CORROSION: ELECTROLYSIS

John Lambert
Brisbane Tramway Museum Society

The aim of this paper is to give COTMA delegates (as traction system owners and operators) a brief introduction into the nature and control of electrolysis caused by stray current from DC traction systems.

The testing of interference, the design and installation of mitigation, plus the correlation of all results is a highly specialised technical area and well beyond the scope of this paper. The State Electrolysis Committee, where it exists, is the appropriate technical body for coordination and consultation regarding stray current problems and mitigation systems.

STRUCTURE

This term is used to describe any underground metallic structures that may be influenced by stray current. Examples of structures are telephone cables, gas mains, oil lines, water mains, electricity cables and the electricity earth (MEN) system.

INTERFERENCE

Interference occurs when stray traction currents influence metallic structures so that their potential to soil is altered. Interference may be either *cathodic* or *anodic*. Where cathodic, the potential of the structure is made more negative and where anodic, the potential of the structure is moved in the positive direction. At points where stray traction current is collected by the structure, the potential changes in the cathodic direction. Where it is discharged the potential changes in the anodic direction and if conditions are right corrosion (electrolysis) will take place. The zones where this occurs may be significantly remote from the traction system. (See Fig. 1)

LIMITS

The tolerable limits of interference vary from state to state. However, it is recommended that anodic interference should be controlled to less than a change of 20 millivolts positive, while cathodic interference is not normally controlled except where the potential change is considered excessive.

TESTING

Testing is performed over a 24 hour period using chart recorders at several strategic locations. At the substation the following items are monitored:

1. Substation load
2. Rail to earth potential.
3. Drain current.
4. TDU output.

At the drainage point on the structure the following items are monitored:

1. Potential to soil.
2. Drainage current.

At several other locations on the structure, known as test points, potential to soil charts may also be taken to assess the function of the drainage bond. (See Fig. 2)

Initial interference testing in a Tramway Museum environment would most likely consist of 24 hour charts on the following items:

1. Substation load
2. Rail to earth potential at the substation.
3. Several test points on the structure.

These charts would then be correlated and the results would indicate what effect the operation of the traction system has on the structure. Should adverse results be indicated then corrosion mitigation would have to be designed and installed. Interference may be reduced (possibly to acceptable levels) by minimisation of track leakage by the following methods:

1. Obtaining maximum conductance in the rail return by ensuring that the rails form an electrically continuous conductor. Bonding should be installed across all rail joints (fishplates) and between rails (across the track) at intervals of approximately 50 metres. Bonding should also be made to and around special work as manganese steel is of higher resistance than carbon steel.

2. The installation of negative feeders from remote parts of the track to the substation.

Special note: Track in mass concrete is notoriously bad for current leakage as concrete is hygroscopic, thereby becoming a conductor under certain conditions. Good bonding is therefore essential during track construction.

MITIGATION (DRAINAGE BONDS)

These drainage bonds are installed so that they "drain" the stray current off the structure and return it to the traction system. There are a number of different types of drainage bonds in Australia; some of these are:

TDU: Thyristor Drainage Unit
VCDB: Variable Conductance Drainage Bond
TRAD: Transformer Rectifier Assisted Drainage

(See Fig. 3)

It is preferable to return stray current to the substation negative busbar via "Electrolysis Feeders" as this gives greater control over the drainage bond than if the stray current is returned to the rail. (See Fig. 4)

CONCLUSION

Operators of tramway museums should be aware of what underground metallic structures exist in the vicinity of their traction systems and appropriate testing should be performed to ascertain if any adverse effects have been created. Consultation and cooperation with the owners of these structures is of great importance in these matters.

ACKNOWLEDGMENTS

I wish to acknowledge Mr Bill Attard and staff of the Victorian Electrolysis Committee for their assistance in gaining information on Traction Electrolysis, Mr Brian Byrne of Telecom Australia who made the initial contact with Mr Attard and Mr Jim McMonagle of Telecom Australia who supplied information on electrolysis in New South Wales.

REFERENCES

1. Australian Standard 2832.1 Guide to the cathodic protection of metals.
2. Information from the Victorian Electrolysis Commission
3. *An Introduction to Corrosion Technology* (Australian Corrosion Association)
4. Information from the NSW Electrolysis Committee.

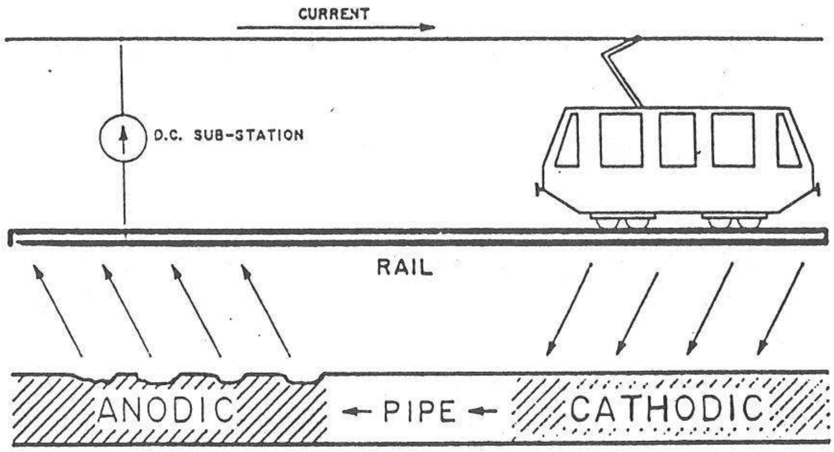

FIGURE 1 : CORROSION DUE TO STRAY TRACTION CURRENT

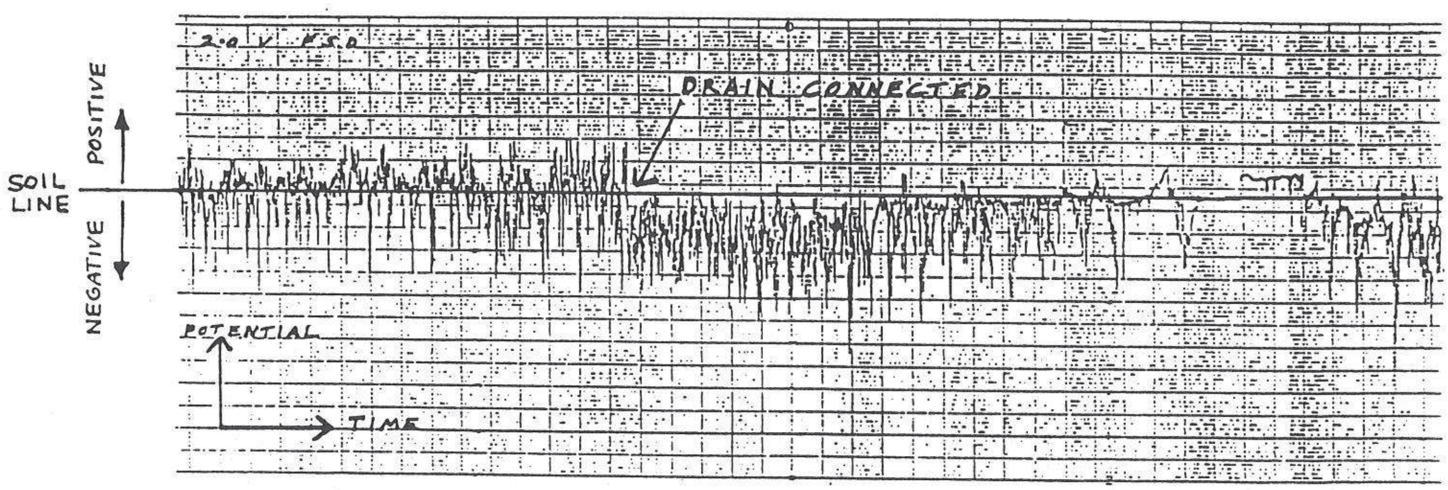

FIGURE 2 : 24-HOUR PIPE TO SOIL POTENTIAL RECORDING SHOWING EFFECT OF STRAY CURRENT DRAINAGE

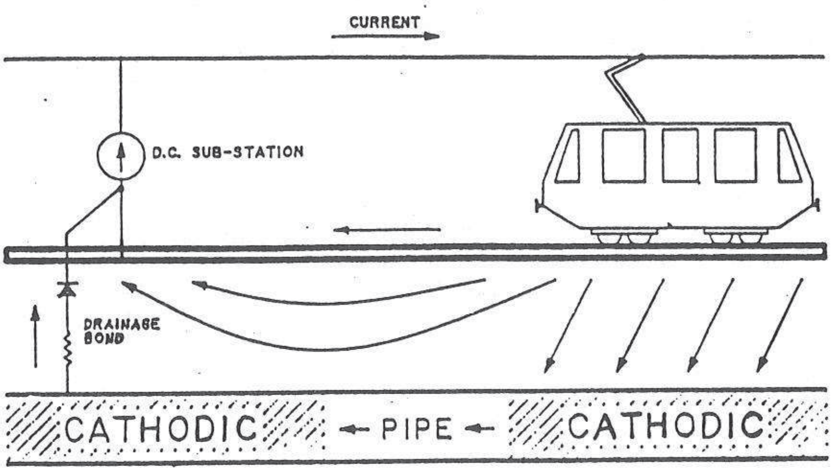

FIGURE 3 : DIODE CONTROLLED DRAINAGE BOND

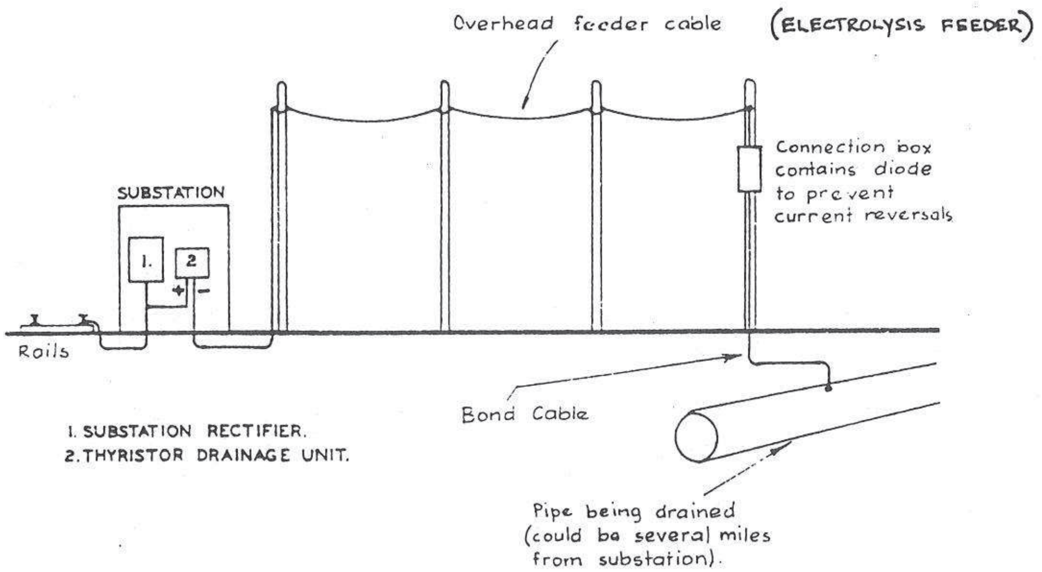

Fig. 4 : Schematic Diagram of Electrolysis Drainage