the Cathodic protection of the pipeline, measuring locations with measuring posts type K3, K4 shall be established along the pipeline in accordance with Technical Specification DSF-SPC-CPR-007 “Marker and Measuring Posts” with a separation of approximately 1.0 - 1.5 km, or less if required for crossings with secondary constructions.

The number and location of the Measuring Posts will be shown during the detail engineering phase in the recording plan drawings (in scale 1:1000 or 1:500) and the longitudinal section drawings in scale 1:1000/1:100 or 1:500/1:50 and in cases of line valve stations or scraper stations at the related plot plan drawings. Final location shall be approved by Supervision and/or the Owner's Representative on site, taking into consideration the following items:

- The post not to disturb the public.
- The post should be avoided to be located in places where risk of damages by cars or people should occur.
- Access road.

The installation of the special measuring probe shall be in accordance with the Supplier's instructions.

Measuring Posts shall be fitted with identification text plates according to Technical Specification DSF-SPC-CPR-007 “Marker and Measuring Posts”.

Principles for installation of measuring posts are indicated on relevant standard drawings.

All Measuring Posts shall be placed at least 7,5 m from any valve, Scraper, Vent or any other piping equipment where a gas leakage may occur.

9. REFERENCE ELECTRODES

For continuous monitoring of the “ON-OFF” potential of the pipeline (without use of special equipment), a reference electrode shall be placed at the Cathodic Protection stations or other specified locations. The reference electrode shall be placed beside the pipeline, at the drain point, to measure the most negative potential of the pipeline.

Reference electrode shall be copper/copper sulphate ($Cu/CuSO_4$), connected with 10 m cable type J1VV-U (NYY-O) 2x2,5 mm^2, as described in Technical Specification DSF-SPC-CPR-003 “Cathodic Protection Polarization Probe, Reference Electrode and ER Coupon”.

The preparation of the reference electrode shall be in accordance with the supplier's preparation instruction.

The reference electrode shall be controlled by the supervisor before installation.

Reference electrode shall be placed 30 cm from the pipeline with the lower edge of the electrode on a level with the centerline of the pipeline. The reference electrode shall be placed in a “built in backfill” i.e., the reference electrode shall be in a special backfill which is enclosed in a cotton bag according to the requirements of the reference electrode manufacturer**.**

Reference electrode cable shall be connected in the transformer rectifier cabinet or the relevant measuring post.

In cases where potential controlled rectifiers are used, an additional reference electrode, conforming to Technical Specification DSF-SPC-CPR-003 “Cathodic Protection Polarization Probe, Reference Electrode and ER Coupon”, shall be used as control electrode. When DC stray

currents or telluric currents are acting on the pipeline, the potential of a combined coupon/reference electrode shall be considered as means of a control potential instead.

10. ANODES FOR "INSTALLATIONS WITH IMPRESSED CURRENT"

The anodes shall be placed in an anode bed which is part of a Cathodic Protection station.
The principles for the installation are indicated on the relevant standard drawings. The anodes shall be placed horizontally, end to end with a mutual separation of 6 m and at a depth of approximately 1.5 m, or vertically with a mutual separation of 6 m and at a depth of approximately 1.5 m from the upper end of the anodes.
The anodes shall be placed in a backfill consisting of coke breeze (size 5), as described in Technical Specification DSF-SPC-CPR-001 “Cathodic Protection Anode Material”.
The anode bed cable shall be terminated in the anode bed in a separate end cable sleeve.

10.1 Horizontal Anodes with a Continuous Coke Bed

In a horizontal anode bed construction with a continuous coke bed, a 20 cm layer of coke shall be laid out in the bottom of the anode bed excavation (depth 1.5 m), watered thoroughly and compressed.

The anodes shall be placed on the coke horizontally in the center line of anode bee with 6 m anode spacing. The end of the coke bed shall exceed the end anode 3 m.

After this, a new 20 cm layer of coke is laid out, also watered thoroughly. The total height of coke bed after compression shall be 40 cm.

The compression must be carried out with great caution as the anodes are very fragile.

All anode cables shall be accessible over the coke bed.

The anode cables are connected with the supply cable as shown on the relevant Standard Drawings, covered with warning tape. The trench is backfilled with soil and compressed with caution. Before backfilling, the anode bee shall be approved by owner's Representative.

The anode cable insulation must not be damaged under any circumstance.

Defective cables shall be replaced.

10.2 Vertical Anodes

For each anode, a hole with a diameter of approximately 0,4 m and a depth of approximately 1,2 m is drilled in the bottom of a common cable trench approximately 1,3 m deep. A distance of 6 m shall be kept between the center of the holes. Each hole is filled with 0,2 m coke, watered thoroughly and compressed.

The anodes shall be placed on the coke vertically in the center of each hole and shall be covered with a watered compressed amount of coke. The anode top must be covered with at least 0,2 m of coke after compression. The compression must be carried out with great caution as the anodes are very fragile.

All anode cables shall be accessible over the coke bed. The anode cables are connected with the supply cable as shown on the relevant Standard Drawing, covered with warning tape and the trench is backfilled with soil and compressed with caution. Before backfilling, the anode bed shall be approved by owner's Representative.

The anode cable insulation must be damaged under any circumstance. Defective cables shall be replaced.

10.3 Deep Well Anodes

If deep well anodes shall be used, they shall be placed vertically, above each other with a mutual separation of approximately 2 m, in a bore hole of 300 mm diameter.

The anodes shall be packed in coke breeze to the upper edge of the uppermost anode and the upper edge shall be approximately 10 m below the final ground level. The bore hole shall be closed with a metal grid.

11. ANODES FOR "INSTALLATION WITH SACRIFICIAL ANODES

Anode bed for temporary protection with sacrificial anodes shall be constructed as a vertical anode bed with magnesium anodes prepacked in backfill. Depth separation of anodes, and distance from pipeline are shown on relevant Standard Drawing.

Soil shall be filled around the anodes which shall be stamped with caution and watered thoroughly.

Anode cables shall be covered with warning tape, and the cable trench shall be backfilled and stamped with caution.

Contractor must not connect the sacrificial anodes with the pipeline in the measuring post unless he is authorized.

12. INSULATION MEASURES ALONG THE PIPELINE

When pipeline is at the proximity of other metal pipes or cables the requirements ISO 21857, EN 50443 and EN 15280 shall be applied.

When casing pipe is used at crossings of roads, railways, etc., this shall be electrically separated from the pipeline with insulating spacers which will be tied with plastic wraps. A measuring post of type K4 shall be established to monitor the isolation, in the area, as indicated on the longitudinal section drawings.

Where the pipeline crosses underground or runs parallel with other pipes or cables, including high voltage cables, the following minimum clearance requirements shall be for

- parallel routing : at least 4.0 m
- crossing : at least 0.5 m
- parallel routing of high voltage cables > 150KV shall be at least the width of the ROW safety zone of the transmission system. However, EN 50443 applies.

Clearances are measured from the outside of the constructions.

Where the above-mentioned clearance at crossings cannot be achieved, or where stray current interference as per ISO 21857 may be detected, insulating means shall be installed between the crossing constructions in order to avoid any possible contact between pipeline and foreign

structure, and minimize any likely interference as specified in ISO 21857. Technical Specification DSF-SPC-PIP-016 “Crossings” applies as well.

Due to possible interference, the coating of the transmission line shall be thoroughly checked by a holiday detection test at crossing points with foreign metallic constructions.

The holiday detection test and improvement of discovered holidays in the coating shall be in accordance with Technical Specification DSF-SPC-PIP-013 “Corrosion Protection of Field Joints and Uncoated Pipeline Components”.

13. POWER SUPPLY

Contractor shall provide and establish the connection of the transformer rectifier cabinet to the PPC (public electricity) network. The work shall be carried out in accordance with the local electricity company's (PPC) regulations.

The Owner shall provide to contractor all necessary convenience in order to get the necessary power to CP stations from the Power Company PPC.

Details are shown on relevant Standard Drawings.

If power supply by PPC is not feasible for the T/R cabinets, then a hybrid system consisting of solar panel and wind generators shall be installed by Contractor.

14. PRECOMMISSIONING

Pre-commissioning checks are to be carried out after the completion of pipeline construction and installation of all permanent CP systems in order to verify the correct installation.

14.1 Method of Tests

14.1.1 Measuring Posts

Correct routing of various cables shall be confirmed by the relevant sketches executed during installation works prior to backfilling of the trench

For all cables connected to the pipeline, continuity checks (resistance measurements) should be carried out between pairs of cables and also pipe-to-soil potential checks by means of a corrosion multimeter and copper-sulphate reference electrode.

Resistance measurements shall not exceed 2 ohms, and the potentials on the unprotected pipe shall correspond to the natural potential of the pipe within the range of -0,3 volts to -0,8 volts and -0,95 volts to -1,5 volts on the protected by the temporary sacrificial anodes pipe.

Measurements shall be according to **ELOT EN 13509**.

The quality of welding of cables to the crossed steel structures, foreign pipeline, etc. shall be also checked.

The resistance and the ΔU between the gas pipeline and the crossed steel structures, as well as the potential of gas pipeline and the crossed steel structure shall be measured.

At insulating coupling, connections to each side of the coupling shall be confirmed. Resistance, ΔU and potential measurements on the insulating coupling shall be measured.

Overvoltage device (discharger) shall be checked according to the instructions of the manufacturer and **ELOT EN 13509**.

Cables of grounding system shall be checked and the earth electrodes potential readings shall be within the limits of -0,3 V and -1,0 V, depending on the earth electrode material and its surrounding environment. The resistance and the ΔU between the gas pipeline and the grounding system (stay wire), shall be registered. The resistance of grounding to remote earth shall be measured.

At cased crossings a measurement methodology similar to the one described in Technical Specification DSF-SPC-CPR-006 “Cathodic Protection Commissioning and Start-up” shall be applied and shall be according to the requirements of **ELOT EN 13509** and **CEOCOR Recommendation for Casings** (Execution, Testing and Reshaping of

crossings of buried pipelines with traffic routes). Additional measurements performed must be at least the dc/ac potential of both the gas pipeline and the casing pipe. The value of the potential of the casing pipe shall be from -0,3 V to -0,8 V (as a rule when the casing is not cathodically protected).

14.1.2 C.P. Station

It should be confirmed that the incoming mains supply is correct and properly connected in terms of polarity and earthing. Cathodic protection station requires a 230 volts (-1,5% - +15%) 50 cycle single phase supply.

The Anode bed installation shall be checked by disconnected cores of the feeder cable at the transformer rectifier terminals and measuring the resistance between pairs of cores. Continuity of the cables runs and anode connections will be confirmed by a low ohmic resistance. The anode bed resistance lands each single anode to remote earth should be measured and recorded.

Connections of cable to the pipe potential measurements shall be performed.

The permanent reference electrode potential should be measured against a portable reference electrode using a high impedance multimeter. The potential difference shall not exceed 20 mV. Pipe to soil potential shall be measured by the same multimeter by means of the permanent and portable reference electrodes. The difference between the value of permanent and portable reference electrodes shall not exceed 20mV.

The performance of the transformer rectifier unit shall be checked in accordance with the Manufacturer's instructions and specifications of Owner.

15. TESTING AND COMMISSIONING

The cathodic protection system shall be energized shortly after the construction period comes to the end.

The protection potential (OFF-Potential) of the pipeline vs. a $Cu/CuSO_4$ reference cell shall be kept within -0.85V to -1.15V as per **ELOT EN 12954.**

A survey must be conducted after the cathodic protection system is energized to determine whether the criteria have been satisfied.

It is to be expected, that a number of coating defects will be detected during the startup period.

The Contractor must repair any coating defect. When a satisfactory condition of the coating is reached the initial setting of the cathodic protection current can be done.

16. TEMPORARY CATHODIC PROTECTION

The pipeline must be protected against corrosion in the period between installation of the pipeline and operation of the Cathodic Protection System. For this reason, a temporary CP-system must be provided and installed by Contractor, for the constructed and backfilled sections of the pipeline, in accordance with the soil resistivity and in accordance with the following table:

SOIL RESISTIVITY (Ω.m)	INSTALLATION
0-10	Immediately
10-30	After three (3) months
Above 30	After twelve (12) months

The Contractor must submit for review and approval to the Owner:

- Temporary CP Study
- Installation Procedure
- Installation Time Schedule

17. PIPELINE GROUNDING SYSTEM

17.1 General

Where the pipeline is routed parallel or obliquely to high voltage transmission lines and AC-traction lines, electromagnetically induced voltages, caused by load and/or fault currents, may reach unacceptable levels on pipeline.

In order to eliminate these effects on the pipeline, a proximity effects study, shall be prepared to determine the locations of electrical earthings of the pipeline, in conjunction with relevant measuring posts.

The proximity effects study, shall take into consideration the following standards:

- ELOT EN 12954
- ELOT EN 50122
- ISO 21857
- EN 50443
- EN ISO 18086
- AfK Recommendations No 3:2007

Contractor shall install, at locations determined by the proximity effects study, a complete earthing system which shall be connected to the pipeline via special AC mitigation devices (AC coupling DC decoupling devices).

The earthing along the pipeline in connection with measuring posts shall be horizontal, continuous hot dip galvanized steel stay wire, connected as shown on relevant Standard Drawing.

The AC mitigation devices shall exhibit a DC leak current rating less than 10 μA. There shall be no AC voltage threshold above which they activate, exhibiting a continuous function, conducting even at low AC voltage (<1 Volt).

Their steady-state AC current rating shall be more than 50A.

The minimum surge current capacity shall be 100 kA (waveform 8/20 microseconds). Their capacitance value, C, must meet the following requirement:

$C < (\pi DL)/(Nr_u)$

where $\pi = 3,1415926$,

D = pipeline nominal diameter,

L = pipeline length,

N = population number of ac-mitigation capacitive devices installed,

r_u = specific coating resistivity.

The AC mitigation devices shall not interfere with the normal CP system operation as well as CP effectiveness monitoring

17.2 Earthing Electrode Material

The horizontal earthings (staywire) shall be established with electrodes in accordance with the following material specification:

- Continuous hot dip galvanized steel stay wire.

- External diameter minimum 12 mm

- 70 μm layer of zinc corresponding to 500 g/m^2.

The electrode material shall be approved by Owner's Representative prior to installation.

17.3 Construction of Horizontal Earthings

The Contractor shall construct horizontal earthings running parallel to pipeline, with leakage resistances to remote earth, according to the results of the proximity effects study, tolerances shall be subjected Owner’s approval.

All parts of the horizontal earthing shall be minimum 0.2m from the pipeline.

Location of the earthing shall be approved by Owner's Representative.

The lengths of horizontal earthing shall be determined by Proximity Effects Study.

Cable connection to earthing electrodes (stay wire) shall be performed by splicing kits (indicative type 3M or equivalent).

All necessary precautions shall be taken in order to avoid electrolytic corrosion between different types of metal.

18. AS BUILT DRAWINGS

As built drawings shall satisfy the requirements of DESFA Technical Specification DSF-SPC-CIV-004.