Cathodic Protection Services

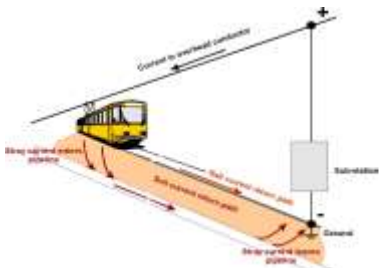
ELECTROLYSIS
&
STRAY TRACTION CURRENT REPORT

FOR A

PROPOSED MULTISTORY DEVELOPMENT

157 REDFERN STREET

REDFERN



Cathodic Protection Services
P O Box 118
CONCORD NSW 2137
Phone 61-2 97452785
Fax: 61-2-97448542
Email: cathodic@pnc.com.au

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1. INTRODUCTION

A new multistory mixed development is proposed for construction at 157 Redfern Street, Redfern. The development will consist of 5 underground levels and 18 above ground levels.

It is a requirement of RailCorp that for all developments in the vicinity of electrified tracks;

a. The existence of stray traction current in the ground is investigated.

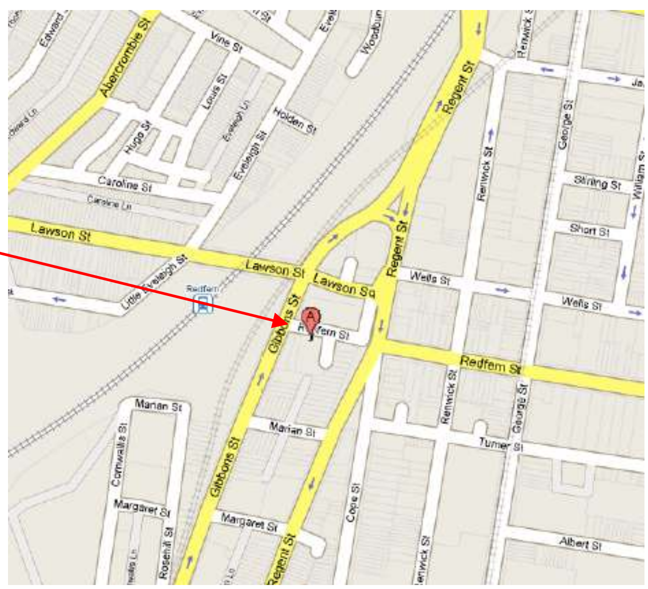
b. A report is developed identifying the extent of the stray traction problem, and what measures should be taken to ensure the stray current does not present a corrosion hazard to the proposed development.

Cathodic Protection Services were commissioned to;

a. Review the development plans and possible exposure to stray traction current.

b. Provide an opinion on whether stray traction current presents a corrosion hazard to the proposed development, and what, if any, remedial or mitigation actions are necessary.

157 Redfern Street
Redfern



2. CONCLUSIONS

The conclusions of this investigation are;

2.1 Stray traction current can be expected to be present on the site of the Development

2.2 The basement floor slab will be cast on a moisture barrier which will act as an insulator to the entry of stray traction current.

2.3 The capping beam of the soldier piles can act as a conductor for stray traction current. This can be avoided by;

a. Constructing the soldier piles from 40 mpa concrete, or

b. Fitting insulating sleeving [ie PVC tubing] to the starter bars of the piles where they tie into the reinforcing of the capping beam.

2.4 Corrosion of the water and fire services or the electrical earth can be caused by stray traction current. Installation of an insulating fitting in the water and fire services, or the use of a non metallic water meter, or PVC pipe eliminates this hazard.

The above are elaborated on in Clause 7.

3. CODES AND STANDARDS

This report has been undertaken with reference to the following RIC Standards;

- EP 12 10 00 13 SP 1500 V Traction System Earthing
- EP 12 10 00 20 SP Low Voltage Distribution Earthing
- EP 12 10 00 21 SP Low Voltage Installations Earthing
- EP 12 10 00 22 SP Buildings and Structures Under Overhead Lines
- EP 12 20 00 01 SP Bonding of Overhead Wiring Structures to Rail

- EP 12 30 00 01 SP Electrolysis From Stray DC Current
- ESC 510 Boundary Fences [Civil]
- SPC 511 Boundary fences [Right of Way]

4. DESCRIPTION OF THE PROPOSED DEVELOPMENT

The Development consists of the following;

a. The structure will be a 18 level multistorey Mixed Use Development incorporating five underground basement parking levels.

b. The concrete for the lowest level will be cast on a moisture barrier.

c. The walls of the underground levels will be supported by soldier piles which will be secured by temporary rock anchors.

d. The underground walls will consist of shotcrete infill between the piles. No electrical continuity will exist between the piles and the reinforcing of the shotcrete.

e. The starter bars of the piles will be tied into steel reinforcement of the capping beams.

f. The site is adjacent to the existing Illawarra electrified rail line. A future proposed rail line will run below the development.

Details of the proposed construction are shown on the following Nordon Jago Drawings;

NUMBER	REVISION	DESCRIPTION
DA023	B	Proposed Building Sections
DA024	B	Proposed Building Sections
DA090	B	Basement 5 Plan
DA091	B	Basement 4 Plan
DA092B	B	Basement 3 Plan
DA093	B	Basement 2 Plan
DA094	B	Basement 1 Plan
DA100	B	Level 1
DA101	B	Level 2
DA102	B	Level 3
DA103	B	Level 4
DA110	B	Level 5
DA111	B	Levels 6 to 12
DA112	B	Levels 13 to 16
DA113	B	Level 17
DA114	B	Level 18
DA120	B	Level 19
DA121	B	Roof
DA200	A	Sections AA & BB
DA201	A	Sections CC & DD
DA202		Section EE
DA300		Elevations
DA301		Elevations

5. THE PROBLEM.

5.1 BACKGROUND

RailCorp use 1500 volt direct current to operate the traction system. The current is delivered by the overhead catenary cables and the return path to the sub station is via the track. The track is not insulated from earth, principally because of the difficultly of achieving insulation and secondly, for safety reasons. Whilst the steel track is large in cross section, some of the current leaks from the tracks and finds alternate paths back to the sub station. Considerable current can be involved, for instance, a Tangara train requires about 4000 amps to start from rest.

All current obeys Ohms Law and if a low resistance metallic structure exists in the path of the “stray” current this can pick up the stray current which then flows along the structure to a point close to the sub station, where it discharges back to earth, and ultimately returns to the sub station.

Where the “foreign” structure picks up the stray current a small measure of corrosion control or “cathodic protection” is achieved. However, where the current discharges from the foreign structure back to the soil, corrosion of the foreign structure occurs as shown on Sketch CP34.

The problem of stray current corrosion was first identified in the 1930’s. For stray current to be a serious problem the foreign structure has to be electrically continuous. t that time the only organisation which had electrically continuous structures were the PMG with their lead sheathed cables. They suffered corrosion failures and for many years considered this to be a necessary evil. However an enterprising Engineer decided to plot failures on a map and found they were predominantly grouped around rail lines or tram lines. Further investigation showed that they were also grouped around the sub stations associated with the tracks. He eventually identified the corrosion problem as being caused by stray current. The PMG approached the Railways for compensation and it did appear that the Federal Government would be suing the State Government.

Whilst this was occurring the Engineering staff developed a solution to the problem. This was to connect the foreign structure to the tracks via a simple control system. This provided a low resistance path for the stray current to return to the tracks thus eliminating the corrosion problem. The control bond could be engineered such that a degree of additional corrosion protection could be provided to the foreign structure.

The above led to the formation of the Electrolysis Committee which has representatives of the owners of all underground services, and RailCorp. Cathodic Protection Services represents the interests of the Oil and Chemical Industry on the Committee. Apart from the War Years the committee has met at about monthly intervals since the 1930's to discuss stray current problems and its mitigation with the Railways.

5.2 CORROSION HAZARD FROM STRAY TRACTION CURRENT

Direct current as used by the traction system can cause serious corrosion to underground metallic services and the steel reinforcement of concrete. Stray traction current flowing in the ground can be picked up by the steel reinforcement one side of the development, flow along the steelwork and discharge back to the soil on the opposite side of the building. At the discharge point of the current, corrosion of the reinforcement will occur.

For a building, the most common means of eliminating the corrosion hazard from stray traction current is to increase the electrical resistance of the concrete to the ground. This prevents the flow of stray traction current through the reinforcement.

Increasing the electrical resistance of the structure to ground for an onground slab is automatically achieved by the moisture barriers installed to prevent water entry into the structure. The moisture barrier is an electrically insulating membrane.

Where the structure is supported on pad and/or piered footings, increasing the resistance of the structure to ground can be achieved by either;

a. Applying moisture barrier to the excavation into which the pad footings or piers are poured.

b. If installation of moisture barriers into the excavation is impractical, ie for piered footings, these can be insulated from the structure by the application of insulating sleeving to the starter bars where they tie into the building reinforcement.

6. MITIGATION OF STRAY CURRENT

There are a number of options to deal with the potential corrosion problems which can result from stray traction current. These include,

a. Prevent or reduce exposure of the structure to stray traction current.
b. Install a mitigation system to offset the problem.

In the case of the latter this is an expensive approach as it requires the establishment of infrastructure necessary for the mitigation of the problem.

6.1. ELIMINATE OF REDUCE EXPOSURE TO STRAY TRACTION CURRENT

The simplest approach is to avoid exposure of the structure to stray traction current. Two approaches, which can be adopted, are;

6.1.1. Reduce Length of Structure in Alignment with Traction Current Path.

As noted in Section 6, the hazard from stray traction current is due to the current flowing onto and then off the metallic structure. Corrosion occurs at the point of discharge of the current back to the soil.

The hazard from the stray traction current increases as the length of the conducting service increases. Stray traction corrosion is a problem because the metallic service presents a lower electrical resistance path to current flow than the alternative path through the earth.

For current to flow onto and discharge from an underground structure, electrochemical reactions need to occur to generate or absorb electrons. Both these reactions require energy, which results in a resistance existing between the structure and the earth. If the structure is short in length, the combined resistance of the pick up and discharge reactions is sufficient to prevent the traction current flowing onto the structure.

Additional to the above, the passage of the stray traction current causes development of potential gradient in the earth. For a short metallic conductor, the potential gradient to which it is exposed to too small to allow the pick up of the current. Accordingly the shorter the length of the metallic structure the less likely it is to be affected by stray traction current.

6.1.2. Isolate the Structure from Stray Traction Current.

The effects of stray traction current can be avoided by increasing the resistance of the structure to the soils in which stray traction current is flowing. This can be achieved by use of moisture barriers such as FORTICON which provides an electrically insulating membrane which prevents entry of stray traction current. Even if the membrane is damaged, it will still provide sufficient resistance to prevent entry of stray traction current.

6.1.3. Use of High Strength Concrete.

Increasing the strength of the concrete increases the electrical resistance of the concrete. Thus if concrete of 40 mpa is used for the underground components, this has a high resistance, due partly to the reduced water content, and acts as an electrical insulator to the entry of stray traction current.

6.2 STRAY TRACTION CURRENT MITIGATION

Stray traction current mitigation is achieved by providing a low resistance path from the structure to allow discharge of any stray traction current directly back to the rail.

Provision of a mitigation system involves the following;

a. The reinforcement of the concrete has to be made electrically continuous. This involves tack welding all members of the reinforcement cages.

b. Testing has to be undertaken to provide evidence to the Railways that a stray traction current corrosion hazard exists.

c. If the testing identifies a corrosion hazard to the steel reinforcement does exist, installation of a “railway drainage bond” can proceed.

It is appreciated that installation of a mitigation system is a particularly expensive option. The only building projects on which Cathodic Protection Services have recommended a stray traction mitigation system are;

- ❖ The Sydney Harbour Tunnel. This structure is 3200m in length and testing indicated the existence of a stray traction current hazard.
- ❖ Chatswood Connection project. This development by Girvan was over one km in length and provision for a stray traction current mitigation system was designed into the proposed project. Unfortunately Girvan went into receivership in the early stages of the project.

7. REDFERN STREET DEVELOPMENT

The elimination of corrosion hazards from stray traction current involves increasing the resistance of the conductive path for stray current which may otherwise be conducted into the underground sections of the structure. If stray current is conducted into the structure, severe corrosion of the concrete reinforcement can result, ultimately resulting in structural failures.

Comments relating to the Redfern Street Development are;

7.1 Basement Slab

The basement slab will be constructed on a water proof membrane. This will provide an insulating barrier to the entry of stray traction current.

7.2 Soldier Piles

The reinforced concrete soldier piles will be independently driven, and starter bars will tie into the reinforcement of the capping beam. Under this arrangement the reinforcing of the capping beam can act as a conductor for stray traction current picked up by the piles. Two solutions are available to mitigate this problem;

a. Manufacturer the piles from high strength concrete, such as 40 mpa. This strength concrete has sufficiently high resistance to prevent the entry of stray traction current .

or

b. Insulate the starter bars of the piles where they tie into the capping beam reinforcement. This can be achieved by fitting PVC or other plastic type tubing to the starter bars at the points of contact with the capping beam reinforcement.

7.3 Shotcrete Walls

The shotcrete infill walls between the piles do not have electrical continuity from section to section, and each section is too short to act as a conductor for stray traction current

7.4 Incoming Services

Stray traction current can affect metallic water, fire and gas services. Should stray traction current be picked up by the services, this can result in a corrosion problem on;

a. The services.

b. The Development's electrical earth system. This is because the earth and the water service have a direct interconnection via the MEN system. Current picked up by the water and/or fire services can discharge back to the earth via the earth system resulting in corrosion of the earth grid or stake.

This problem can be eliminated by installation of an insulating fitting, or non-metallic sections in the services at or close to the boundary of the property as detailed in RIC Standard EP 12 30 00 01 SP "Electrolysis from Stray DC Current", Clause 5.3.

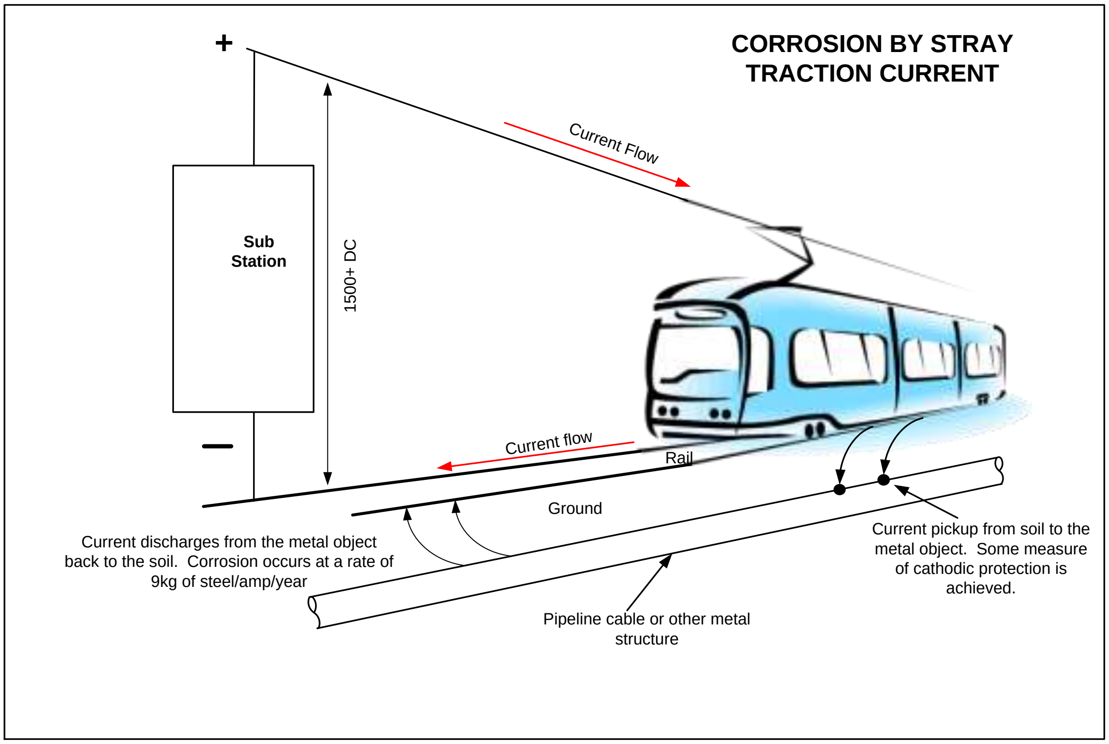
> *"Water and gas pipes servicing buildings on the Railway Corridor and near 1500 V track to have an isolating joint installed at the boundary."*

Suitable insulating fittings are available from Savcor Art, telephone 96632322.

If the water service, or the water meter is constructed from non metallic materials, no other insulation is necessary.

Gas services do not require any additional insulation. If the incoming service is steel construction, this will be fitted with a cathodic protection system incorporating an insulating joint at the meter. If the service is low pressure, this will be run in non-metallic pipe.

APPENDIX A


CORROSION BY STRAY TRACTION CURRENT
+
Sub Station
1500+ DC
Current Flow
Current flow
Rail
Ground
Current discharges from the metal object back to the soil. Corrosion occurs at a rate of 9kg of steel/amp/year
Current pickup from soil to the metal object. Some measure of cathodic protection is achieved.
Pipeline cable or other metal structure