DEPARTMENT OF THE ARMY
U.S. Army Corps of Engineers
CEMP-ET Washington, D.C. 20314-1000

Technical Letter
No. 1110-3-474 14 July 1995

Engineering and Design
CATHODIC PROTECTION

1. Purpose. This letter provides criteria for the design of cathodic protection (CP) systems for aboveground and direct-buried or submerged structures.

2. Applicability. This letter applies to all HQUSACE/OCE elements, major subordinate commands, districts, laboratories and field operating activities (FOA) having military design and construction responsibility.

3. Reference.

a. 40 CFR, Part 280

b. 49 CFR, Part 192

c. 49 CFR, Part 195

d. AR 200-1

e. TN 5-811-7, E4ectrical Design, Cathodic Protection

f. MIL-HDBK-1004/10, Electrical Engineering Cathodic Protection

g. National Association of Corrosion Engineers (NACE) Standard RP0169, latest edition, Control of External Corrosion on Underground or Submerged Metallic Piping Systems

h. National Association of Corrosion Engineers (NACE) Standard RP0285, latest edition, Control of External Corrosion on Metallic Buried, Partially Buried, or Submerged Liquid Storage Systems

i. National Association of Corrosion Engineers (NACE) Standard RP0286, latest edition, The Electrical Isolation of cathodically protected Pipelines

j. National Association of Corrosion Engineers (NACE) Standard RP0388, latest edition, Impressed Current Cathodic Protection of Internal Submerged Surfaces of Steel Water Tanks

k. ER 1110-345-100, Design Policy for Military Construction

l. ETL l110-9-10(FR), Cathodic Protection System Using Ceramic Anodes

m. ANSI/AWWA C105/A21.5 Polyethylene Encasement for Ductile-Iron Pipe Systems

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This ETL supersedes ETL 1110-3-440, 20 Aug 92

4. Discussion. Numerous aboveground, direct-buried, and submerged ferrous metallic structures have been installed without cathodic protection in an effort to reduce first costs or to stay within budget. Leaks due to corrosion can cause environmental damage. Installing a low maintenance cathodic protection system where and when it is required benefits not only the entire Army but the Nation. Certain types of systems, used for fuels and natural gas, pose safety problems if cathodic protection is not installed and maintained. Department of Transportation guidance as stated in 49 CFR, Part 192, requires that all metallic natural gas piping be coated and cathodically protected regardless of the soil resistivity. Corrosion control is mandated for all metallic underground storage tanks (UST) storing petroleum or hazardous substances by 40 CFR, Part 280 and AR 200-1 and on Hazardous Liquid Pipelines,(e.g., liquid fuel) by 49 CFR, Part 195.

5. Action to be Taken.

a. A CP system shall be provided where applicable; project design and construction without considering CP are not acceptable. CP is a functional requirement for virtually all projects involving new aboveground water tanks, direct buried or submerged metallic structures, or the repair or replacement of similar existing structures.

b. Design of cathodic protection systems shall incorporate guidance from all referenced documents, other applicable criteria, and this ETL.

c. All pre-design surveys, CP designs, and acceptance surveys must be performed by a "corrosion expert." A "corrosion expert" is a person who, by reason of thorough knowledge of the physical sciences and the principles of engineering and mathematics acquired by a professional education and related practical experience, is qualified to engage in the practice of corrosion control of buried or submerged metallic piping and tank systems. Such a person must be accredited or certified by the National Association of Corrosion Engineers (NACE) as a NACE Accredited Corrosion Specialist or a NACE certified CP Specialist or be a registered professional engineer who has certification or licensing that includes education and experience in corrosion control of buried or submerged metallic piping and tank systems. The "corrosion expert" designing the system must have a minimum of five years experience in the design of CP systems and the design experience must be type specific. For instance, a CP engineer who only has experience designing water tank systems, should not design the CP system for an underground gas line. The design of the CP system shall be completed prior to construction contract advertisement except for Design-Construct and preapproved underground heat distribution systems.

d. All CP designs must be based on historical knowledge and specific field tests made at the proposed construction site. Tests should include, but not be limited to, soil or water corrosivity (resistivity), current requirements, potential surveys, stray current interference potential, and water chemistry/corrosivity (pH).

e. Excluding the few exceptions listed in this ETL, all aboveground and submerged or buried ferrous metallic structures will be installed with Cathodic Protection. See paragraphs 5j,5k, and 51.

f. All installed CP systems must be based on providing a protective potential to meet the requirements of NACE Standard RP-0169 or RP-0185, as applicable. Recommend that all steel structure-to-earth potentials be measured in accordance with NACE RP-0169 using either minus 850 mv instant off potential and/or 100 mV of cathodic polarization shift.

g. New or supplemental CP shall be compatible to the existing CP systems (if operational) and other adjacent structures or components. New systems will be compatible with installation wide systems to allow ease of repair and maintenance.

h. When plastic pipe is used to extend or to add onto a steel gas distribution main, an insulated No. 8 AWG copper wire shall be exothermically welded to the existing steel main and run the length of the new plastic main. This wire can be used as a locator tracer wire and to maintain continuity to any future steel gas main extension.

i. CP and protective coatings shall both be provided for the following buried/submerged ferrous metallic structures, regardless of soil or water resistivity:

(1) Natural gas and propane piping

(2) Liquid fuel piping

(3) Oxygen piping

(4) Underground storage tanks

(5) Fire protection piping

(6) Ductile or cast iron pressurized piping under floor (Slab on Grade) in soil

(7) Underground heat distribution and chilled water piping in ferrous metallic conduit in soils with resistivity of 30,000 ohm-cm or less

(8) Other structures with hazardous products as identified by the user of the facility

j. For soil resistivities below 10,000 ohm-cm at pipeline installation depth cast iron pipe requires CP, bonded joints, and protective coatings. When soil resistivity is between 10,000 and 30,000 ohm-cm at pipeline installation depth, cast iron pipe requires bonded joints only. Joint bonds will be No. 4 AWG insulated wire. Exothermic welds and exposed copper wire will be coated. Copper water service lines will be dielectrically isolated from ferrous pipe. Dielectric isolation shall conform with NACE RP-0286.

k. For ductile iron piping systems, unless covered in item i. above, the results of an analysis by a "corrosion expert," as defined in paragraph 5.c, shall govern the application of cathodic protection and/or bonded or unbonded coatings. Unbonded coatings are defined in ANSI/AWWA C105/A21.5.

l. The results of an economic analysis and the recommendation by a "corrosion expert" shall govern the application of CP and protective coatings on gravity sewer lines, regardless of soil resistivity, and the following structures in soil resistivities above 10,000 ohm-cm:

(1) Potable water lines

(2) Concentric neutral cable

(3) Other buried/submerged ferrous metallic structures not covered above

m. All steel water storage tanks shall have interior cathodic protection in accordance with CEGS 16641 and NACE RP-0388.

n. Composite type underground storage tanks using a 3.2mm minimum thick layer of fiberglass coating in accordance with UL 1746 and holiday tested at 35,000 volts are exempt from CP requirements. All ferrous metallic underground storage tanks shall have CP designed as though two and one-half percent (2.5%) of the tank is bare metal. The sacrificial anodes shall be either magnesium or zinc.

o. A ferrous metallic pipe passing through concrete shall not be in contact with the concrete. The ferrous metal pipe shall be separated by a non-metallic sleeve or a sleeve with waterproof dielectric insulation between the pipe and the sleeve.

p. Ferrous metal piping passing through a concrete thrust block or concrete anchor block shall be insulated from the concrete or cathodically protected.

q. The need for surge and fault current protection at isolating devices (dielectrically insulated flanges) should be considered. If an insulated flange is installed in an area classified by NFPA criteria, (e.g., a natural gas line joint inside the classified area), a sealed, weatherproof surge arrester must be installed across each isolating device. The arrester should be the gapless, self-healing, solid state type (e.g., metal oxide varistor). Cable connections from arresters to isolating devices should be short, direct, and of a size suitable for short-term, high current loading.

r. During MSC review of the DD Form 1391, ensure that cost data for cathodic protection are provided as a separate line item in the DD Form 1391 under supporting utilities where the CP is required or where CP impact is vital to the project, e.g., new underground heat distribution system or replacement thereof, jet fuel hydrant systems, natural gas lines, etc.

s. During the design review, ensure that a life cycle cost analysis (LCCA) was done if more than one pipe material (e.g., copper v. steel V. non-metallic) was considered. If the ferrous metallic system requires CP, the cost of that CP design and installation must be included in the LCCA comparison.

t. Ensure preliminary design submittal includes soil corrosivity (resistivity, pH, etc.) data, current requirement tests (if applicable), potential surveys, and all design calculations for CP in the basis of design.

u. If the project contains factory assembled components (e.g., heat distribution line) that are direct buried or submerged metallic structures made of steel, the system supplier is responsible for the preliminary survey, design, and acceptance testing of the CP system. In addition, ensure that the construction contract specifications specifically provide for the following:

(1) The preapproved direct buried distribution system supplier shall use a "corrosion expert" with five years of specific experience for the predesign survey (if required), design, inspection, and testing of the CP system required for protection of the conduit. The latest revision of NACE Standard RP-0169 criteria shall be used. The contractor shall be held responsible for correcting all CP construction deficiencies.

(2) The construction contractor shall not proceed with the CP work until the CP system shop drawings have been approved by the contracting officer (CO). The CO or his representative shall be knowledgeable in the installation of CP systems and shall utilize the USACE cathodic protection acceptance criteria.

(3) The contractor must notify the contracting officer 48 hours in advance (minimum) prior to starting any installation of CP systems, CP testing and commissioning, or final acceptance.

v. Ensure that all potential readings on the CP system are taken at the proper locations and are in accordance with the contract specifications prior to acceptance of the system.

w. Ensure that the as-built drawings show the location of rectifiers, test stations, anodes, insulated fittings, etc., as applicable. Locations shall be shown referenced to two permanent facilities or marker points.

x. Any variance from the requirements of this ETL must be requested in writing from HQ USACE, CEMP-ET, 20 Massachusetts Ave., N.W., Washington, D.C., 20314-1000.

y. Designer Responsibilities.

(1) The preliminary design submittal shall include economic justification for selection of type of CP system (sacrificial or impressed), soil corrosiveness (resistivity, pH, etc.) data, current requirement tests (if applicable), potential survey data (if applicable to existing structures), and all design calculations for CP in the basis of design.

(2) In addition to the soil and water resistivity surveys, current requirement tests and design, the designer shall provide recommended tests, formats, required methodology, etc., for the final acceptance of the CP System based upon the USACE cathodic protection acceptance criteria.

(3) Guidance in this ETL shall be followed.

(4) The design shall provide sufficiently detailed calculations and one line diagrams at the early preliminary design stage to show the magnitude and layout of the CP system.

(5) The design drawings shall show the locations of anodes, rectifiers, test stations, junction boxes, wiring, etc., installation details, insulators, bond connections, and the structure or component connected to the cathodic protection. Coordinate with mechanical, site and other disciplines.

(6) The design shall identify all locations for interference testing (all pipe that passes within 305 meters of an impressed current anode bed and then crosses the cathodically protected line).

(7) The design drawings shall identify all locations where structure-to-soil potential measurements are needed to assure complete protection and/or to ensure that maximum allowed potentials have not been exceeded. Provide flush mounted test stations or provide pavement inserts to allow structure-to-soil potential testing over concrete and asphalt.

(8) Identify testing of the isolation and continuity for insulators and bonding equipment in the contract document.

6. Implementation. This letter will have special application as defined in paragraph 6c, ER 1110-345-100.

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