Sydney Trains

Engineering System Integrity
Engineering Instruction
Common

EI A 25-07

Disconnecting and Reconnecting OHW Spark Gaps

This Engineering Instruction includes urgent engineering information. Adherence to the information in this Instruction is **MANDATORY**.

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Audience:

- Signal Engineers
- Signal Electricians
- Project Managers
- Signal Project Engineers
- Maintenance Operation Managers
- Electrical Maintenance personnel
- Electrical Construction personnel
- Electrical Asset Engineers
- Electrical Team Managers
- Overhead Line Workers
- ICON

Main Points:

- Highlight the potential risk of electrical injury when disconnecting and reconnecting spark gap cables.
- No rail connections or spark gaps for 1500 V switches shall be removed by signalling personnel. Arrange with an Authorised Electrical Representative to disconnect and reconnect.
- Enhanced signalling procedures for disconnecting and reconnecting spark gap cables.
- Temporary spark gap bonding arrangements for planned works.

Primary Affected Document: **PR S 40042 Safety Issues for Signalling Personnel**
PR D 78303 Work on 1500 Volt Negative Equipment Outside Substations

Document Control

Version	Date	Summary of change
1.0	17/09/2025	First issue as a Sydney Trains document

Scope

This Engineering Instruction outlines enhanced Signalling procedures for the disconnection and reconnection of overhead wiring (OHW) spark gap cables and the arrangements for temporary spark gap bonding.

Signalling personnel maybe required to disconnect spark gap cables where the spark gap is affecting track circuit operation (unplanned) or disconnect and reconnect spark gap cables for planned works.

There are no changes to the Electrical procedures as described in *PR D 78303 Work on 1500 Volt Negative Equipment Outside Substations.*

Background

Spark gaps and spark gap cables perform a safety function and are used to control the risk of an OHW structure becoming electrically live.

A spark gap is normally open circuit and is designed to short circuit (failed state) in the event of failure of the 1500-volt insulation on the structure. This will then connect the structure to the return rail and initiate a trip of the traction supply circuit breaker in the substation.

Defective (i.e., failed) spark gaps may affect the operation of track circuits, contribute to electrolysis corrosion, and may even lead to a loss of rail vehicle detection. To overcome such issues, signalling personal are sometimes required to disconnect spark gap cables, which under certain circumstances can pose an electrical hazard.

Action required

Note:

At 1500 V switches, No rail connections or spark gap cable shall be removed by signalling personnel. Arrange for the spark gap to be disconnected and reconnected by an Electrical Representative.

1 Precaution checks and tests prior to disconnection of a spark gap

For planned and unplanned works before disconnection of any spark gap cable, signalling personnel are to avoid touching the OHW structure until the following checks and tests are performed to determine if it is safe to disconnect (ensuring appropriate SWMS and SWIs are implemented):

1. Undertake a visual inspection for broken insulators attached to the structure or other signs of electrical faults.
2. Check visual signs of overheating of terminals and cables or insulation melted, blistering or damaged. This may indicate high current flow or high resistance connections.
3. Measure the structure to rail voltage. If greater than 50 Volts D.C. (using a 100K shunt), this may indicate poor OHW insulation.
4. Measure D.C. current in the spark gap cable using a tong meter.
   a. If current flow is from structure to rail, this may indicate a damaged OHW insulator.
   b. If the current flow is from rail to structure, and is greater than 0.1 Amps D.C., may pose an electrical hazard upon disconnection.

Signalling personnel shall **not** disconnect spark gap cables if any of the above checks and tests indicate it is unsafe. In such cases, they shall notify ICON Electrical to arrange for an Authorised Electrical Representative to carry out the disconnection, replacement or reconnection of the spark gap cable or spark gap.

2 Unplanned work

2.1 Defective spark gaps affecting track circuit operation

Where a spark gap is missing, defective or affects the operation of the track circuit, ICON Electrical shall be notified immediately and spark gap to be arranged to be replaced as a priority.

Following checks and tests as per section 1, if it is determined that it is safe to disconnect the spark gap cable, signalling personnel may disconnect for operational reasons by following the process below:

a. Disconnect the spark gap cable at the spark gap unit end.
b. Apply insulation to the spark gap cable removed (at the spark gap unit end) to prevent stray traction current entering the earth and causing electrolysis corrosion and to prevent others being exposed to any potential hazard.
c. Notify ICON Electrical and ICON Infrastructure that the spark gap cable has been removed from the spark gap unit and is isolated.

3 Planned Works

3.1 Precaution checks and tests prior to disconnection and connection of spark gap cable

Before disconnection of any spark gap cable for planned works, signalling support personnel are to perform the checks and tests as per section 1 to determine if it is safe to disconnect.

If any of the above checks and tests indicate it is unsafe, they shall notify ICON Electrical to arrange for an Authorised Electrical Representative to carry out the disconnection and installation of the spark gap bonding, including any temporary arrangement as per the temporary spark gap bonding plan or design in the Signalling Support Work Package.

3.2 Where temporary spark gap bonding is not required

If the existing spark gap cable is required to be disconnected from the rail and the installation of a temporary spark gap cable is not required, perform the checks and tests as per section 1 to determine if it is safe to disconnect.

If it is determined that it is safe to disconnect, the spark gap cable at the rail end is to be disconnected. Ensure the disconnected end is insulated appropriately to prevent stray traction current entering the earth and causing electrolysis corrosion and to prevent others being exposed to any potential hazard. The disconnected spark gap shall be recorded on a signalling disconnection list.

Before reconnecting the spark gap cable to rail, signalling support personnel should **not** touch the OHW structure until checks and tests 1 to 3 in section 1 above have been completed to determine if it is safe to reconnect.

3.3 Where temporary spark gap bonding is required

3.3.1 Temporary spark gap bonding – Planning

For planned work (e.g., re-railing, ballast cleaning, track recon, etc.) where the overhead wiring will remain energised and requires disconnection of a spark gap cable, a temporary spark gap cable shall be provided and connected to the nearest continuous rail in the negative return circuit. This includes all 1500 V D.C. structures including portal, gantries or bridges that may span single or multiple roads and have a spark gap installed.
A temporary spark gap bonding plan is required and signalling support personnel shall identify a suitable nearby traction rail as an alternate temporary rail connection point for the installation of the temporary spark gap bonding.

The following conditions apply for the temporary spark gap bonding:

a. The temporary spark gap cable shall **not** be installed for longer than 10 days.
b. The cable type and length of the proposed temporary spark gap cable shall be detailed in the temporary spark gap bonding plan and shall meet the following requirements:
    i. Make every reasonable effort to replace the existing steel bonding cable with 300 mm^2 aluminium cable, allowing for up to 20 metres of additional length. If site-specific constraints make replacement impractical, up to 20 meters of 300 mm aluminium are permitted to be attached to the existing spark gap cable, ensure that the mating surfaces of the joint are clean to minimise any resistance.
    ii. Where temporary spark gap cable longer than 20 metres is required, the solution shall be of the equivalent resistance of the cable being replaced. This requires re-terminating the new cable to the structure (not extending the existing cable).
c. If the planned works is greater than 10 days or where requirements i and ii cannot be met, signalling support personnel shall request Engineering Systems Integrity (ESI) Electrical Engineering Design Section at least 8 weeks prior to the works to produce a temporary spark gap bonding design. This will require the assistance of the Electrical staff to support the disconnect and reconnect at the structure.
d. Temporary spark gaps bonds shall be recorded on a signalling disconnection list.
e. The signal support personnel shall inspect the temporary spark gap bonding cable during the works. The frequency of inspections of the temporary spark gap bonding cable shall be determined by the support signal engineer based on the assessment of works being performed and included on a work instruction.
f. The support signal engineer shall approve the temporary spark gap bonding plan or endorse the designed temporary spark gap connection as part of the signals support works package.

3.3.2 Temporary spark gap bonding - installation and connection

Before disconnecting any spark gap cable, signalling support personnel are to confirm that it is safe to disconnect by performing the checks and tests as per Section 1. If it is determined that it is safe to disconnect the spark gap cable, signalling personnel shall follow the process below:

a. Before connecting the temporary spark gap cable to the alternate rail connection, clean the rail of dust, paint, or any other insulating material to ensure good electrical contact.
b. Remove the original spark gap cable and replace with the temporary spark gap cable. Where the temporary spark gap cable is extended, ensure both the original and new spark gap cable mating surfaces are thoroughly cleaned and prepared to minimise contact resistance of the connection.

c. Connect the temporary spark gap cable to the alternate rail connection point, in accordance with the temporary spark gap bonding plan or design.

3.3.3 Temporary spark gap bonding - disconnection and removal

On completion of the planned works where temporary spark gap bonding is connected, signalling support personnel shall perform the checks and precautions as per Section 1 to ensure that it is safe to remove the temporary spark gap cable and reconnect and certify the original spark gap cable.

If at any time it is determined that it is unsafe to disconnect the temporary spark gap cable or reconnect the original spark gap cable, contact ICON Electrical to arrange for an Authorised Electrical Representative to perform the disconnection, reconnection, and certification of the spark gap cable.

Contact

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Engineering System Integrity
Electrical Network Safety Rules

Engineering Procedure
Electrical Distribution Unit

Electrical Distribution Network Management

PR D 78303

Work on 1500 Volt Negative Equipment Outside Substations

Version 1.3
Date in Force: 1 February 2022

Transport Sydney Trains

Approved by:	Associate Director Electrical Distribution Unit Engineering System Integrity	Authorised by:	Engineering Technical Publications Manager System Integrity

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Document control

Version	Date	Author/ Prin. Eng.	Summary of change
1.0	28 July 2015	Christopher Leung	First release for Sydney Trains, rebranded from previous RailCorp SMS-06-EN-0568 V1.3
1.1	12 July 2018	Christopher Leung	3 Yearly Review
1.2	19 February 2019	Nick Loveday	Updated PR D 78303 "Approved by" to Associate Director Electrical Distribution Unit
1.3	1 February 2022	ENSR Project Team	Reviewed as part of the ENSR Project.

Summary of changes from previous version

Summary of change	Section
Minor grammatical updates	All
Updated document references	All

Table of Contents

1 Purpose

To describe the procedures required in carrying out work on 1500 Volt negative equipment outside Substations.

NOTE

A Sectioning Hut is defined as a substation. Refer to Electrical Safety Definitions page available on the RailSafe site.

NOTE

Refer to *PR S 40027 Traction Return (1500V DC)* for precautions necessary when work is performed that may affect any part of the traction return in 1500V DC electrified areas.

2 Definitions

Refer to the **Electrical Safety Definitions** page available on the **RailSafe** site.

3 Safety Principles

When work is to be carried out on 1500 Volt negatives outside substations, precautions must be taken to ensure that:

- The return path for current from trains and other equipment is not broken.
- Workers do not bridge across a broken negative connection.
- Workers are not exposed to dangerous voltages between negative (rail) and earth.

4 Work Which Requires the Substation Negative to be Disconnected from Rail

Refer to *PR D 78304 Work on 1500 Volt Negative Equipment Inside Substations* Section 3.1 Work requiring the substation negative to be disconnected from rail, for details.

5 Negative Bus Rail Termination (Track Side Negative Bus)

The Negative Bus Rail Termination, commonly referred to, and hereafter referred to as the Track Side Negative Bus, is the interface between the substation negative(s) and the traction rail.

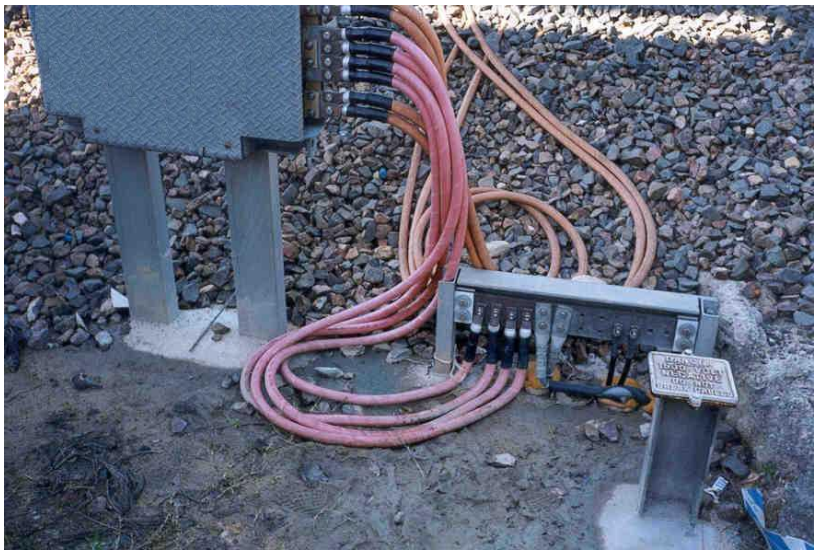

Figure 1: Example of a Track Side Negative Bus

The Electrical discipline is responsible for:

- The installation and maintenance of cables from the Substation to the Track Side Negative Bus.
- The **running** of cables from the Substation to the Traction Rail, when a Track Side Negative Bus does not exist.

The Signalling and Control Systems discipline is responsible for:

- The installation and maintenance of Cables from the Track Side Negative Bus to the Traction Rail.
- The **connection** of the cables to the Traction Rail, when a Track Side Negative Bus does not exist.

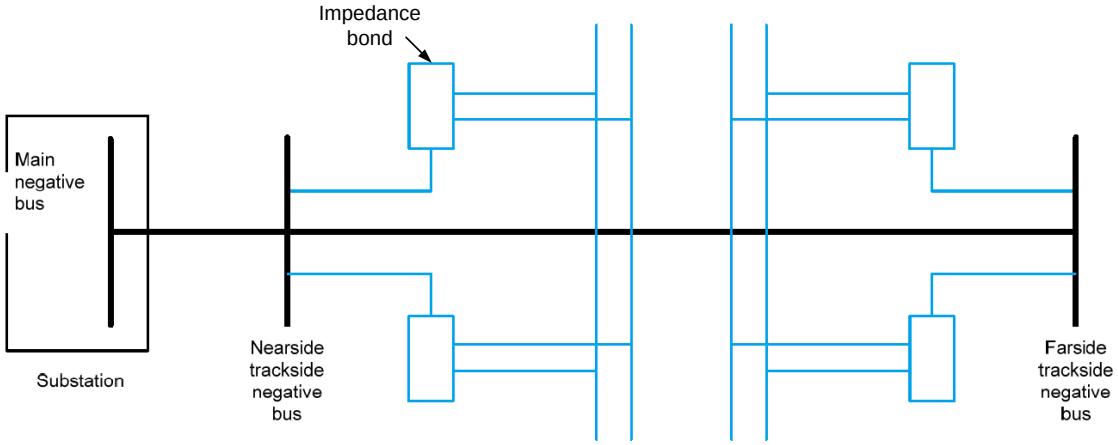

Figure 2: Typical negative track connections

6 OHW Permanent Rail Connections

All permanent OHW rail connections shall be done in accordance with an Approved and Accepted Signal Design. Rail bond welding shall be done by workers appropriately qualified in accordance with TfNSW Engineering Specification *SPG 0709 Traction Return, Track Circuits and Bonding*. Connection of the permanent rail connections to rail shall be done by the Signal Engineer in accordance with SPG 0709.

These requirements are applicable to:

- Rail connections from trackside negative bus.
- Rail connections from OHW structure spark gaps.
- Rail connections from OHW switches.
- Provisions for permanent connection points for portable rail connections.

7 Work Which Requires the Substation Negative to be Disconnected from the Track Side Negative Bus

7.1 Breaking, making or working on a SINGULAR substation negative connection, i.e. not all the connections, to the Track Side Negative Bus

With the substation live, a singular substation negative connection may be disconnected, connected or worked upon for a short time only. This time period shall be a maximum of one shift only.

Any replacement of a cable or connection shall be a 'like for like' or as dictated via an Engineering Advice.

When breaking, making or working on a SINGULAR substation negative connection, i.e. not all the connections, to the Track Side Negative Bus:

NOTE

The number of cables and preferred cable size for the equipotential bond shall be identical to the negative cable being disconnected or as that specified in Transport for NSW (TfNSW) standard *T HR EL 20002 ST 1500 V DC Cables and Cable Ratings*.

a. A temporary equipotential bond shall be installed across the break.

b. When disconnecting a "singular" negative connection to the Track Side Negative Bus, it is necessary to ensure that no current is flowing in the connection to be disconnected. Accordingly, prior to disconnecting a negative connection:

   - The negative cable(s) to be disconnected shall be positively identified.
   - A tong tester (DC) shall be used to prove that no current is flowing in the circuit.

c. Persons shall not bridge themselves between the disconnected substation negative cable and the Track Side Negative Bus and should perform any work on an insulated platform.

d. Providing the above instructions 6.1 (a) to (c) are complied with *PR D 78502 Substation Access Permit* would not be required.

NOTE

A Substation Access Permit would only be required for work on the traction return circuit if all connections between the substation negative and the Track Side Negative Bus will be broken. No permit is required if an electrical path from the substation negative to the traction rail remains and its continuity has been checked.

7.2 Breaking making or working on ALL substation negative connections to the Track Side Negative Bus

Refer to PR D 78304 Section 3.1 Work requiring the substation negative to be disconnected from rail, for details.

8 Rail Spark Gaps

8.1 General

Steel structures supporting 1500 Volt equipment are connected to the traction rail at prescribed locations in accordance with TfNSW standard *T HR EL 12005 ST Bonding for 1500 V DC Traction Systems* through a rail spark gap and rail bond.

The rail spark gap device, normally bolted to the structure, is fitted with a spark gap capsule. These capsules are normally open circuit and are designed to short circuit in the event of failure of the 1500 Volt insulation on the structure.

WARNING

The OHW structure is considered safe to touch if the measured structure to rail voltage does not exceed 50Vdc. Workers must not touch the structure and the rail bond at the same time unless the bond and the structure are bridged together with a jumper lead. Refer to SMS SWMS *D2013/80641 Structure Bond Testing and Maintenance* for further information.

8.2 Testing

The voltage across a spark gap must only be measured with an approved test equipment, refer to *SP D 79039 Electrical Tools and Test Equipment*.

If voltage measured across a spark gap is > 2V, the spark gap is considered to be satisfactory. If the voltage measured is in the range of 0 to ≤ 2V, the spark gap could be short circuited or the rail bond could be open circuited.

For details refer to *PR D 78306 1500 Volt DC Overhead Wiring Structure to Rail Voltage Test* and D2013/80641.

8.3 Working on Rail Spark Gap and Bond

Before personally bridging between rail and structures, the rail to structure jumper lead must be used as follows:

a. Install the rail clamp to the foot of the traction rail. Ensure that the clamp bites into metal if rust or other debris is present on the rail foot.

b. Install the insulated clamp onto the overhead wiring structure in a firm and unhesitating manner.

NOTE

The jumper lead must be connected to the same rail as the spark gap rail bond, i.e. the traction rail.

WARNING

The time for which the structure is connected directly to traction rail must be minimised to reduce the risk of electrolysis damage occurring.

When work is completed, remove the jumper lead as follows:

a. Disconnect the insulated clamp from the structure in a quick and unhesitating manner. Do not touch the overhead wiring structure at the same time as touching an exposed clamp or bond.

b. Disconnect the rail clamp from the foot of the traction rail.

9 Electrolysis Bond

Workers must not:

- Bridge between underground services and rail.
- Bridge themselves across a broken electrolysis bond connection.

10 Structure Bond Testing and Maintenance

For work regarding structure bond testing and maintenance refer to D2013/80641.

11 Reference documents

D2013/80641 Structure Bond Testing and Maintenance

PR D 78304 Work on 1500 Volt Negative Equipment Inside Substations

PR D 78306 1500 Volt DC Overhead Wiring Structure to Rail Voltage Test

PR D 78502 Substation Access Permit

PR S 40027 Traction Return (1500V DC)

SPG 0709 Traction Return, Track Circuits and Bonding

T HR EL 12005 ST Bonding for 1500 V DC Traction Systems

T HR EL 20002 ST 1500 V DC Cables and Cable Ratings