Sydney Trains

Engineering System Integrity
Engineering Instruction
Electrical Engineering

EI E 17-04 V3.0

OHW Structure to Rail Bonding – Rail Spark Gaps

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

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Audience:

- Electrical Asset Engineers
- Electrical Construction Staff
- Electrical Maintenance Staff
- Earthing and Bonding Maintenance Staff
- Electrical Design Engineers
- Authorised Engineering Organisations
- Transport for NSW – I&S Electrical Staff
- ICON Electrical
- PAM Director Energy Networks and Systems

Main Points:

- Mark 3 Rail Spark Gap (DEHN) to be used as the preferred spark gap arrangement for 1500 Volt OHW Structures.
- Work on Rail Spark Gaps to be in accordance with *PR D 78303* Electrical Engineering Document.
- Mark 3 Rail Spark Gap installation Megger Test required.
- Unit to be sprayed with “Cold Gal” to deter theft.

Primary Affected Document: **PR D 78303 Work on 1500 Volt Negative Equipment Outside Substations**
PR D 78306 1500 Volt DC Overhead Wiring Structure to Rail Voltage Test
SWMS D2013/80641 Structure Bond Testing and Maintenance

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Document Control

Version	Date	Summary of change
3.0	27/10/2025	ASA updated to PAM (Prioritisation and Asset Management)

Scope

This Engineering Instruction (EI) introduces into use and provides installation and maintenance requirements for the new DEHN Rail Spark Gap and renaming of the existing Rail Spark Gaps used for Bonding 1500 Volt OHW Structures to rail.

This Engineering Instruction supersedes *Engineering Instruction EI E 17/01*, *Electrical Technical Notes ETN 04/05* and for Rail Spark Gaps only *ETN 09/19*.

It is noted that this EI has been superseded by the Standard Operating Instruction (SOI) *NMD-ME-INS-538* and is to be withdrawn upon the expiry of the current review period.

Background

Structures supporting 1500 Volt equipment are connected to the traction rail at prescribed locations in accordance with Electrical Standard *TS 03743 Bonding for 1500 V DC Traction Systems*.

There are currently two Rail Spark Gap arrangements in service, namely:

- The most common by far is the brass capsule on drawing *EL 0585360* now called the “Mark 1 Rail Spark Gap”.
- For some selected locations – Ferraz Unit on drawing *EL 0590277* now called the “Mark 2 Rail Spark Gap”.

The new DEHN (MA SDS Mast Adaptor Part Number 723199 and SDS1 spark gap capsule Part number 923110) Rail Spark Gap now called “Mark 3 Rail Spark Gap” was PAM Type Approved under approval number E00032. It is capable of discharging surges without forming a permanent short circuit and returning back to its original state. A permanent short circuit or failure of this unit will only occur if the surge exceeds its maximum limits.

Some of these Mark 3 Rail Spark Gaps were predominately trialled in the Blue Mountains and some other selected locations to drawing EL0191530 using a different housing and mast attachment. However, the Type Approved Mark 3 Rail Spark Gap to drawing EL0573512 looks different but operates the same way using the same capsule (item 1) DEHN SDS1. Some Transport Projects may have already installed the Mark 3 Rail Spark Gap for their work.

The manufacturer of the Mark 1 Rail Spark Gap capsule has stopped manufacturing this unit. Therefore, the Mark 1 Rail Spark Gap will not be used for future construction, modifications or capsule maintenance corrective actions. Old stock can be used up where available.

Traditionally track failures (track circuit failures) are sometimes attributed to failed Mark 1 Rail Spark Gaps capsules. Now with Mark 3 Rail Spark Gaps these track failures may only be seen momentarily and automatically reset unless it permanently short circuits due to failure of the unit.

The related drawings are:

- Mark 1 Rail Spark Gap (Old Spark Gap) – EL0585360
- Mark 2 Rail Spark Gap (Ferraz) - EL0590277
- Mark 3 Rail Spark Gap (DEHN) – EL0573512
- Bonding to rail for Mark 1 and Mark 3 – EL0583866.

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Action Required

1. Maintenance, Construction and Design are to use the "Mark 3 Rail Spark Gap" shown on drawings EL0573512 and EL0583866 for all new and existing installations as per Electrical Standard *TS 03743*. This will be the preferred Rail Spark Gap and is to be installed as per the attached installation instructions for the MA SDS M12 Mast Adaptor. It is to be noted that connection to the appropriate rail to be determined by the Signalling Engineer and in accordance with *TS 05168*.

2. When installing a new Mark 3 Rail Spark Gap, or replacing the SDS 1 Voltage Limiter (Red Capsule Part Number 923110) within it, or suspect unauthorised tampering with the unit, the following Insulation Resistance (Megger) test is required across the cable connection side and the dome enclosure cover (across the spark gap). This is to test for the presence and correct operation of the SDS1 voltage limiter capsule and is to be conducted with the rail bond cable disconnected:

    a. Apply 250 V d.c. – Acceptable equals an open circuit indication or high insulation resistance (Minimum 1MΩ)

    b. Apply 1000 V d.c. – Acceptable equals a short circuit (the unit conducts at 600 V d.c. +/- 20%). The unit will need a brief time to reset before the next step. It is noted that from 2023, the manufacturer has updated the DC sparkover voltage limit for the Mark 3 spark gap from 600 V ±20% to 700 V –14% / +28%, while retaining the same part number. Therefore, these new limits should be used when testing new devices accordingly.

    c. Apply 250 V d.c. again – Acceptable equals an open circuit indication or high insulation resistance (Minimum 1 MΩ)

    d. If any of the above tests a, b or c are unacceptable then replace the capsule and carry out the above tests again.

3. The Mark 3 Rail Spark Gap is a shiny brass coloured unit, therefore upon installation the unit is to be sprayed with "Cold Gal" to deter theft of the unit. If repair work removes some of the original Cold Gal paint, simply touch it up with Cold Gal. Ensure that the external insulating sleeves are not compromised during this process.

4. Staff carrying out maintenance or modifications to existing "Mark 1 Rail Spark Gaps" is to replace them with the Mark 3 Rail Spark Gap only:

    a. When the bond is being modified due to a project or

    b. When a capsule fails and no existing stock available or

    c. In locations where there are frequent spark gap failures.

5. Staff engaged in work or testing of Rail Spark Gaps need to be conducted in compliance with Sydney Trains Engineering Procedure *PR D 78303 Work on 1500 Volt Negative Equipment Outside Substations* in particular Sections 7 and 9.

6. When a Mark 2 Rail Spark Gap – Ferraz unit is encountered, please contact Electrical Engineering for advice or follow the approved earthing and bonding design provided for your project.

7. Logistic Stores are to release for general issue the "Mark 3 Rail Spark Gap" units under stock codes 2095487 and 2095495 and set up stock levels for these stock codes.

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8. Asset Management to update relevant databases and establish funding to allow for changing Rail Spark Gap units from Mark 1 to 3.

9. Rail Spark Gap defects are to be recorded in Teams3 or from July in Transport Equip.

10. Engineering and System Integrity's Electrical Engineering to arrange update of relevant documents to include the Mark 3 Rail Spark Gap, namely:

    a. Electrical TMP's including updating the name for the Mark 1 and 2 Rail Spark Gaps

    b. PR D 78303 Work on 1500 Volt Negative Equipment Outside Substations

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

    d. *SWMS D2013/80641 Structure Bond Testing and Maintenance.*

11. Engineering and System Integrity's Electrical Engineering to arrange update of drawing EL0583866 to clearly show how to connect other OHW Structures in a daisy chain configuration onto one Rail Spark Gap, where required by design.

List of Reference Drawings

1. Mark 1 Rail Spark Gap – EL0585360
2. Mark 2 Rail Spark Gap (Ferraz) - EL0590277
3. Mark 3 Rail Spark Gap (DEHN) – EL0573512
4. Bonding to rail for Mark 1 and Mark 3 – EL0583866

Contact

Technical Specialist Earthing Bonding or Principal Engineer Power Systems

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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

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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

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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.

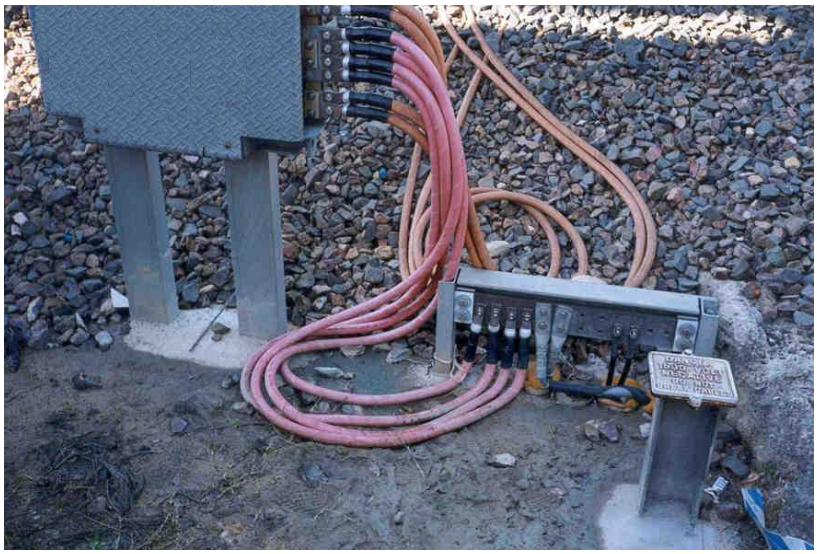


Figure 1: Example of a Track Side Negative Bus

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.

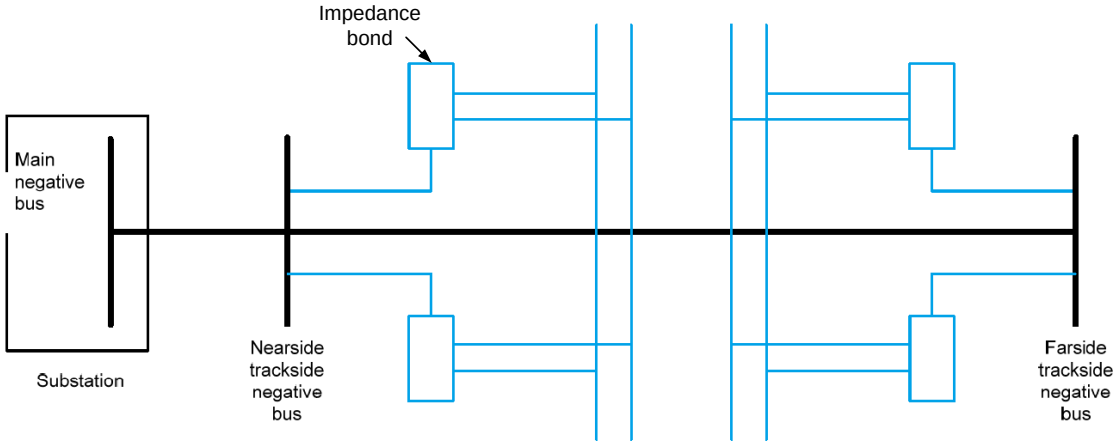


Figure 2: Typical negative track connections

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

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