INFORMATION PACKAGE

for

UTILITY ORGANISATIONS

INTERFERENCE (CORROSION) TESTING

of

CATHODIC PROTECTION

and

TRACTION CURRENT DRAINAGE SYSTEMS

OCTOBER 2000

INTERFERENCE TESTING OF CATHODIC PROTECTION AND DRAINAGE SYSTEMS

Extract: *Cathodic Protection of Underground Structures WK Woodberry. Energy Authority of New South Wales, October 1985*

1. Introduction

Interference is that change of potential which is caused to buried or submerged metallic structures by direct current from a source external to the affected structure. The problem is closely related to, if not identical with, stray current corrosion. If there is a subtle difference in the meaning of stray current corrosion and is perhaps more often considered to be caused by the action of cathodic protection installations or stray current drainage bonds; whereas stray current corrosion is generally the result of an industrial process, thus usually involving large currents and large potential changes, for example the electric railway system.

In densely populated areas interference to some structure(s) follows, almost inevitably, the installation of cathodic protection or a stray current drainage bond and the decision which follow – whether these effects are to be tolerated or offset or whether the proposed protection system must be abandoned – are based on empiricism and often inexact testing techniques. Adverse potential changes of up to 10 millivolts are generally tolerated and where greater changes occur, the discretionary powers of electrolysis committee members are often used where mutual or community benefits result.

2. Limits of Interference

About 1960, The Joint Committee for Co-ordination of the Cathodic Protection of Buried Structures financed Hoar and Farrer in experimental work which was to determine the allowable adverse potential change of a structure affected by stray current. The results indicate that a 10 millivolt rise in structure potential leads to approximately a 50% increase of the existing corrosion rate and a 20 millivolt rise to a doubling of the rate. In the presence of active sulphate-reducing bacteria, a 20 millivolt rise may indicate a four-fold increase of the rate of corrosion.

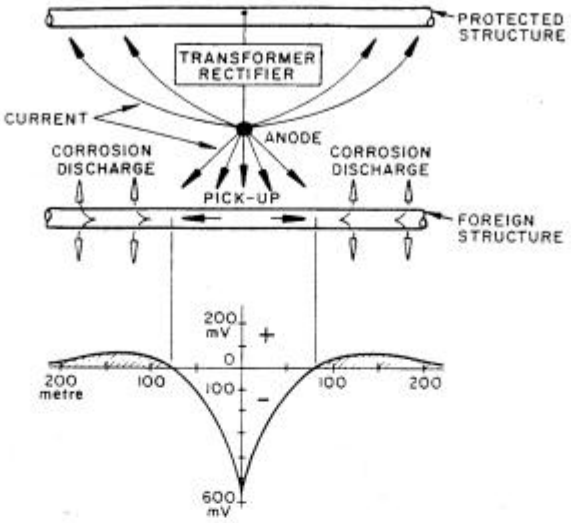

Figure 25 - Potentials on Foreign Structure to Ground
(Anodic Interference)

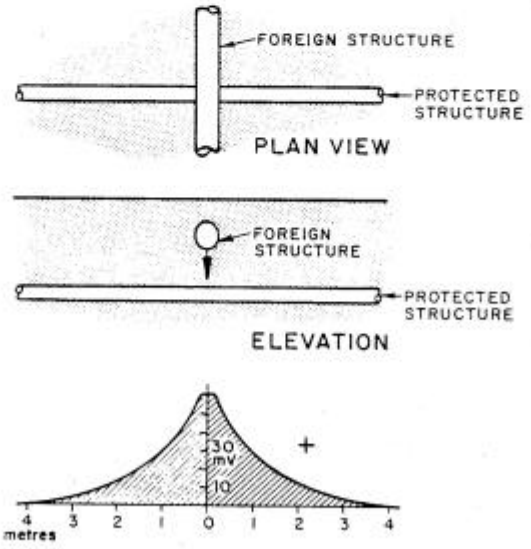

Figure 26 - Potentials on Foreign Structure to Ground
(Cathodic Interference)

On the basis of these results The British Code of Practice for Cathodic Protection C.P. 1021:1973 recommended that:

> "The maximum positive potential change at any point of a secondary structure resulting from interaction should not exceed 20mV. The adoption of a single criterion for all types of structure, irrespective of the value of the structure/electrolyte potential, is over simplification. It is however believed to be reasonable on the basis of evidence at present available. Where, however, there is a definite reasons to suppose that the secondary structure is already corroding at an appreciable rate, even a small potential change will reduce the life of the structure and no change of the structure/electrolyte potential should be permitted".

Other codes and organisations have different criteria. The Dutch Code for Cathodic Protection of Gas Pipelines permits an upper limit of 50mV, when tested in a prescribed manner for the allowable positive change of potential, but cautions that lower values would cause inadmissible adverse effects in low resistivity soils. The equivalent Indian code follows British Practice.

The NACE Standard RP-01-69, and some Australian States' legislation are not prescriptive but rely instead on the professionalism of those involved to reach agreement.

Factors which modify interference effects are:

i) the degree of intermixing of the protected and affected structures;
ii) the level of protection applied to the protected structure;
iii) the isolation of the anode sites;
iv) the soil resistance involved;
v) the electrical continuity of the affected structure; and
vi) the quality of the coatings of the structures involved.

With these as the major controls, either anodic or cathodic interference may occur. These problems are illustrated in Figures 25 and 26.

When anodic interference occurs, current is generally received by the affected structure over a relatively short distance and discharged over a wide area, hence the major potential change is negative. Excessive negative potentials may result in coating damage because of hydrogen

evolution or water absorption and secondary corrosion where amphoteric metals are involved but the majority of buried metals are unaffected. Therefore negative potential changes should generally be considered as indications that significant corrosion may possible result where the current is discharged.

Conversely, cathodic interference is generally the result of current being picked up over a wide area and discharging from a small section of the affected structure. Here the major potential change is positive and corrosion must result where the discharge takes place.

3. Testing Procedures

Testing of the interference effect of cathodic protection installations is a tedious procedure, if properly carried out, because interference can occur not only in the vicinity of the cathodic protection installation, but in any area where a significant change of potential, 40 millivolts has been suggested, of the protected structure occurs. With modern pipeline techniques this may be over many kilometres.

The testing procedure involves the measurement of the change of potential-to-soil, if any, of a structure when the cathodic protection current is applied. This is conveniently done using an automatic switch with a time cycle of 5 seconds on and 15 off, a cycle readily identified by observing a wrist watch

Measurements of the potential change should be made at each accessible point of all "foreign" structures, these having been identified from records, visually and by pipe locators.

To minimise potential gradients in the soil, the test half-cell should be as close as possible to the foreign structure being tested, particularly where the protected structure is close by. The structure under test must be electrically (metallically) continuous between the site of the ½ cell and the electrical connection to it. Suitable measuring instruments should have a high impedance and high A.C. rejection ration.

4. Mitigation of Effects

Objectionable potential changes may be modified in a number of ways – those used are generally one of more of the following:

(a) Reduction of the level of protection of the protected structure may be accomplished either by reducing the current output of the protection system or by use of sacrificial anodes, either alone, or in combination with the impressed current system.

(b) In the case of cathodic protection interference, coating of the affected structure and perhaps a reconstitution of the coating of the protection structure will be of assistance. Where the structures are very close together, the distance to be coated may not be great.

(c) Restoration of the "as found" potentials may be achieved by the connection of sacrificial anodes to the affected structure. This method appears to impose a maintenance requirement to ensure a continuing adequacy of the anode performance.

(d) The use of "cross bonds" is probably the most useful technique in overcoming interference. Physically, cross bonds consist of a resistive interconnection between the affected and protected structure, the resistance being adjusted either to restore the "as found" condition or, more usually, to give a measure of protection to the foreign structure. Such an installation is essentially the same as a stray current drainage bond, but handling smaller currents and operating with non-reversing and lower potentials.

5. Conclusion

Where it can be shown by accepted testing techniques that a cathodic protection installation (including stray railway traction drainage bonds) causes an adverse effect to a foreign structure, historically, the owner of the affected structure has an absolute right to veto. As a result, those who wish to apply cathodic protection are put to some trouble to overcome these objections.

It is difficult to convince the operator of a pipeline that, in law, his million-dollar investment ranks equally with the water or gas service of an unrepresented householder. Nevertheless, if it can be shown that damage to such a service was caused by the cathodic protection of the pipeline, the operator of the pipeline could be liable for the damage that resulted. Further, if it were shown that incomplete or inadequate testing had been carried out, those responsible for ensuring the adequacy of the testing procedures may well be negligent, either for knowing that such

could occur and failing to test adequately, or being in breach of a statutory duty.

Cathodic protection regulations, where such exists, in Australia have been designed to ensure that:

i) The installer of a cathodic protection system is responsible for the costs involved. This however, can be varied by mutual arrangement.

ii) The design of the system complies with statutory requirements if such exist.

iii) The rights of the owners of other structures are preserved and that the operator of the cathodic protection installation has a continuing obligations to test and, if necessary, to modify existing or install new suppression systems.

iv) Permission to install a cathodic protection system does not confer any special rights nor it waive any responsibility of the installer.

In, Australia, it is now accepted that for many structures, particularly oil and gas pipelines, complete cathodic protection is a legal prerequisite for their operation, and indeed, without such protection their rapid failure would be certain. On the other hand, the Electricity (Corrosion Protection) Regulation 1993 (NSW) was introduced to protect parties, other than the operator of the cathodic protection installation, from the corrosive affect of stray current.

These Regulations may seem unduly restrictive but it should be remembered that they are those self-imposed rules by which electrolysis committees have operated for over fifty years. The success of these committees is dependent now, as it always has been, on the acceptance of responsibility and the mutual forbearance and cooperation of the parties involved.

MINISTRY OF ENERGY AND UTILITIES
NSW ELECTROLYSIS COMMITTEE

PROCEDURE FOR TESTING AND APPROVAL OF COUNTRY-LOCATED CATHODIC PROTECTION SYSTEMS

INTRODUCTION

All impressed current and larger capacity (>150mA) galvanic anode cathodic protection systems in NSW must be approved by the Ministry of Energy and Utilities pursuant to the Electricity Safety (Corrosion Protection)Regulation 1998. Approval usually involves testing by the Ministry, carried out in close consultation with the NSW Electrolysis Committee.

However, for systems located in country regions it is costly for Ministry staff to attend all tests. For this reason, a practice has developed where some country testing is carried out by other parties and the results forwarded to the Ministry for consideration and if satisfactory, for approval. Letters from local utilities (ie. water, gas, electricity, sewer) noting no objection to the operation of the system, are required A sample letter is attached.

All country systems, with the exception of galvanic systems under 150mA output will require approval by the Ministry of Energy and Utilities.

The primary requirement of the Ministry is to have documentary evidence that all of the utilities who own nearby structures do not have any objection to the operation of the CP system in question. Where full documentation is provided, the Ministry will usually proceed to approve operation of the system.

A secondary and related requirement of the Ministry is to know that all owners of nearby structures are aware of the implications of possible interference and that no important structures have been forgotten.

A third requirement is to know that interference testing has been properly carried out and that copies of the results are forwarded to the Ministry.

Where Ministry staff carry out testing, and this always requires the active assistance of utility staff or there consultants, then letters are not needed as the Testing Officer will normally collect all necessary information during the test. This information takes the form of electrolysis charts for all relevant local utility structures.

In certain limited circumstances, the Ministry may approve of a remotely-located system without any testing, but only when the system proponent obtains letters (sample attached) from nearby utilities that state that they understand the issue and have no objection to operation of the system. This arrangement would only apply to systems installed in remote locations, for example, cathodic protection on a water-bore pipe on a sheep property.

PROCEDURE--PROPOSED NEW SYSTEMS

1. A new system, other that a galvanic system with output less than 150mA, cannot be operated without approval of the Ministry of Energy and Utilities (Regulation 6(1)). The exception is operation for the purpose of testing where it may be operated for up to 24 hrs without prior approval (Regulation 6(2)).

2. The owner, or their agent, must submit an application form to the Ministry of Energy and Utilities.

3. If testing is deemed necessary by the Ministry, then the Ministry will organise testing through the facilities of the Electrolysis Committee. The party to carry out the testing will be nominated and agreed by the Ministry, and may be the Ministry's Testing Officer.

4. If testing is not deemed to be necessary then the Ministry will inform the applicant and will issue an approved certificate in due course.

5. Where testing is required, the Ministry will usually request the applicant to supply contact name and contact telephone number of all utilities near to the proposed installation.

6. The Ministry will contact the utilities and arrange/confirm their participation in any necessary field testing and will explain obligations/ regulations/ procedures to the utilities.

7. The party responsible for testing (usually the applicant or his agent) is also responsible for obtaining letters from the utilities (stating no objections), the test result and other details pertinent to the system, and forwarding these to the Ministry.

8. The performance of interference testing will be carried out by a party (usually the owner of the system or his agent) approved by the Ministry. The party that owns the primary structure (or his agent) will carry out interference tests on readily available foreign structures in those cases where the foreign structure owner is not present to assist.

9. The party performing the test will accept responsibility for explaining and assisting the local utility staff on matters of testing.

10. Where unacceptable interference is found, the party responsible for testing (ie. the owner or their agent) will undertake effective remedial action so that the unacceptable interference is eliminated. The actions taken are for the owner/agent to determine, the Ministry's responsibility is only to determine that interference is acceptable or eliminated.

11. In determining the acceptable standards for interference, the owner/agent will be guided by the standards set in "The Guide to Measurement of Interference Caused bye Cathodic Protection and Railway Drainage Systems". The Ministry can advise on the matter. This document is available on the Ministry's web page (refer below).

12. The Ministry may elect to directly supervise/carry out testing on any system using its own or the owner/agent's measuring equipment. The cost to the Ministry will be charged to the system owner.

13. The Ministry will, where agreement between parties is not readily achieved, conciliate/arbitrate as to the acceptable level of interference.

14. The methodology for interference testing is an defined in "The Guide" or as specified by the Ministry from time to time.

15. The party responsible for carrying out the test will forward the original charts/tables to the Ministry. All charts/tables to be clearly marked as to date, location, owner of system, owner of utility, etc. as per "The Guide".

16. The system may be continuously operated when agreed by either the Leader Electrolysis of the Ministry of Energy and Utilities or a certificate of approval is issued by the Ministry.

PROCEDURE--RETESTING OF EXISTING SYSTEM

The procedures for re-testing existing systems are the same as for proposed new systems.

The Ministry of Energy and Utilities will determine when an existing approved system is to be retested but will do this in consultation with the system owner or their agent and the Electrolysis Committees. The cycle for CP system is about 7 years and the DB system is about 4 years.

Thereafter the procedure for proposed new systems applies, from item 5 onward.

The existing approved system will continue to operate unless retesting demonstrates unacceptable/objectionable interference and approval is subsequently withdrawn by the Ministry. RE-approval may include changed conditions for operation of the CP system.

ASSISTANCE TO MINISTRY'S TESTING OFFICER

Assistance by the holder of the approval for a cathodic protection system is essential to enable testing to be carried out. This assistance is a legal requirement under Clause 12 of the Regulation. Assistance includes:

- ?? Provide access to the system
- ?? Generally assist by for example connecting electrical leads to the protected structures
- ?? Install equipment to enable testing to be carried out.

Assistance by the utility structure owners, not being the holder of the approval, is not a legal requirement, but is essential to enable the Testing Officer to carry

out tests. Because the purpose of testing is to protect the utility structure from electrolysis corrosion, it is in the interest of the utility to actively assist in testing. Assistance usually consists of identifying relevant/nearby metallic structures and providing connection of a test lead.

MINISTRY WEB SITE

A comprehensive guide on the topic of electrolysis testing is available at the Ministry's web page: www.doe.nsw.gov.au. Look under "committees" and "Electrolysis Committee", then: "Guide for Measurement of Interference".

B Dover
Leader Electrolysis
Ministry of Energy and Utilities

SAMPLE LETTER

Mr Bruce Dover
Leader Electrolysis
Ministry of Energy and Utilities
PO Box 536
ST LEONARDS NSW 1590

Dear Mr Dover

TESTING OF CATHODIC PROTECTION SYSTEMS

The cathodic protection systems listed below were tested by [utility that owns the cathodic protection system] on [date] and testing was/was not* observed by our staff. Test currents are listed in the table below.

We are satisfied that the system(s) is/are not* causing electrolysis corrosion on our structures and we have no objections to the continuing operation of the/these systems.

[name]
[title]

No.	Address of cathodic protection system	Test current
1		
2		
3		
etc		

* Strike at the word not applicable.

[Note:if there is a problem of interference that has not been resolved then the utility should let the Ministry know, either verbally or by letter/fax of these concerns so that the Ministry can take appropriate action to remedy the problem.]