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TECHNICAL SPECIFICATION

HIGH PRESSURE (HP) TRANSMISSION SYSTEMS

CATHODIC PROTECTION TRANSFORMER RECTIFIER CABINETS AT ANODE BEDS

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1. SCOPE AND OBJECTIVES

This Specification covers the minimum requirements for the design, fabrication and supply of the Transformer Rectifier (T/R) Cabinets at anode beds, in Impressed Current Cathodic Protection Installations.

The requirements of the following apply for the manufacturing and documentation of the transformer rectifier cabinet:

- This Specification,
- Applicable EU and Greek legislation, regulations, etc.

2. REFERENCES

2.1 Reference Documents

DSF-SPC-CPR-005: Installation of Cathodic Protection System.

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

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

2.2 Reference Codes and Standards

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 60079: Electrical apparatus for explosive gas atmospheres.

ELOT EN 61000: Electromagnetic compatibility (EMC).

ELOT EN 61558-2-4: Safety of Power Transformers, Power Supply Units and Similar Part 2-4: Particular Requirements for Isolating Transformers for General Use.

ELOT EN 61643-21: Low voltage surge protective devices - Part 21: Surge protective devices connected to telecommunications and signaling networks - Performance requirements and testing methods.

DIN 4065: Gas pipelines indicating labels

DVGW Afk No 6: Errichtung von Fernstromanlagen für den kathodischen Korrosionsschutz; Schutz gegen gefährliche Körperströme.

DIN VDE 0100-717: Low voltage electrical installations - Part 7-717: Requirements for special installations or locations – Mobile or transportable units.

DIN EN 61663-1: Lightning protection - Telecommunication lines - Fibre optic installations

DIN EN 61663-2: Lightning protection - Telecommunication lines - Lines using metallic conductors

VDE 0847: Electromagnetic Compatibility (EMC) Testing and Measuring Techniques.

3. ACRONYMS

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

4. TRANSFORMER RECTIFIER CABINET

Transformer Rectifier (T/R) cabinet shall be installed and positioned as shown on Standard Drawing STD-3-78-02 and it shall be delivered with a detailed user's manual.

Cabinet shall be constructed of 1.5 mm galvanized sheet steel, with corrosion resistant phosphate primer and light grey epoxy finish. All hardware shall be plated to prevent corrosion.

The transformer rectifier cabinet shall be installed outside hazardous areas otherwise ELOT EN 60079 series apply. A degree of protection IP 65 applies.

The cabinet shall be suitable for outdoor installation within an ambient temperature range from -25°C to +50°C.

Cabinet shall be provided with space heater and exhaust fan controlled via thermostats, for winter (-25°C) and summer (+50°C) conditions.

Cabinet shall be provided with precast concrete foundation pad and suitable opening for cable passage as shown on relevant Standard Drawing. Precast concrete foundations shall be supplied with the cabinet as an assembly. The cabinet shall be equipped with sun / rain canopy.

The lower parts of the cabinet must be designed suitably for anchoring into the concrete footing without disturbing the function of the cabinet.

The port of the ground plate with the cable glands will have the required cable glands for each incoming or outgoing cable and 20% spares for future extension.

The Transformer Rectifier (T/R) cabinet shall be provided with door locking device suitable for the size of the door, which will lock the door preferably at three places (the center of the door, the upper part and the lower part). The locking device shall be strong enough to withstand attempts to open the door by unauthorized personnel.

The cabinet doors shall be provided with a safety cylinder lock and shall be able to open up to 90° and they shall be supplied with holder to be held in open position.

The T/R Cabinet must be equipped with a pocket in the back side of its door for the Operation and Maintenance Manual.

Details for construction of the cabinet and low voltage part are given on the relevant Standard Drawing.

Each cabinet shall be equipped with an identification plate which shall be offered in the tender documents and it shall be according to DIN 4065 with Owner's firm, telephone, CP station number, etc.

The mounting rails for the clip-on terminals will have provision for additional future terminals. The terminals will be delivered with 4 mm test sockets a-d bridges.

4.1 Low Voltage Part

The Transformer Rectifier (T/R) unit shall be supplied by low voltage PPC network (230V service line). The following appurtenances shall be included:

- One (1) main incoming 2 poles switch 40 A, with fuse of 25A.
- Two (2) panel switches 40 A, 2 poles, with fuses 6 A and 16 A.
- Two (2) sockets for tools and metering equipment.
- One (1) GFI relay, 40 A, release current 30 mA.
- Auxiliary earth Rg < 2 Ohm.
- Surge Protective Devices.

The Transformer Rectifier Unit supply must not be affected by the GFI.

In case of solar panel electricity supply preventive measures shall be taken for solar panel protection from theft or vandalism.

4.2 Transformer Rectifier Unit

The Transformer Rectifier (T/R) unit should have a stable performance for the present output voltage or current values for both automatic and manual operation independently of any variation of input voltage or any influences from the pipeline (e.g. on varying input voltage (230V) 10% the output current - on galvanostatic control - varies max. 1mA: on potentiostatic control the potential varies max. 10mV).

The Transformer-Rectifier Unit shall be of a draw-out or plug-in type.

The performance of the unit must not be affected by supply voltage variations within a range ± 15 %.

4.2.1 Connections and Performance

• Input, AC	:	Power supply, 230 V, 50 Hz.
• Output, DC	:	Voltage 0-12V, Current 0 -1 A, or Current 0 -1 A and 0-5 A via a selector switch.
• Metering Input / Output	:	as per 5.2.2.

The connection to the T/R unit shall be of a plug-in type, except external metering connections which are described in paragraph 5.2.2.

The isolation between the AC - input / DC - output shall be based upon an isolating dry type AN cooling safety transformer with separate windings according to ELOT EN 61558-2-4.

Protection against contact hazard shall be class II.

The output terminals shall be permanently labeled / engraved in accordance with the label figures shown on Standard Drawing STD-00-78-01. Additionally, the terminals shall be labeled with the following:

"ΑΝΟΔΟΣ" - "ANODE" for the positive pole (terminals A1 to A4).

"ΚΑΤΑΣΚΕΥΗ ΥΠΟ ΠΡΟΣΤΑΣΙΑΝ" - "UNDER PROTECTION STRUCTURE" for the negative pole (terminals K).

There shall be no parallel or alternative current path for the output current.

The output current and the output voltage shall be continuously adjustable with a maximum resolution of less than 2% of the output ranges.

The variation of the output current and voltage due to temperature shall be less than 0,05% per °C of actual setting.

It shall be possible to lock the settings of the output current and voltage in such a manner that release will only be possible by authorized personnel with proper tool use.

The transformer rectifier unit shall be able to withstand arbitrary interruption of the output current.

During an on/off operation on the output side of the transformer rectifier unit, no cut-in peak current exceeding the pre-set output current must occur.

The T/R unit shall be able to keep the output current constant (± 0,1%) at present value (galvanostatic control) or the pipeline Cathodic protection potential (on and / or off) constant (± 0,1%) at present value (potentiostatic control).

The transformer rectifier unit operation must not affect the AC voltage level of the pipeline with the exception of an acceptable level of ripple not exceeding 15 mVrms.

It should either supply no current to the protected structure or should supply a

minimum pre-set current level (base current) in case of fault such as disconnection of the reference electrode.

4.2.2 Measuring Instruments

The Transformer Rectifier unit shall be equipped with the below mentioned measuring instruments:

- One digital voltmeter with 4-20mA transducer for monitoring the output voltage of the T/R. The voltmeter shall have resolution of 0.01V or better while the range of it shall be 0-12V. The accuracy both the voltmeter and the transducer shall be of class 1.0 or better.
- One digital ammeter with shunt and 4-20mA transducer for monitoring the current output of the T/R. The ammeter shall have resolution of 0.001A or better. The accuracy both the ammeter and the transducer shall be of class 1.0 or better.
- Two potential voltmeters with one 4-20mA transducer each. The first potential voltmeter shall measure the potential on the pipeline with reference to the reference electrode (Also the ON/OFF potential) while the second one will measure the AC induced voltage on the pipeline. The internal resistance of the potential voltmeters shall be equal or greater than 10Mohm. The resolution shall be 0.01V and the accuracy must be class 1.0 or better. The range of the potential meter, which shall be used for measuring the DC potential on the pipeline, shall be 0-3V DC while the range of the potential meter, which shall be used for measuring the AC induced voltage, shall be 0-20V AC.
- One micro-voltmeter with 4-20mA transducer for measuring microvolts on the pipeline and calculating the current which flows on the pipeline. The range of the microvoltmeter shall be 0-1000μV and the resolution shall be of 10μV.

All instruments shall have external metering jacks (4mm) on the front plate of the unit, in order to be able to perform external measurements.

4.2.3 Induced Voltages on the Pipelines

The Transformer Rectifier (T/R) unit shall be able to function with a permanent alternating voltage up to 50 V (50 Hz) between the primary construction and the earth.

The T/R unit shall be able to withstand an alternating voltage up to 3500 V (50 Hz) between the primary construction and the earth with a duration of 0,5 seconds.

Alternating current / voltage on the pipelines must not be rectified by the T/R unit and transferred to the direct current / voltage supply side of the T/R unit.

The T/R unit shall be effectively protected against 50 Hz including voltage between anode (earth) and cathode (pipeline) via an additional or a built-in low-pass AC filter (min 35dB at 50 Hz attenuation) – see standard DVGW Afk No 6.

To prevent contact danger during occurrence of induced voltages on the pipeline, the isolation between all accessible parts of the installation shall be equivalent to class II.

4.2.4 Over Voltage Protection

The Transformer Rectifier unit shall be protected against lightning surge both on the input and the output terminals of the DC side or on the AC 230V power supply side.

The overvoltage protection must fulfill the requirements given in DIN/VDE 0847, DIN EN 61663-1, ELOT EN 61643-21, applicable parts of ELOT EN 61000- series and DVGW Afk No 6.

The surge / lightning protection devices shall be mounted on DIN 35 mm rail according to ELOT EN 50022 or alternatively on 35 mm G-form DIN rail (ELOT EN 50035, G-32).

The surge / lightning protection devices shall be dedicated to protect the impressed current Cathodic protection rectifiers from surge / lightning overvoltage.

In case that solar panel power supply is provided, special lightning protection shall be installed dedicated to solar panel installations.

4.3 ON – OFF Timer Switch

The Transformer Rectifier (T/R) cabinet shall be equipped with a timer switch for "ON - OFF" measurements connected at the supply of the pipeline (Cathode). The connection of the switch shall be arranged so that for normal use the supply of the pipeline to be performed without the intercalation of the switch.

The "ON - OFF" period will be of 12 - 3 seconds accordingly.

The Timer switch will be energized by local command (via pushbuttons) as well as by remote command (via cold contact). The Timer switch will be equipped with operation status auxiliary contact for remote indication feedback reasons.

The Timer switch shall be removable.

4.4 Terminal Strip

2 Terminals for Power connection	25.0 mm^2
1 Terminal for the Earthing connection	16.0 mm^2
4 Terminals as spare	10.0 mm^2
4 Terminals for the anodes	10.0 mm^2
6 Terminals as spare	10.0 mm^2
4 Terminals for the pipeline connection (Cathode)	10.0 mm^2
4 Terminals for the connection of the Timer with the remote command and feedback signals	10.0 mm^2
2 Terminals for the Reference Electrode	10.0 mm^2
4 Terminals to the pipeline for measuring cable, primary construction	10.0 mm^2
12 Terminals for remote measurements	10.0 mm^2
6 Terminals spare	10.0 mm^2

The terminals shall be separating terminals with metering jacks (4 mm).

4.5 Interface Signals

The interface signals of each Transformer Rectifier unit shall be the below mentioned:

- Existence of Transformer AC Input Voltage : DO (Cold Contact)
- Transformer Output Voltage Measurement : AO (4-20mA)
- Current Measurement : AO (4-20mA)
- Pipe / Soil Potential Measurement & ON/OFF : AO (4-20mA)
- AC Induced Voltage Measurement : AO (4-20mA)
- Line Current Measurement : AO (4-20mA)
- Command ON / OFF Potential : DI (Cold Contact)
- ON / OFF Potential Status : DO (Cold Contact)
- Door Open : DO (Cold Contact)

The Measurement and Control signals of each T/R unit shall be remote transmitted with the use of the MiniTrans remote monitoring / control system via GSM net. In this case the abovementioned signals will be hardwired to the MiniTrans GSM Unit (RTU with GSM modem).

In case the GSM net is not available at the installation place of the T/R unit, the signals will be transmitted via single mode fiber optic to the nearest RTU within available GSM net. This RTU shall be connected with the MiniTrans system in order the signals to be transmitted via GSM. In this case, the abovementioned signals will be hardwired to a media converter in order to communicate with the nearest RTU or Switch via Modbus TCP/IP protocol. The speed of the protocol shall be 100 Mbps. The communication shall be implemented via single mode fiber.

5. QUALITY CONTROL

At least the following tests and inspection procedures shall be carried out for the cathodic protection transformer rectifier:

- Performance type and factory test.

- Inspection of installation by owner and marking of components.
- Inspection of cables and cable installations inspection by owner of quality of component materials.

Owner Representative shall approve the transformer rectifier drawing before commencement of fabrication, and reserves the right to be present at all checks and to carry out all checks and tests considered necessary.

Type test shall be carried out for the cabinets and transformer rectifier units. All cabinets shall be visually checked and certified according to the applicable EU legislation, before release for shipment. Supplier shall furnish the detailed type test program for Owner's approval, at least one month before the date of tests.

The Supplier shall, without any charge to the Owner, provide all necessary check and test facilities.

6. SPARE PARTS

Supplier shall propose spare parts list for two years' operation for Cathodic Protection T/R cabinet. Unit prices valid for one (1) year for spare parts shall be submitted by the Supplier with the quotation.

7. DOCUMENTS

Supplier shall submit type and factory test certificates, together with construction and "as built" drawings.

Supplier shall also submit Operation and Maintenance Manual including test procedures of the transformer rectifier operation.

8. PACKING

Packing should be durable enough to withstand strikes and frequent handling, vertical overhead loads when stacked and transportation to the site.

Packing material should be suitable for storage for a period of approximately one year.
All equipment shall be completely drained of water, thoroughly dried and cleared prior to packing and shipment to prevent freezing and damage.

9. CONTRACTOR'S DOCUMENTATION

At the tendering the Contractor shall submit a principle drawing of the transformer rectifier cabinet installation, including main cable connections, and state the name of the Supplier.
Before installation Contractor shall forward to Owner's Representative, for approval, the following but not limited to documents:

- Detailed drawing showing anode bed, reference electrode and earth electrode locations and detailed specification of the transformer rectifier cabinet installation.
- Material requisition for order the transformer rectifier cabinet and unit.
- Detailed specifications of transformer rectifier overvoltage protection.
- Wiring diagram.
- Detailed user's manual, including test and maintenance instructions.
- Type factory test certificates.