



NATIONAL PETROCHEMICAL COMPANY STANDARDS

CONSTRUCTION STANDARD FOR CATHODIC PROTECTION

NPCS CS-TP-08

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APPENDIX A : STORAGE TANKS & VESSELS

APPENDIX B : STEEL STRUCTURES



1 SCOPE

This standard covers the minimum requirements for construction and installation of the cathodic protection systems for all underground pipelines, storage tanks & vessels, and steel structures. Also this standard recommends procedure for the installation of cathodic protection system that achieve protection of the structure when design consideration recommended in NPCS-ES-TP-03 have been followed.

2 STANDARDS AND CODES

- 2.1 All constructions and installations shall be in accordance with the latest editions of NACE standards.
- 2.2 Coating application procedures shall be in accordance with the latest ASTM standards.
- 2.3 Electrical equipment installation shall be in accordance with IEC or NEC code or other equivalent international accepted standards.

3 GENERAL

- 3.1 All construction work on cathodic protection system should be performed under surveillance of trained and qualified personnel to verify that the installation is made in strict accordance with the project specifications.
- 3.2 All deviations from project construction specification should be noted on as-built drawings.
- 3.3 No substitution or modification to construction and/or installation methods of application detailed in this standard is permissible unless prior approval of client has been obtained.
- 3.4 All buried steel pipes shall be coated prior to installation.

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- 3.5 A site survey shall be made to determine soil resistivities and suitable locations for anode beds unless the information is available from existing systems or previous surveys made by the client corrosion control department.
- 3.6 Cathodically protected pipes shall be electrically continuous.
- 3.7 Facilities for pipe-to-soil potential measurements shall be installed at 1 Km markers for pipelines and at 250 to 300 m for distribution lines.
- 3.8 On pipelines longer than 10 Km, in-line current measurement facilities shall be available at intervals of not more than 10 Km.
In addition, these facilities shall be installed at all branches or intersections with other pipework. The current measurement facilities shall consist of two pairs of cables, each pair connected to the pipeline 60 m apart.
- 3.9 All pipeline anchors and all pipeline supports except abovegrade concrete pads shall be electrically separated from the pipeline.
- 3.10 The pipe should, whenever possible, be surrounded with a backfill that is free from stones and carbonaceous material such as coke.
If this is impracticable, an additional wrapping of heavy bituminized felt or other suitable material should be provided.
Where pipes cross streams or rivers, additional protection in the form of concrete encasement over the pipe coating may be required.
- 3.11 All above grade facilities such as transformer rectifiers, junction boxes, AC step down transformers, etc., should be located in the lowest electrically classified area.

4 CATHODIC PROTECTION INSTALLATION

4.1 ANODE BEDS

4.1.1 For Impress Current System

- 4.1.1.1 The construction of anode beds shall be of the following form:



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- Horizontal trench, with carbonaceous backfill and multiple inert anodes laid horizontally in the center of the backfill (Fig. 4.1).
- Vertical augered or excavated holes each with a single anode surrounded with carbonaceous backfill (Fig. 4.2).
- Deep anode beds, constructed vertically to depths which may approach 400 m. These beds may or may not contain carbonaceous backfill and casing alongwith the selected anode material as specified in NPCS-MS-TP-03 (Fig. 4.3).

- 4.1.1.2 The backfill surrounding the anode should be well tamped solidly for maximum coupling between anode and earth. For vertical anode bed tamping shall be layer by layer. When tamping with power tampers (preferred) or by hand, particular care shall be exercised to prevent damage to the anode or anode lead wire.
- 4.1.1.3 In horizontal installations, ditch width at anode depth should be that of the design width of the carbonaceous backfill layer;
- 4.1.1.4 In deep well ground bed, depending on the type of drilling rig used, it may be possible to use the rig itself for placing the anode system in the hole. Where a well is being drilled in soft formations which can not be depended on to hold an open hole without collapsing, a rotary rig can continue circulating drilling mud in the hole, after reaching design depth, until just prior to placing the anode system.
- 4.1.1.5 A site survey shall be made to determine soil resistivities and suitable locations for anode beds. The ground bed location shall be established so to optimize the distribution of the current to the structures, ensure low resistance values and keep interferences to a minimum.
- 4.1.1.6 The minimum anode bed distance from the buried pipe or adjacent structure shall be 50 m for 30 ampere rated output, 100 m for 50 ampere output, 200 m for 100 ampere output and 300 m for 150 ampere output. Multiple rectifier anode bed installations in the same general area shall have anode bed separated by a minimum distance of 300 m. Multiple anode beds to be separated by a minimum distance of 100 m. The anode bed shall be installed at right angles or parallel to pipeline.



4.1.1.7 No other underground metallic structure exists within the area of influence surrounding the anode bed.

4.1.2 **For Galvanic Anode Systems**

4.1.2.1 Anodes can be installed with a backhole, trenching machine or auger.

4.1.2.2 The simplest installation is that involving the burying of a single packaged anode at a leak repair location or for distributed anode installations along a **pipeline** (Fig. 4.4).

Where several anodes are to be installed at a single location, the anode may be connected to a header wire. The header wire may be connected directly to the pipeline or preferably be passed through a test point. Anodes in a multiple anode bed should be placed in straight line configuration for lowest resistance to earth (Fig. 4.5).

Also galvanic anode can be installed below the pipe for less subject to seasonal current output variation associated with soil moisture content (Fig. 4.6). Galvanic anodes may be used unpackaged. Anodes and backfill may be installed in auger holes as shown in Fig. 4.7.

4.1.2.3 Put the anode deeper in the earth (at least one foot) than the pipeline. This will generally insure that the anode will be in more moist soil than the pipeline.

4.1.2.4 Firmly tamp earth around all sides of the anode to insure better electrical contact between the anode and the earth.

4.1.2.5 Locate the anode at least three to five feet away from the coated pipeline and ten feet away from a bare pipeline. Do not install anode in some ditch as pipeline.

4.2 **CABLE AND CONNECTION**

4.2.1 **Impress Current Systems**

4.2.1.1 The negative terminal of the DC source is connected to the pipeline and the positive terminal connected to the anode.

4.2.1.2 All underground cable connected to the positive terminal of the rectifier is subject to corrosion at any insulation breaks in the main cable insulation or in field-applied insulation on connections.

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- 4.2.1.3 Connections between anode leads and header cable shall be made absolutely waterproof by taping after applying insulating materials. Four half-lapped layers of top grade rubber splicing compound (overlapping the cable insulation) followed by four-lapped layers of self-adhesive plastic tape are effective when applied with care.
- 4.2.1.4 All negative drain or bonding cable connections to pipeline shall be thermit welded.
- 4.2.1.5 All positive anode cables from rectifiers to anode beds shall be run in continuous lengths to a maximum length of 150 m. An abovegrade splice box (bond box) shall be used for every 150 m cable run exceeding this length. Only in exceptional cases buried splices shall be used in epoxy filled splice case. Generally, buried splices shall be restricted to header to anode cable connections and negative cable splices.
- 4.2.1.6 Because of the danger of cable insulation breaks, care shall be taken to be sure that there are no sharp rocks or other objects in the cable trench bottom that could damage insulation.
- 4.2.2 Galvanic Anode System
- 4.2.2.1 Connections between individual anode leads and header wire should be insulated by taping with at least one half-lapped layer of rubber tape and one half-lapped layer of self-adhesive plastic tap (or equivalent insulation) with the joint insulation overlapping the wire insulation. The Copper wire connection to the steel main is the most critical insofar as insulation is concerned. At this point, all Copper at the connection shall be coated completely to avoid the possibility of a shielded Copper-steel corrosion cell.
- 4.2.2.2 All connections shall be permanently low resistance. Any gradual development of joint resistance can reduce anode output. Permanent connections such as soldered joints (Lead-Tin solder or Silver solder) or powder-welded connections are reliable.
- 4.3 RECTIFIER INSTALLATION
- 4.3.1 Rectifier installation may be pole-mounted and/or concrete pad mounted. Differences in installation practices depend on local conditions and individual preference.
- 4.3.2 Air cooled rectifiers shall be installed pole mounted, and oil filled and/or explosionproof rectifier shall be installed concrete pad.



- 4.3.3 Rectifier shall be placed where inspection and maintenance are easy.
- 4.3.4 If the proposed rectifier site is in an area where flooding may be a problem, the maximum high water level should be ascertained and the rectifier mounted so that it will be above this level.
- 4.3.5 Prior to installing a rectifier, the details of local electrical codes should be checked.
- 4.3.6 Rectifier cabinets should be grounded separately for safety.
- 4.4 PIPELINE COATINGS
- 4.4.1 Damage to *coating* can be minimized by *careful* handling and by using proper pads and slings.
- 4.4.2 Surface preparation, primer application, coating thickness, temperatures, bonding, and other specific requirements should be checked periodically, using suitable test procedures for conformance with specifications.
- 4.4.3 The use of holiday detectors is recommended to detect faults that would not be observed visually.
- 4.4.4 Joints, fittings, and tie-ins should be coated with a material compatible with the existing coating. Coating defects should be repaired with materials that shall be compatible with existing pipe coating.
- 4.4.5 The ditch bottom should be graded and free of rock or other foreign matter that can damage the coating. Under difficult conditions, consideration should be given to padding the pipe or the ditch bottom. Pipe should be lowered carefully in to the ditch, avoiding coating damage.
Care should be taken when backfilling so that rocks and debris will not strike and damage the pipe coating.
- 4.4.6 All oil and grease shall be removed by solvent cleaning. Sand, shot or grit abrasive cleaning will effectively remove all other material and leave the best surface for coating application.
- 4.5 TEST POINT INSTALLATION
- 4.5.1 Test stations for potential, current, or resistance measurements should be provided at sufficient locations to facilitate cathodic protection testing. Such locations may include, but not be limited to the following:

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