APPENDIX F
RECTIFIER CURRENT INTERFERENCE*

F-1. This appendix is taken from an unpublished document by T.F. Lewicki of the U.S. Air Force Civil Engineering Center, Tyndall Air Force Base, FL. It is used in the Air Force Corrosion Reports as an internal document.

F-2. Cathodic interference.

a. Method of detecting cathodic interference.

(1) Cathodic interference may be detected by conducting structure-to-soil potential surveys on all foreign underground structures in the vicinity of the impressed current systems or the structure being protected. The results are usually plotted as a curve as shown in figure F-1.** To save time, a shortcut method of detecting cathodic interference may be used. Base maps showing the locations of the proposed rectifier ground beds, the protected POL system, and all foreign structures should be obtained and studied. A foreign structure is considered to be a structure which is not part of, or metallically connnected to, the protected structure. Foreign underground structures that come close to (400 to 1000 feet) the ground bed and cross or come close to the protected structure at some remote location (greater than 1000 feet from the ground bed) are prime suspects for cathodic interference. All other suspects should not be ruled out, but the structures that fit into the category described in the previous sentence will be the most likely structures to have interference problems. The point at which the foreign structure crosses or comes closest to the protected structure is the most likely point of cathodic interference or current discharge, commonly referred to as *maximum exposure area.* An exception to this would be a case where the foreign structure was well coated. The holiday in the coating closest to the crossing could be a considerable distance from the crossing.

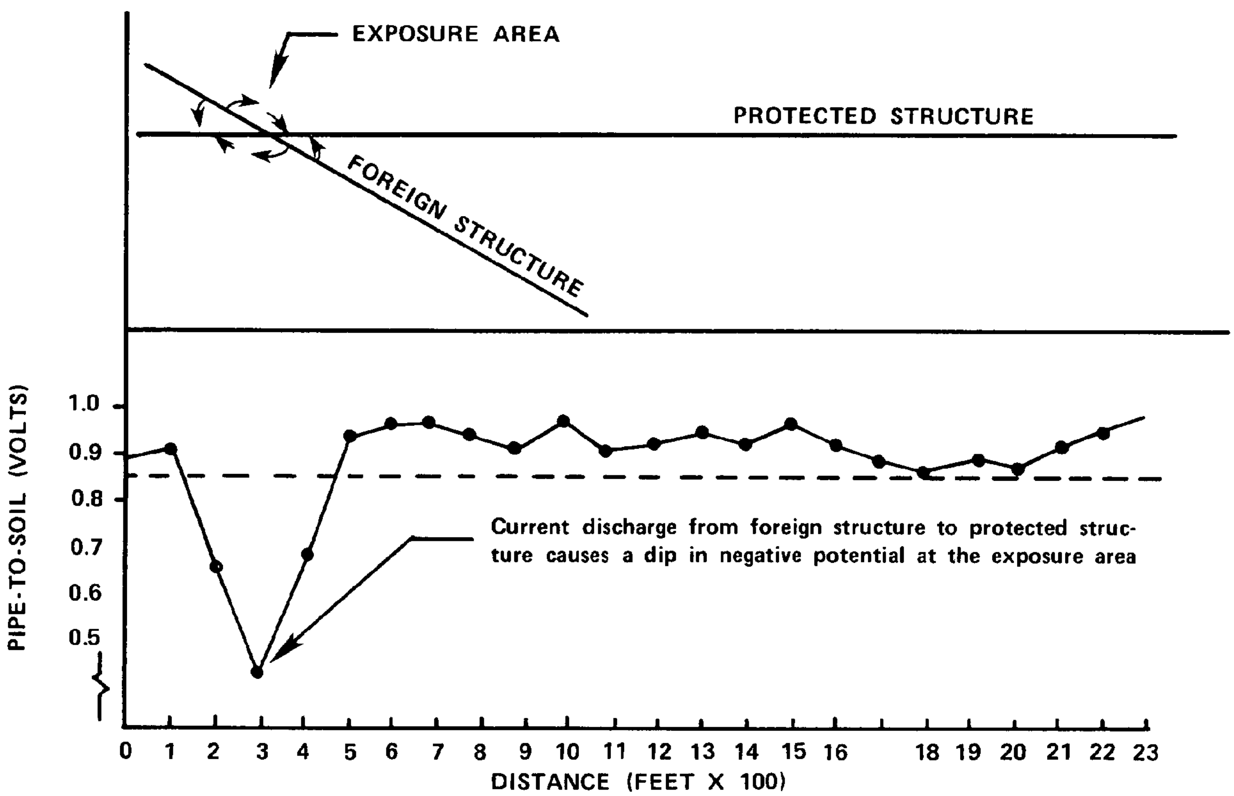

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Figure F-1. Structure-to-soil potential versus distance from foreign structure.

*From T. F. Lewicki, Air Force Civil Engineering Center, Tyndall AFB, FL 32401, 1974.
**For discussion purposes, a POL line is to be protected.

(2) To determine if cathodic interference exists at one of these prime suspect areas, the following should be done:

(a) Refer to figure f-2. Using a high-resistance voltmeter (100,000 ohms per volt or higher) or a potentiometer-voltmeter circuit, measure the structure-to-earth potential of the foreign structure at the crossing with all of the proposed rectifiers off. This is called the "natural" or “original” potential. When making this test, one terminal of the voltmeter should be connected to the foreign structure and the other terminal connected to a copper-copper sulfate half-cell electrode. The electrode should be placed on the surface of the earth directly over the structure to be observed.

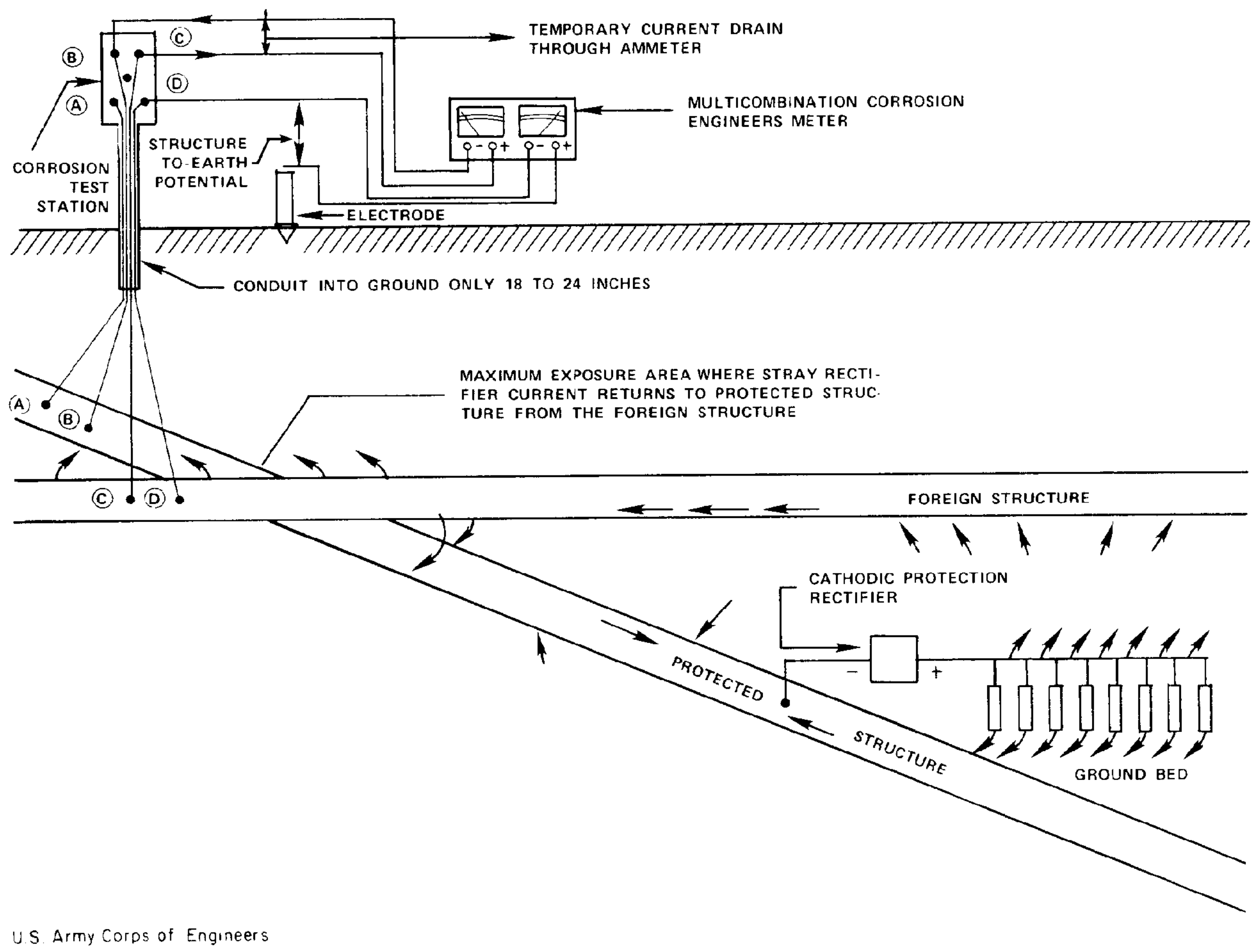

Figure F-2. Cathodic interference testing.

(b) Turn one of the rectifiers on and record the potential as in a above with the electrode in the same location. Repeat this procedure with the other rectifiers one at a time to determine which rectifiers are causing the interference and in what proportion. If the negative structure-to-earth potential is decreased or swung toward the positive direction when the rectifiers are turned on, current is leaving the structure and cathodic interference exists.

b. Correction of interference.

(1) When interference has been discovered, permanent corrosion test stations must be installed. During the preliminary tests for cathodic interference, the minimum size of the wires required for draining the necessary current should be calculated. Make a temporary bond between the foreign structure wire and the protected structure wire. The current drained should be measured by placing a milliammeter or am meter in the circuit. All rectifiers that affect the particular crossing being tested must be turned on for this current drain test. The following measurements must be recorded: natural structure-to-earth potential of foreign structure; structure-to-earth potential of foreign structure with all affecting rectifiers ??? structure-to-earth potential of foreign structure with temporary bond in; current through temporary bond, and potential between the foreign structure and protected structure with temporary bond in. A meter with a small scale such as the

M. C. Miller multicombination corrosion engineer's meter that has ammeter scales as large as 10 amperes or as small as 20 milliamperes or less and a number of small voltmeter scales should be used. The total current required in a resistance bond to clear the interference current leaving the foreign structure can be calculated by using the following simple algebraic formula:

$$\frac{\Delta E_t}{J_d} = \frac{\Delta E_r}{I_t} \qquad \text{(eq. F-1)}$$

and:

$$I_t = \frac{E_r \times I_d}{\Delta E_t},$$

where $\Delta E_r = E_{fn} - E_{fr}$ = change in structure-to-earth potential required to clear interference; $E_t = E_{fn} - E_{frd}$ = change in structure-to-earth potential caused by the temporary bond; E_{fn} = natural structure-to-earth potential of the foreign structure; E_{fr} = structure-to-earth potential of foreign structure with all affecting rectifiers on; E_{frd} structure-to-earth potential of foreign structure with temporary bond in; I_d current through temporary bond; and T_t = total current required through final resistance bond to correct cathodic interference caused by all of the rectifiers. The minimum size of wire required should also be calculated, but wire smaller than No.12 AWG should not be used because of poor mechanical strength. The permanent test station should include two wires thermit welded or brazed to the foreign structure and two wires thermit welded or brazed to the protected structure. This will allow one wire to be used as a current drain while the other is used to measure potential.

(2) After the permanent test station has been installed, the resistance bond can be most easily installed as follows: bare nichrome resistance wire in the range of ½ ohm per foot, or 1 ohm per foot, or 10 ohms per foot, depending on the total resistance needed, should be used.

(a) Since as many as three rectifiers may be involved in an interference bond in the hydrant refueling area, a current interrupter in the rectifier circuit for interrupting all the rectifiers simultaneously would not be practical. All the rectifiers should be turned on and off manually if more than one rectifier is involved. If only one rectifier causes the interference at a particular site, a current interruptor should be placed in the a.c. circuit to interrupt the current output.

(b) Place a copper-copper sulfate half-cell electrode on the surface of the earth at the point of greatest exposure. Measure and record the natural structure to-earth potential of the foreign structure with all interfering electrical circuits off.

(c) After all interfering sources are turned on, insert a portion of nichrome resistance wire between the foreign structure wire and the protected structure wire and observe the structure-to-earth potential of the foreign structure. Increase or decrease the amount of nichrome in the circuit until the structure-to-earth potential of the foreign (the interfered-with) structure becomes equal to the natural potential measured in b above. The current flowing through the resistance bond is now the correct amount and the interference has been cleared. No ammeters or additional test leads can be in series with the resistance bond when this test is made.

(d) Mark or note the exact contact of the nichrome resistance wire with the test station lead wires. Add ¼ or ½ inch to each end of these points and cut the nichrome. Crimp an eyelet or fork solderless terminal at the *exact points* where the nichrome contacted the test station lead wires. A permanent resistor has now been fabricated with the exact resistance required for the resistance bond. This resistance may be installed, removed, and reinstalled for testing purposes without changing the value of the resistance. Install the fabricated resistor in the test station and check to see that the natural structure-to-earth potential is achieved. If the potential measured is even a slight amount off, reduce the length of the nichrome or fabricate a longer piece until the natural structure-to-earth potential is achieved with all rectifiers on and resistance bond in (E_{fn} will now equal E_{frd}). When the proper resistor has been fabricated, the wire should be coiled on a pencil to make a neat, compact coil that can be installed inside of the test stations without shorting to the sides of the test station box or the terminals. After the pencil has been removed, the bare nichrome should not be wrapped with tape to allow proper cooling. Primer and tape may be placed inside the test station box to prevent a short. The amount of current flowing through the bond will be equal to the value calculated in paragraph b above. An ammeter cannot be placed in series with the resistance bond because the resistance would be increased slightly and the current through the bond would be reduced.

c. Bond installation. The installation of cathodic interference resistance bonds will reduce the cathodic protection current coming onto the protected POL structure from the electrolyte by an amount equal to the total current flowing through all of the bonds, This total bond current originates from the rectifiers installed to protect the protected structure (the POL system in this case). The portion of rectified or d.c. current equal to the total bond current does not contribute to corrosion mitigation of the POL system. Therefore, the rectified or d.c. current output may have to be increased as bonds are installed to maintain an adequate POL structure-to-earth potential of -0.85 volt.