

Engineering Procedure
Electrical Distribution Unit

PR D 78305

1500 Volt Operating Procedures

Version 1.1

Date in Force: 19 February 2019

Procedure

Approved by: Nadine Youssef
 Associate Director
 Electrical Distribution Unit
 Engineering System Integrity

Authorised by: Jonathon McKinnon
 Engineering Technical
 Publications Manager
 System Integrity Unit

Disclaimer

This document was prepared for use by persons in connection with works on or near the rail network electricity system operated by Sydney Trains. Sydney Trains makes no warranties, express or implied, that compliance with the contents of this document shall be sufficient to ensure safe systems or work or operation. It is the document user's sole responsibility to ensure that the copy of the document it is viewing is the current version of the document as in use by Sydney Trains. To the extent permitted by law, Sydney Trains excludes any and all liability for any loss or damage, however caused (including through negligence), which may be directly or indirectly suffered in connection with the use of this document.

Copyright

The information in this document is protected by copyright and no part of this document may be reproduced, altered, stored or transmitted by any person without the prior consent of Sydney Trains.

Document control

Version	Date	Author/ Prin. Eng.	Summary of change
1.0	16 May 2016	Chris Leung	First issue as a Sydney Trains document, rebranded from previous RailCorp SMS-06-EN-0570 V2.1
1.1	19 February 2019	Nick Loveday	Updated roles and position names to reflect the current organisation

Summary of changes from previous version

Summary of change	Section
<i>Updated Approved by for PR D 78305 to Associate Director Electrical Distribution Unit</i>	<i>General Change</i>
<i>In (b), the position "Territory Engineer" has been updated with "Regional Electrical Engineer"</i>	<i>7.4.11.</i>

Table of Contents

1. Purpose and Scope	4
2. Isolation of 1500 Volt Equipment	4
2.1. Rectifiers.....	4
2.2. Harmonic Filters.....	5
2.3. 1500 Volt Positive Busbar	5
3. Operation of Overhead Wiring Isolating Devices	5
3.1. Sectioning Switches.....	7
3.2. Isolating Links	8
3.3. Two-Position Combined Isolating and Rail Connecting Field Switch	9
3.4. Three-Position Combined Isolating and Rail Connecting Switches	11
3.5. Isolating and Rail Connecting Switch Pairs	16
3.6. 1500 Volt Withdrawable Type Circuit Breakers	18
3.7. Removal of Bridges.....	19
4. DANGER Tags.....	19
5. Identification of Traction Rail.....	19
6. Proving Dead 1500 Volt Equipment.....	19
6.1. General.....	19
6.2. Proving Dead 1500 Volt Cables	20
6.3. Proving Dead for Equipment Inside Substations	20
6.4. Proving Dead for Equipment Outside Substations.....	21
6.5. Proving Dead 1500V OHW Sections (Testing When Working From EWP, Bucket or Ladder)	22
7. Approved Test Equipment	23
7.1. RailCorp Substation 1500V DC 2-Pole Hollow Tube Conduit (HTC) Tester	23
7.2. Dehn PHE/GII (Dehn) Tester	24
7.3. Line to Rail (LR) Tester	27
7.4. Hivotech 1500V DC OHW Tester.....	29
7.5. Portable Insulated Operating Sticks	39
7.6. Rail Clamp Specification	40
8. Rail Connecting Equipment	42
8.1. Where Rail Connections Shall Be Applied	42
8.2. Methods of Rail Connecting	43
8.3. Rail Connection Application Guide.....	44
8.4. Portable Rail Connecting Equipment.....	45
8.5. Temporary Rail Connections.....	47
8.6. Rail Connecting Switches	48
8.7. Rail Connecting Links	49
8.8. Equipment Subject to Fault Currents.....	50
9. References	50

1. Purpose and Scope

To describe the operating procedures that are applicable to RailCorp's 1500 Volt system.

2. Isolation of 1500 Volt Equipment

1500 Volt equipment shall be isolated from all sources from which it could be made live, by providing at least one visible break in each source.

Isolation may be achieved by:

- Opening of switches or links, or
- Racking out circuit breakers, or
- Removal of bridges.

The opened switches or links and racked out circuit breakers that provide these breaks, shall be DANGER tagged (refer section 4).

Jumpers that have been removed to effect isolation are not required to be DANGER tagged or locked.

An isolating device shall be locked with a Special Lock (refer *PR D 78104 Locking Systems for Electrical Equipment*) for the duration of the isolation:

- (a) Where it is outside of a substation or sectioning hut, or
- (b) Where the isolating device has facilities for locking, and provided that the action of locking does not bring the Authorised Person within the minimum Safe Approach Distances (SAD) of exposed electrical equipment as specified in *PR D 78700 Working around Electrical Equipment*.

When an isolating device can also be operated by remote control, the remote control shall be made inoperative and the means of ensuring that it remains inoperative shall be DANGER tagged (refer section 4).

Operation of equipment in substations and sectioning huts shall be carried out in accordance with Local Instructions.

Switches or links that are used to provide an isolating function may also incorporate a rail-connecting feature, either as an interlocked pair or as a single combined unit.



Warning

An open circuit breaker is not a sufficient isolating break. The circuit breaker shall be racked out or the associated switch or links opened.

2.1. Rectifiers

To isolate a rectifier, the following steps shall be carried out whilst ensuring that no person comes within the minimum SADs:

- (a) Isolating the High Voltage supply to the rectifier transformer.
- (b) Racking out the DC circuit breaker or opening the positive link.
- (c) Opening the negative link.
- (d) Isolating the Low Voltage AC and DC supplies as required.



Warning

*The negative link shall not be opened before the DC circuit breaker is racked out or the positive link is opened.
The negative link shall be closed before the DC circuit breaker is racked in or the positive link is closed.*



Warning

Rectifiers contain capacitors that shall be isolated and discharged in accordance with Local Instructions or PR D 78102 Electrical Hazards and Warnings, section 8 Capacitors, and then proved dead prior to the commencement of work.



Warning

Ensure that capacitors are isolated, completely discharged (for at least 5 minutes) and "Tested before Touched" prior to working on the equipment.

2.2. Harmonic Filters

Harmonic Filters shall be isolated by opening the link or switch connecting the filter to the 1500 Volt positive busbar and opening the link in the connection to the negative busbar when a link is provided.



Warning

Harmonic Filters contain capacitors that shall be isolated and discharged in accordance with Local Instructions or PR D 78102 Electrical Hazards and Warnings, section 8 Capacitors, and then proved dead prior to the commencement of work.



Warning

Ensure that capacitors are isolated, completely discharged (for at least 5 minutes) and "Tested before Touched" prior to working on the equipment.

2.3. 1500 Volt Positive Busbar

When a 1500 Volt positive busbar is isolated for work, the harmonic filter shall be considered as a source of supply and shall be discharged or isolated from the bus bar.

3. Operation of Overhead Wiring Isolating Devices



Warning

An isolating device with a DANGER tag attached shall not be operated.

The following types of Overhead Wiring Isolating Devices are covered in this section:

- Sectioning Switches (refer section 3.1)
- Isolating Links (refer section 3.2)
- Two-Position Combined Isolating and Rail Connecting Field Switches (refer section 3.3)
- Three-Position Combined Isolating and Rail Connecting Switches (refer section 3.4)
- Isolating and Rail Connecting Switch Pairs (refer section 3.5)
- 1500 Volt Withdrawable Type Circuit Breakers (refer section 3.6)

In addition, isolations can sometimes be achieved by removal of bridges (refer section 3.7)

Operation of all isolating devices shall be carried out under the direction of the Electrical System Operator (ESO) and agreed to by the Authorised Person undertaking the switching operation.

All communications between the ESO and the Authorised Person shall be in accordance with the communications protocol that is set out in *PR D 78103 Electrical Operational Communication and Records*.

The ESO shall instruct the Authorised Person:

- (a) Which isolating device is to be operated, and
- (b) The operation to be undertaken.

The Authorised Person shall confirm either that these instructions match the written schedule that they have, or they shall record the instructions in writing.

All off-load isolating devices shall not be opened before their controlling circuit breakers have been opened. Where practicable, prove dead these devices before opening, refer section 6.

The Authorised Person shall then ensure that the isolating device is the correct one by checking the location and the label on the isolating device against the written schedule or instruction.

The Authorised Person shall also check that the isolating device is in the expected condition (open, closed, racked in or racked out) prior to the operation. In the case of a switch, this shall be done by checking both the blade and handle positions. In the case of a link, this shall be done by checking the blade position.

When operating a field switch, the Authorised Person shall stand on the Operator's platform, where installed.

The Authorised Person shall then carry out the operation required.

After the required operation has been carried out, the Authorised Person shall advise the ESO of the operation that has been carried out.

3.1. Sectioning Switches

3.1.1. Description

Sectioning Switches are used to isolate a section of the 1500 Volt overhead wiring (OHW) from another section or from an aerial or cable feeder.

Sectioning Switches may be hand lever or motor operated. They are of a pivoted blade construction and have two positions, labelled "CLOSED" and "OPEN".

Table 1 – Pivoted Blade Switch Positions

State of electric circuit through switch	Switch Position
Continuous	"CLOSED"
Broken	"OPEN"

Sectioning Switch isolation is carried out as follows:

- (a) Hand lever operated switches are fitted with a locking pin for locking the switches in either position. The locking pin is secured by a padlock.
- (b) Motor operated switches are fitted with a padlock for locking the door of the motor cubicle.

3.1.2. Sectioning Switch Operating Procedure

Hand Lever Type

The Authorised Person shall:

- (a) Remove the padlock and locking pin from the switch-operating handle. Where required, use the locking pin to secure the sections of the hinged type handle.
- (b) Move the switch handle to the required position with a single unhesitating movement.
- (c) Check that the switchblade has moved to the required position.
- (d) Insert the locking pin in the switch handle and lock the switch in the required position

Note 1:

If operating the switch for isolating purposes, Danger Tag the switch as per section 4.

Motor Operated Type

There are three methods of operation for this type of Sectioning Switch:

- Remotely controlled electrical operation.
- Locally controlled electrical operation.
- Manual operation.

The procedures for operating the motor operated switch are documented in the Local Instructions, which are available in the switch cabinet.

- Movement of the switch between the “OPEN” and “CLOSED” positions (either direction) is by motor operation under remote or local control. Movement between these positions is normally controlled remotely by the ESO. Remote control is disabled by selecting local control. Manual operation can be used when motor operation is not available.
- Where a locking device is located inside the cabinet, it should be used to secure and padlock the switch in the “OPEN” position. The locking device operates an auxiliary switch to disable the motor.

Note 2:

When supply is being restored, a remotely controlled switch shall finally be operated by the ESO to test the control system.

3.2. Isolating Links

3.2.1. Description

Isolating links are installed at some substations and sectioning huts for isolating 1500 Volt OHW sections.

At the majority of these substations and sectioning huts, the links are in the outdoor area. At a few of the older locations, the links are inside the building.

The links, of a pivoted blade construction, are operated by hand using an operating stick and have two positions, “CLOSED” and “OPEN” (which are not labelled).

Table 2 – Pivoted Blade Link Positions

State of OHW Section	Link Position
Live	"CLOSED"
Isolated at that location	"OPEN"

3.2.2. Isolating Link Operating Procedure

To Open the Link

When advised by the ESO that the controlling circuit breaker has been opened by SCADA and that the isolating link is to be opened, the Authorised Person shall:

- (a) Operate the blade of the link vertically from the “CLOSED” to the “OPEN” position with the operating stick, using a double-shuffle action where possible. The double-shuffle involves opening the link momentarily to check if arcing occurs and then closing the link.
- (b) If no arcing was observed, proceed to fully open the link. If arcing was observed, ensure the link remains “CLOSED” and immediately advise the ESO.
- (c) DANGER tag the isolating link, (refer section 4).

At indoor locations, the Authorised Person shall check the written program or instruction to confirm that the correct circuit breaker has opened prior to operating the feeder isolating link and the link shall be operated using a double-shuffle action. Care shall be taken to ensure that the link is fully opened.



Warning

The isolating link shall not be opened before its controlling circuit breaker has been opened. Opening the link under load may cause severe and dangerous arcing. If this occurs, the link should be immediately reclosed.

To Close the link

When advised by the ESO that the isolating link is to be closed, the Authorised Person shall operate the blade of the link vertically from the "OPEN" to the "CLOSED" position, using the operating stick, in a single unhesitating movement.

Care shall be taken to ensure that the link is closed completely and that the safety latch, where fitted, is engaged.

3.3. Two-Position Combined Isolating and Rail Connecting Field Switch

3.3.1. Description

Two-position combined isolating and rail connecting field switches are installed at various sidings and terminating roads to enable the 1500 Volt OHW section that is switched to be isolated and rail connected.

This type of switch is used only when it is the single source of 1500V supply to a subsection, such as in a siding or terminating road.

The switch has a pivoted single blade construction, is operated by a hand lever and has two positions labelled "CLOSED" and "TO RAIL".

Some types of switch prevent the movement of the blade directly from one position to the other, by means of an intermediate stop position in the hand lever mechanism.

Another type of switch has a pivoted two blade construction, having a compound action that causes the isolating blade to move from the "CLOSED" position to an isolated position before the rail connecting blade moves to the "TO RAIL" position. This operation is reversed during the restoration of supply, when this switch is operated from the "TO RAIL" position to the "CLOSED" position.

Table 3 – Pivoted Two Blade Switch Positions

State of OHW Section	Switch Position
Live	"CLOSED"
Isolated at that location	Intermediate (See Note 3)
Rail connected at that location	"TO RAIL"

Two-position combined isolating and rail connecting field switches are fitted with a pin for locking the switches in either position. The locking pin is secured by padlock.

Note 3:

The switches cannot be locked in the intermediate position and shall not be left in this position. The intermediate position is not labelled.

3.3.2. Two-Position Combined Isolating and Rail Connecting Field Switch Operating Procedure

Prior to operating the switch, the Authorised Person shall check that the rail connecting cables are connected to rail. This should be done by:

- an end to end visual inspection, or
- by testing from the rail connecting jaw using the LR Tester.

To operate the switch, the Authorised Person shall:

- (a) Remove the padlock and locking pin from the switch handle. Where required, use the locking pin to secure the sections of the hinged type handle.
- (b) Move the switch handle to the intermediate stop position with a single unhesitating movement.
- (c) Check that the switch blade has moved to the isolated position.
- (d) Move the switch handle horizontally and then to the required position.
- (e) Check that the switch blade has moved to the required position.
- (f) Insert the locking pin in the switch handle and lock the switch in the required position and
- (g) DANGER tag the switch, (refer section 4).

Proving dead is not required before moving this type of switch into the "TO RAIL" position.

(Remainder of page left intentionally blank)

3.4. Three-Position Combined Isolating and Rail Connecting Switches

3.4.1. Description

Three-position combined isolating and rail connecting switches (Three-position switches) enable the 1500 Volt OHW section controlled by the switches to be isolated and rail connected. These switches are installed at most substations and sectioning huts, as a preferred alternative to Isolating Links (refer section 3.2) or Isolating and Rail Connecting Switch Pairs (refer section 3.5).

Table 4 – Three-Position Switch Positions at Substations/Section Huts

State of OHW Section/Subsection	Switch Position
Live	"CLOSED"
Isolated at that location	Open
Rail connected at that location	"TO RAIL"

Three-position switches are also installed at some field locations, as an alternative to Sectioning Switches (refer section 3.1). They enable the rail connection of **one** of the 1500 Volt OHW subsections controlled by the switch.

Three-position switches may be hand lever or motor operated, are of pivoted blade construction and may be set at three positions labelled: "CLOSED", "OPEN" and "TO RAIL".

Hand Lever Operated Type Three-Position Switch

Movement of the hand lever directly from the "CLOSED" position to the "TO RAIL" position, or vice versa, is inhibited by the configuration of the operating handle lever slot which ensures that the operating handle lever is placed into the "OPEN" position prior to being moved from the "CLOSED" position to the "TO RAIL" position or vice versa.

Locking tabs are fitted to allow the locking of the switch in the "CLOSED", "OPEN" or "TO RAIL" position by the use of a padlock.

In the case of three-position switches installed in substations and sectioning huts it is not required that they be locked when in the "CLOSED" position

Motor Operated Type Three-Position Switch

There are three methods of operation for this type of switch:

- Remotely controlled electrical operation
- Locally controlled electrical operation
- Manual operation.

Procedures for operating the motor operated switch are available in the switch cabinet and are documented in Local Instructions.

Motor operated switches are fitted with a padlock for locking the door of the motor cubicle.

- Movement of the switch between the “OPEN” and “CLOSED” positions (either direction) is by motor operation under remote or local control. Movement between these positions is normally controlled remotely by the ESO. Remote control is disabled by selecting local control. Manual operation can be used when motor operation is not available.
- Movement of the switch between the “OPEN” and “TO RAIL” positions (either direction) can be by local motor or manual operation only.
- A locking device, located inside the cabinet, is used to secure and padlock the switch in the “TO RAIL” position. The locking device operates an auxiliary switch to disable the motor.

3.4.2. Three-Position Switch Operating Procedures

3.4.2.1. To Isolate the 1500 Volt OHW at a Substation or Sectioning Hut Using a Three-Position Switch

Hand Lever Type Switches

Before proceeding, the Authorised Person shall be advised by the ESO that:

- (a) The controlling circuit breaker has been opened by SCADA
- (b) EITHER:
 - The circuit breaker for the other end of the section has been opened by SCADA, or
 - Any field switches have been operated as necessary to remove supply from the section
- (c) The three-position switch is to be opened

Then the Authorised Person shall:

- i. Prove dead the blade/upper jaw of the switch in accordance with approved procedures. (See Section 6 Proving Dead 1500 Volt Equipment)

Where the switch is mounted at a high level on a mast, with its blade / upper jaw not easily accessible, it is acceptable that the proving dead can be carried out at the contact wire instead of the switch. This method may only be used when the contact wire in question can be physically traced back to the switch.



Warning

Do not proceed unless the blade/upper jaw of the switch is dead. The switch shall not be opened before the OHW section/sub-section connected to the switch is dead. Opening the switch under load may cause severe and dangerous arcing.

- ii. Operate the switch from the “CLOSED” position to the “OPEN” position with a single unhesitating movement.
- iii. Check that the switchblade has moved to the “OPEN” position and then advise the ESO that the switch is in the “OPEN” position.

Should it be necessary for the Authorised Person to have to leave the immediate vicinity of the switch with the switch in the “OPEN” position as part of this isolation procedure (such as is necessary, for example, when one Authorised Person is switching at multiple locations) then it will be necessary to proceed as follows:

- Special Lock the isolating switch in the “OPEN” position, and
- DANGER tag the isolating switch, (refer section 4).

Motor Operated Type Switches

None are installed at this time.

3.4.2.2. Emergency Switching at a Substation or Sectioning Hut

In a life-threatening situation and provided that ALL circuit breakers (feeders and rectifiers) connected to the 1500V bus-bar are opened by SCADA prior to the switch being opened, it is permissible to move the switch from the “CLOSED” position to the “OPEN” position without first proving dead.

3.4.2.3. To Rail Connect the Overhead Wiring at a Substation or Sectioning Hut using a Three-Position Switch

Hand Lever Type Switch

When advised by the ESO that:

- (a) The other end of the 1500 Volt overhead wiring section concerned has been isolated, and
- (b) The rail connecting switching is to proceed

the Authorised Person shall:

- i. Operate the switch from the “OPEN” position to the “TO RAIL” position with a single unhesitating movement, and
- ii. Check that the switch blade has moved to the “TO RAIL” position, and
- iii. Special Lock the switch in the “TO RAIL” position and attach a DANGER tag (refer section 4), and
- iv. Advise the ESO that the switch is in the “TO RAIL” position.

Motor Operated Type Switches

None are installed at this time.

3.4.2.4. To Isolate the 1500 Volt Overhead Wiring at a Field Location Using a Three-Position Switch

Hand Lever Type

When advised by the ESO that the switch is to be operated to the “OPEN” position, the Authorised Person shall:

- (a) Stand on the Operator’s platform, (where installed), during the operation of the switch handle.
- (b) Remove the padlock and operate the switch from the “CLOSED” position to the “OPEN” position with a single unhesitating movement.
- (c) Check that the switch blade has moved to the “OPEN” position and then advise the ESO that the switch is in the “OPEN” position.

Should it be necessary for the Authorised Person to have to leave the immediate vicinity of the switch with the switch in the “OPEN” position as part of this isolation procedure (such as is necessary, for example, when one Authorised Person is switching at multiple locations) then it will be necessary to proceed as follows:

- Special Lock the isolating switch in the “OPEN” position, and
- DANGER tag the isolating switch, (refer section 4).

Motor Operated Type Switches

The procedures for operating the motor operated switch are available in the switch cabinet and are documented in Local Instruction.

3.4.2.5. To Rail Connect the Overhead Wiring at a Field Location Using a Three-Position Switch

Prior to operating the switch to the “TO RAIL” position, the Authorised Person shall check that the rail-connecting cables are connected to rail. This should be done by either:

- an end to end visual inspection,
- by testing from the rail-connecting jaw using the LR tester.

Hand Lever Type

When advised by the ESO that the rail connecting switching is to proceed, the Authorised Person shall:

- (a) Prove dead the overhead wiring section to be rail connected in accordance with approved procedures. (See Section 6 Proving Dead 1500 volt Equipment)



Warning

*Do not proceed unless the relevant overhead wiring section is dead.
Proving dead is not required if the switch is the only source of supply to the overhead wiring section to be rail connected.*

- (b) Operate the switch from the “OPEN” position to the “TO RAIL” position with a single unhesitating movement,
- (c) Check that the switchblade has moved to the “TO RAIL” position.
- (d) Special Lock the switch in the “TO RAIL” position & attach a DANGER tag (refer section 4), and
- (e) Advise the ESO that the switch is in the “TO RAIL” position.

Motor Operated Type Switches

The Authorised Person shall, when advised by the ESO that the switch is to be operated to the “TO RAIL” position;

- (a) Prove dead the overhead wiring section to be isolated, in accordance with approved procedures. (See Section 6 Proving Dead 1500 Volt Equipment)dead the overhead wiring section to be rail connected in accordance with approved procedures. (See Section 6 Proving Dead 1500 volt Equipment)



Warning

*Do not proceed unless the relevant overhead wiring section is dead.
Proving dead is not required if the switch is the only source of supply to the overhead wiring section to be rail connected.*

- (b) Carry out switching as described in procedures for operating the motor operated “TO RAIL” switch, available in the switch cabinet and documented in Local Instructions.

3.4.2.6. Emergency Three-Position Switch operation at a field location

In a life-threatening situation, and provided that the switch has been operated from the "CLOSED" to the "OPEN" position and the 1500 volt overhead wiring section concerned has been isolated, the switch may be operated to the "TO RAIL" position on instruction from the ESO without first proving dead.

3.4.2.7. To Restore Supply to a 1500 Volt Overhead Wiring Section Using a Three-Position Switch.

Hand Lever Type

When advised by the ESO, to operate the switch from the "TO RAIL" position to the "OPEN" position, the Authorised Person shall:

- (a) Remove the Special Lock and then proceed to operate the switch from the "TO RAIL" position to the "OPEN" position with a single unhesitating movement,
- (b) Check that the switch blade has moved to the "OPEN" position, and
- (c) Advise the ESO that the switch is in the "OPEN" position.

Should it be necessary for the Authorised Person to have to leave the immediate vicinity of the switch with the switch in the "OPEN" position following operation of the switch from the "TO RAIL" position to the "OPEN" position as part of this isolation procedure (such as is necessary, for example, when one Authorised Person is switching at multiple locations) then it will be necessary to proceed as follows:

- Special Lock the isolating switch in the "OPEN" position and
- DANGER tag the isolating switch, (refer section 4).

When advised by the ESO that:

- (a) ALL rail connections have been removed from the 1500 Volt overhead wiring section concerned, and
- (b) The isolating switch is to be operated from the "OPEN" position to the "CLOSED" position, and
- (c) The Authorised Person is to proceed to operate the switch from the "OPEN" position to the "CLOSED" position,

The Authorised Person shall:

- i. Operate the switch from the "OPEN" position to the "CLOSED" position with a single unhesitating movement,
- ii. Check that the switch blade has moved to the "CLOSED" position,
- iii. If outside a Substation, lock the switch in the closed position with a Standard Lock, and
- iv. Advise the ESO that the switch is in the "CLOSED" position.

Motor Operated Type Switches

The Authorised Person shall carry out the following switching operations in accordance with procedures located in the switch cabinet and documented in local instructions:-

- (a) when advised by the ESO, operate the switch from the "TO RAIL" position to the "OPEN" position.
- (b) when advised by the ESO, operate the switch from the "OPEN" position to the "CLOSED" position.

Should it be necessary for the Authorised Person to have to leave the immediate vicinity of the switch with the switch in the "OPEN" position following operation of the switch from the "TO RAIL" position to the "OPEN" position as part of this restoration procedure (such as is necessary, for example, when one Authorised Person is switching at multiple locations) then it will be necessary to proceed as follows:

- Special Lock the isolating switch in the "OPEN" position, and
- DANGER tag the isolating switch, (refer section 4).

3.5. Isolating and Rail Connecting Switch Pairs

3.5.1. Description

Isolating and rail connecting switch pairs (switch pairs) are installed at some sectioning huts and substations to enable the 1500 Volt overhead wiring section, controlled by the switches, to be isolated and rail connected.

The switch pair arrangement consists of two single switches mounted alongside each other and interlocked so that the isolating switch cannot be placed in the "CLOSED" position when the rail connecting switch is in the "TO RAIL" position.

The switches are of a pivoted blade construction and operated by hand levers. Each switch has two positions, "CLOSED" and "OPEN" for the isolating switch and "OPEN" and "TO RAIL" for the rail connecting switch. These positions may not be labelled.

Table 5 – Switch Pair Positions

State of OHW Section/Subsection	Switch	Switch Position
Live	Isolating Switch	"CLOSED"
	Rail Connecting Switch	"OPEN"
Isolated at that location	Isolating Switch	"OPEN"
	Rail Connecting Switch	"OPEN"
Rail connected at that location	Isolating Switch	"OPEN"
	Rail Connecting Switch	"TO RAIL"

3.5.2. To Isolate and Rail Connect the 1500 Volt Overhead Wiring Using Switch Pairs

The following procedure describes the situation where the Authorised Person at a location can commence and complete the isolation and rail connection process at that location without having to leave the location concerned.

When advised by the ESO that:

- (a) The controlling circuit breaker has been opened by SCADA, and advised by the ESO, operate the switch from the "OPEN" position to the "CLOSED" position.
- (b) The isolating switch is to be opened,

then the Authorised Person shall:

- (a) Operate the isolating switch from the "CLOSED" to the "OPEN" position with a single unhesitating movement, and

- (b) Check that the isolating switch blade has moved to the "OPEN" position, and,
- (c) Advise the ESO that the switch pair is in the "OPEN" position.



Warning

The isolating switch shall not be opened before its controlling circuit breaker has been opened. Opening the switch under load may cause severe and dangerous arcing.

When advised by the ESO that

- (a) The other end of the 1500 Volt Overhead Wiring section concerned has been isolated, and
- (b) Proving dead and rail connecting switching is to proceed,

then the Authorised Person shall:

- i. Prove dead the fixed top 1500V contact of the rail connecting switch in accordance with approved procedures. (Refer section 6 Proving Dead 1500 Volt Equipment.)
- ii. Operate the rail connecting switch from the "OPEN" to the "TO RAIL" position.
- iii. Check that the rail connecting switch blade is in the "TO RAIL" position.
- iv. Special lock the rail-connecting switch in the "TO RAIL" position where facilities for locking are provided and provided that the action of locking does not bring the Authorised Person within the minimum SADs of exposed electrical equipment as specified in *PR D 78700 Working around Electrical Equipment*,
- v. DANGER tag the rail-connecting switch (refer section 4).
- vi. Advise the ESO that the rail-connecting switch has been operated to the "TO RAIL" position.

Should it be necessary for the Authorised Person to leave the immediate vicinity of the switch pair with the isolating switch in the "OPEN" position prior to operating the rail-connecting switch from the "OPEN" to the "TO RAIL" position (such as is necessary, for example, when one Authorised Person is switching at multiple locations) then it will be necessary to proceed as follows:-

- Special lock the isolating switch in the "OPEN" position where facilities for locking are provided and provided that the action of locking does not bring the Authorised Person within the minimum safe approach distances of exposed electrical equipment as specified in *PR D 78700 Working around Electrical Equipment*, and
- DANGER tag the isolating switch (refer section 4).

3.5.3. To Restore Supply to the 1500 Volt Overhead Wiring Using Switch Pairs

The following procedure describes the situation where the Authorised Person at a location can commence and complete the restoration process at that location, without having to leave the location concerned.

When advised by the ESO that the rail-connecting switch is to be operated from the "TO RAIL" to the "OPEN" position, then the Authorised Person shall:

- (a) Operate the rail-connecting switch from the "TO RAIL" to the "OPEN" position.
- (b) Check that the rail-connecting switch blade has moved to the "OPEN" position and advise the ESO that the rail-connecting switch is in the "OPEN" position.

When advised by the ESO that:

- (a) ALL rail connections have been removed from the 1500 Volt OHW section concerned, and
- (b) The isolating switch is to be operated from the "OPEN" to the "CLOSED" position,

then the Authorised Person shall:

- i. Operate the isolating switch from the "OPEN" to the "CLOSED" position with a single unhesitating movement,
- ii. Check that the isolating switch blade has moved to the "CLOSED" position, and
- iii. Advise the ESO that the switch is in the "CLOSED" position.

Should it be necessary for the Authorised Person to leave the immediate vicinity of the switch pair during the restoration process with the isolating switch in the "OPEN" position prior to operating the isolating switch from the "OPEN" to the "CLOSED" position (such as is necessary, for example, when one Authorised Person is switching at multiple locations) then it will be necessary to proceed as follows:-

- Special lock the isolating switch in the "OPEN" position where facilities for locking are provided and provided that the action of locking does not bring the Authorised Person within the minimum safe approach distances of exposed electrical equipment as specified in *PR D 78700 Working around Electrical Equipment*.
- DANGER tag the isolating switch (refer section 4).

3.6. 1500 Volt Withdrawable Type Circuit Breakers

3.6.1. Background

At some substations and sectioning huts, isolation of 1500 Volt OHW sections is carried out by the racking out of the controlling circuit breakers. In such instances, the relevant circuit breakers shall be DANGER tagged, refer section 4.

3.6.2. Racking Procedure

The Authorised Person shall carry out the procedure to rack out or rack in the circuit breaker as set out in the Local Instruction held at the substation or sectioning hut.

3.6.3. Withdrawal for Work on the 1500 Volt OHW Section

To ensure adequate isolation of the 1500 Volt OHW section, the controlling circuit breaker should be racked out a distance of at least 300 mm. This may generally be achieved if the front truck wheels of the breaker frame are clear of the cubicle.

3.6.4. Withdrawal for Work on the Circuit Breaker

For work on withdrawable type circuit breakers, the:

- Circuit breaker shall be fully withdrawn, and
- Low Voltage control-wiring plug shall be removed.

The Low Voltage control wiring plug may be reinserted for testing purposes.

Whilst the circuit breaker is fully withdrawn, a *special barrier* shall be placed across the circuit breaker cubicle opening to prevent access to live 1500 Volt equipment.

3.7. Removal of Bridges

Where bridges are to be removed to isolate a portion of overhead wiring or cable, any free ends shall be positively secured to avoid contact with other conductors, structures, masts, guy arrangements or earth etc.

4. DANGER Tags

The devices providing isolating breaks shall be DANGER tagged in accordance with *PR D 78105 DANGER Tags for Electrical Equipment*.

5. Identification of Traction Rail

When proving dead 1500V OHW whilst working on track or when applying portable rail connection on track, this procedure requires the identification of the Traction Rail.

At steel masts with spark gaps, the traction rail is the rail to which the steel masts are bonded.

For all other cases, e.g. wood pole construction or steel construction with missing bonds, a representative of the Signal Discipline shall identify the Traction Rail.



Warning

Care shall be taken when applying rail connections so that they do not short circuit rails and affect signal operation.



Warning

Care shall be taken to ensure that rail connections are not made to portions of rail that are, or will become, disconnected from the traction return path as a result of work.

6. Proving Dead 1500 Volt Equipment

6.1. General

Prior to coming within the Safe Approach Distance (SAD), touching exposed equipment or commencing work on all 1500 Volt equipment, the 1500 Volt equipment shall be:

- (a) isolated for work (refer section 2), and other end of the 1500 Volt Overhead Wiring section concerned has been isolated, and
- (b) proven dead (refer section 6) using Approved Test Equipment (refer section 7), and
- (c) rail connected (refer section 8), where appropriate, and
- (d) included in the Safe Work Area defined by an Electrical Permit to Work, where appropriate.

For 1500V cables, proving dead shall be carried out at cable/exposed equipment junctions.

For discrete items of Substation equipment, Local Instructions shall be followed concerning proving dead procedures and designated test points to be used. These procedures usually only require proving dead at the time of isolation prior to work commencing.

For 1500V OHW, proving dead shall be performed immediately prior to rail connecting to ensure that rail connections can be safely applied. However, proving dead may also be required at additional times during the progress of the work.

The RailCorp Substation 1500V DC 2-Pole Hollow Tube Conduit (HTC), Dehn PHE/GII (Dehn) are high impedance testers. High impedance test equipment can be used for proving dead 1500V equipment when the test point at which the proving dead is performed is not part of an OHW Section/Subsection. This test equipment cannot generally be used for proving dead 1500V equipment when the test point at which the proving dead is performed is part of an OHW Section/Subsection. This is because low source resistance often exists between isolated 1500V OHW Sections/Subsections and other live 1500V OHW Sections/Subsections. The Hivotech 1500V DC OHW Tester shall be used for this purpose.



Warning

Although electrical equipment or a section of OHW is "dead" or de-energised, this does not mean that the equipment or the section of the OHW is safe to work on.

6.2. Proving Dead 1500 Volt Cables

Prior to work, 1500 Volt dc cables shall be isolated and proven dead at cable/exposed equipment junctions.

Note 4: 1500 Volt dc cables shall not be proved dead by spiking.

Before cutting an isolated 1500 Volt dc cable at a worksite that is remote from the worksite location where the cable was proved dead, it shall be identified as the proved dead cable at the worksite by two independent methods. Identification methods include, but are not limited to:

- (a) visual tracing
- (b) utilisation of an electronic cable tracing device; or
- (c) reference to labelling on the cable or the cable enclosure.

6.3. Proving Dead for Equipment Inside Substations

The proving dead of isolated 1500V equipment inside substations can usually be performed at test points that are **not** part of an OHW Section/Subsection, e.g. rectifiers, 1500V busbars and harmonic filter components such as capacitors.

The capacitors of harmonic filters shall also be proved dead to ensure that they have been discharged.

The Approved Test Equipment for use inside substations for testing at test points that are **not** part of an OHW Section/Subsection is a high impedance tester and is the:

- 1) RailCorp Substation 1500V DC 2-Pole Hollow Tube Conduit Tester, or
- 2) Dehn PHGE/GII Tester.

However, the proving dead of some isolated 1500 Volt equipment inside substations includes proving dead at test points which are part of an OHW Section/Subsection; such as the overhead wiring isolating devices identified in section 3.

Consequently, the Approved Test Equipment for use inside substations for testing at test points that **are** part of an OHW Section/Subsection is a medium impedance tester and is the Hivotech 1500V DC OHW Tester.

All testers shall be checked immediately prior to proving dead and at the completion of the test in order to ensure that the tester was functional throughout the proving dead test. Where the tester has an in-built self test facility, this shall be used for this purpose. Where the tester does not have an in-built self test facility, this check shall be done on known live 1500 Volt equipment.

Refer to section 7 for Approved Test Equipment details and instructions for use.

6.4. Proving Dead for Equipment Outside Substations

Sections of the 1500 Volt OHW system that have been isolated for work shall be proven dead using the appropriate Approved Test Equipment immediately prior to applying rail connections.

The rail to be utilised for the proving dead process is the Traction Rail (refer section 5) associated with the section of 1500 Volt OHW to be isolated, rail connected and worked on. Should that particular Traction Rail not be available, i.e. a section of rail has been removed, the Traction Rail of the nearest adjacent track can be utilised as the Traction Rail; and hence connected to the rail connection lead (negative return) of the Approved Test Equipment for the proving dead procedure.

Should an associated/adjacent Traction Rail not be available for the prove dead procedure then the Authorised Person is to prove dead the 1500 Volt OHW section to be worked on by visual tracing of the 1500 Volt OHW from another location where the prove dead test procedure can be successfully completed.



Warning

An OHW supporting structure or earth stake shall not be utilised for connection to the rail connection lead (negative return) of the Approved Test Equipment.

The Hivotech 1500V DC OHW Tester is used to determine if a section of the 1500 Volt OHW system:

- i. is live or dead; or
- ii. **after** isolation is safe to rail connect, or
- iii. safe to work on **under** Permit conditions.

Refer to section 7 for Approved Test Equipment details and instructions for use.

Note 5: *When proving dead in outdoor link areas at the:*

- (i) **Isolating and Rail Connecting Switch Pair** – the metal head shall be connected to the fixed top 1500V contact (not the blade) of the rail-connecting switch to be operated.
- (ii) **Three-Position Combined Isolating and Rail Connecting Switch** – the metal head shall be connected to the blade of the switch.
- (iii) **Isolating link** – testing can only be carried out if there is provision to connect the tester to a Traction Rail. The metal head shall be connected to the jaw (not the blade) of the rail-connecting link to be operated.

6.5. Proving Dead 1500V OHW Sections (Testing When Working From EWP, Bucket or Ladder)

Both at the beginning of a shift and whilst a shift is in progress, the OHW and associated equipment that normally conducts, isolates or may be energised with a voltage of 1500 volts dc shall be tested and proven dead. The test shall be performed prior to coming within the electrical SAD of the OHW and associated equipment as specified in *PR D 78700 Working around Electrical Equipment*. Regardless of work being done under an Electrical Permit, the test shall be performed:

- (a) prior to ascending from track level in an elevated work platform (EWP), bucket or ladder up to OHW height, i.e. the OHW and associated equipment shall be tested and proven dead, or
- (b) if any section insulator, pennant insulator or air gap is to be passed when working from an EWP, bucket or ladder, i.e. the OHW and associated equipment on the other side of that insulator or air gap shall be tested and proven dead, or
- (c) before working at less than the electrical SAD from any mid-track insulator or section insulator, i.e. the OHW and associated equipment on the other side of that insulator shall be tested and proven dead, or
- (d) before working at less than the electrical SAD from any OHW or associated equipment located over an adjacent track to that which the EWP, bucket or ladder is located on, i.e. the OHW and associated equipment over the other track shall be tested and proven dead, or
- (e) before working at less than the electrical SAD from any exposed conductor such as a bare aerial feeder passing over or near the track on which the EWP, bucket or ladder is located, i.e. the conductor shall be tested and proven dead or proven rail-connected.

Note 6: Only the Hivotech 1500V DC OHW Tester may be used for testing when working from an Elevating Work Platform, Bucket or Ladder.

Refer to section 7 for Approved Test Equipment details and instructions for use.



Warning

If a wire has not been visually traced from a set of rail connections, the wire shall be considered live until tested and proven dead or proven rail-connected. When working from an Elevating Work Platform, bucket or ladder, an insulated operating stick shall be used when using the Hivotech 1500V DC OHW Tester.

(Remainder of page left intentionally blank)

7. Approved Test Equipment

7.1. RailCorp Substation 1500V DC 2-Pole Hollow Tube Conduit (HTC) Tester

The HTC Tester is to be used within substations ONLY to determine if 1500V DC equipment, located indoor or outdoor, is live or dead. The HTC tester is NOT to be used outside in wet weather and shall ONLY be held below the hand guards.



7.1.1. Functional Test

The HTC tester does not have a self-test facility and as such it shall be functionally tested both before and after test on a known live 1500V DC voltage source.

To functionally test the HTC tester, place the negative probe (the probe without the indicating meter) on the designated rail-connected point. Place the positive probe (the probe with the indicating meter) on the known live 1500V DC source and ensure that the indicating meter reads 1500V (nominal).

7.1.2. Operation of the HTC Tester

The following sequence shall be followed when operating the HTC Tester:

- (a) Verify that a "Defect / DANGER" tag is not attached to the equipment and the equipment is in a serviceable condition.
- (b) Perform Functional Test as per section 7.1.1.
- (c) Place the negative probe (the probe without the indicating meter) on the designated rail-connected point.
- (d) Place the positive probe (the probe with the indicating meter) on the equipment to be tested.



Warning

During use caution shall be taken to ensure that the negative probe is kept clear of any other object other than the designated rail-connected point

- (e) The HTC Tester is polarity dependent, i.e. the 'Voltage present' can only be indicated with the negative probe connected to the negative and the positive

probe connected to the positive. If the probes are reversed, the meter will be reverse biased and damaged.

- (f) Live equipment is indicated by a deflection of the indicating meter.
Dead equipment is indicated by no deflection of the indicating meter.
- (g) Repeat the Functional Test as per section 7.1.1

Note 7: The HTC Testers were made by Sydney Trains' Rail Equipment Centre of Strathfield but with no more units being made in-house, they are being progressively phased out and replaced by other commercially available high impedance 1500V DC testers such as the Dehn PHE/GII Tester.

7.2. Dehn PHE/GII (Dehn) Tester

The Dehn PHE/GII Tester is to be used within a substation ONLY to determine if 1500V DC equipment (located indoor or outdoor) is live or dead.



The Dehn Tester is a suitable replacement for the RailCorp Substation DC 2 Pole Hollow Tube Conduit Tester and can be used in wet weather. Extension probes are available and rated up to 7.5 kV dc, instead of 1500V dc. There is a label stipulating that the extension probes are to be used under dry conditions only. However, it is acceptable that the extension probes are to be used for wet weather provided that they are used in conjunction with the Dehn Tester instead of on their own. There is no need to remove the label on the extension probes.

Note 8: The Dehn Tester shall not contact a live part permanently for more than 1 minute. The Dehn Tester shall be grasped by its handle below the hand guard. If needed, an extension probe provided by the same supplier can be attached to the Tester.



7.2.1. Self Test

The Dehn Tester does not have an 'ON – OFF' switch. Activation of the tester always commences with pressing of the test button as part of the Self Test.

The Dehn tester does have a self-test facility. To perform the Self Test it is not necessary to connect the red and blue probes together.

The red lamp flashes on and off continuously whilst the test button is pressed.

Upon releasing the test button, the red lamp is off and the green lamp comes on for approximately 40 – 60 seconds indicating the tester is ready for use. The Dehn Tester is to be used during this period.

7.2.2. Operation of the Dehn Tester

The following sequence shall be followed when operating the Dehn Tester:

- (a) Verify that a "Defect / DANGER" tag is not attached to the equipment and the equipment is in a serviceable condition.
- (b) Perform Self Test as per section 7.2.1.
- (c) Place the blue-marked (negative) probe on the designated rail-connected point.
- (d) Place the red-marked (positive) probe on the equipment to be tested



Warning

During use caution shall be taken to ensure the blue-marked probe is kept clear of any other object other than the designated rail-connected point

- (e) The Dehn Tester is polarity dependent, i.e. the 'Voltage present' can only be indicated with the blue-marked probe connected to the negative and the red-marked probe connected to the positive.
- (f) 'Voltage present' is indicated by the green lamp going out and the red lamp flashing on and off continuously whilst the positive probe is in contact with a live 1500V conductor.
- (g) Repeat the Self Test as per section 7.2.1

Table 6 – Test Results Using a Dehn PHE/GII Tester

Lamp Indication	Status
Neither green or red lamp on	Self Test has not been carried out – Tester cannot be used or 40-60 second 'ready for use' period has expired
Red lamp flashes on off continuously whilst test button is pressed	Self Test successful
Red lamp flashes on and off continuously whilst testing a conductor	Conductor under test is 'LIVE'
Green lamp on	Ready for use or No Voltage present
Red & Green lamp on together when test button is pressed	Battery Low

{Remainder of page left intentionally blank}

7.3. Line to Rail (LR) Tester

The LR is **restricted** to checking the continuity of rail-connecting cables at 1500V field switches that cannot be visually inspected from end to end. It is **not** to be used for any other purpose such as proving dead.

Historically, the LR Tester was used to determine if a section of 1500V OHW is live, dead (provided that OHW sections adjacent to points of isolation have been proved dead and rail connected) or rail connected.



LR Tester Checking Continuity of Rail-Connecting Cables at 1500V Field Switch

The LR Tester consists of an indicating unit, an insulated rail connection lead, a 1500 Volt test probe with insulated lead and an insulated connection stick. The indicating unit contains two meters mounted in a box in a leather carry case. The meter with the full red scale is labelled “ALIVE” and the meter with the half-clear and half-blue scale is labelled “RAIL”.

A brass bolt and wing nut is provided for the Negative lug and a screw type plug is provided for the 1500 Volt test probe lead. An in-built test facility is incorporated in the side of the box.

Connection of the LR Tester to the field switch side of the rail-connecting cable may only be made using the 1500 Volt test probe which **shall** be attached to the insulated stick provided or to the insulated stick of the rail connection equipment. The 1500 Volt test probe shall never be hand-held whilst touching the rail-connecting cable to be tested.

7.3.1. Test Procedure using a LR Tester

- (a) Self Test the LR Tester as follows:
- i. Verify that a “Defect / DANGER” tag is not attached to the equipment and the equipment is in a servicable condition.
 - ii. Connect the rail connection lead to the Traction Rail and to the LR Tester.
 - iii. Connect the 1500 Volt test probe lead to the LR Tester.
 - iv. Touch the Traction Rail with the probe end.

A reading in the blue scale range of the “RAIL” meter indicates that the LR Tester is functional for the continuity checking of rail-connected cables at 1500V field switches.

Where an LR tester is installed on an elevating platform, connection to the Traction Rail will be via the frame and wheels of the vehicle. The rail connection test may be performed by touching the probe on the frame of the elevating work platform.

- (b) To Test for Continuity of the Rail-Connecting cable.
- i. With the rail connection lead connected to the Traction Rail and to the LR Tester, and the 1500 Volt test probe lead to the LR Tester,
 - ii. Touch the field switch side of the rail-connecting cable with the probe end and note the reading on the RAIL meter. Refer to Table 7 below to interpret the result.

Table 7 – Test Results Using a LR Tester

LR Tester Reading	Overhead Wiring Section
Reading on the RAIL meter is in the blue scale range	Rail-connected cable is continuous
Reading on the RAIL meter is in the half-clear scale range	Rail-connected cable is NOT continuous

{Remainder of page left intentionally blank}

7.4. Hivotech 1500V DC OHW Tester

7.4.1. Introduction

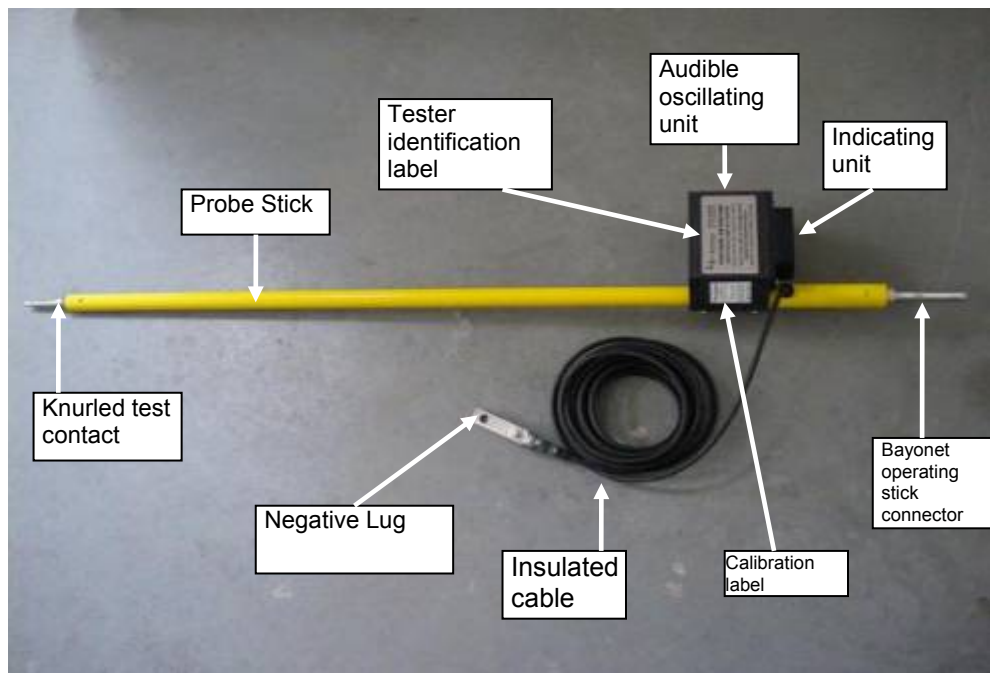
The Hivotech 1500V DC OHW Tester Model DE-300/1, hereafter called the Hivotech OHW Tester, is used to determine if a section of the 1500V OHW system:

- (a) is live or dead; or
- (b) **after** isolation is safe to rail connect or
- (c) safe to work on **under** Permit conditions.

Note 9: *The Hivotech OHW Tester is **NOT** suitable for use within or on substation equipment with the exception of the OHW side of:*

- *Isolating Links (refer section 3.2),*
- *Three-Position Combined Isolating Rail Connecting Switches (refer section 3.4) and*
- *Isolating and Rail Connecting Switch Pairs (refer section 3.5) used as isolation points for OHW.*

The Hivotech OHW Tester consists of an audible and visual indicating unit mounted on a probe stick and an insulated rail connection cable. On the negative end of the probe stick is mounted a bayonet connector which is used to attach the tester to an operating stick. On the positive end of the probe stick is mounted a knurled test contact that is used to make contact with the conductor being tested. The insulated cable is fitted with a negative lug on the remote end of the cable from the probe stick. This lug is used to connect this end of the insulated cable to Traction Rail.



The Hivotech OHW Tester when not in use is to be stored and carried in the aluminium carry case. The carry case also contains a copy of the Operating Instructions and a silicon impregnated cloth.



7.4.2. Indicating unit

The indicating unit consists of:

- One digital LCD screen (0~1999V)
- Green indicating "TEST OK" lamp
- White indicating "VOLTS DETECTED" lamp
- Tester "OFF/ON" switch
- Self test yellow push button labelled "TEST"



The Hivotech OHW Tester is an electronic device and includes a 9 Volt battery. The Hivotech OHW Tester also includes an "OFF /ON" switch which shall be turned "ON" before any of the indications provided by the tester will function.

Immediately the switch is turned "ON", the following will occur:

- A steady "000" will appear in the LCD display
- The LCD backlight will turn on. It will remain on whilst self testing and OHW testing is being performed. (The backlight may not be visible in daylight.)

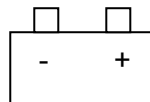
If the Hivotech OHW Tester is left "ON" for approximately 3 minutes without any testing activity, the tester will switch automatically into "SLEEP" mode in order to save the battery. The LCD screen of the tester will then:

- Extinguish the backlight i.e. backlight is off
- Display a blank screen i.e. no numerals or figures

If a tester is in "SLEEP" mode, the tester shall be switched "OFF" and then "ON" before it can be used.

7.4.3. Battery low Voltage

The LCD screen gives visual warning that the Hivotech OHW Tester battery is depleted and in need of renewal. In such a case, the following low battery symbol will appear as a steady indication in the top left hand side of the LCD screen:



If a low battery indication symbol displays on the LCD screen, continue to use the Hivotech OHW Tester for the current shift and then return this Tester to your Team Manager for battery replacement.

7.4.4. Bayonet operating stick connector

This connector has been designed to allow the Hivotech OHW Tester to securely attach to the Bayonet Head of an approved operating sticks such as the Catu CM-4. The Hivotech OHW Tester shall never be hand-held whilst touching the OHW; i.e. hold the operating stick only.

When testing the OHW from the ground, a full length operating stick with a bayonet head suitable for attaching to the Hivotech OHW Tester bayonet operating stick connector shall be used. When testing the OHW before touching from an EWP, a special short operating stick shall be used. For details of approved Sydney Trains 1500V operating sticks, see document *PR D 78307 Inspection and Care of Portable Rail-Connecting Equipment for 1500 Volt Overhead Wiring*.

7.4.5. Knurled test contact

Connection to the 1500 Volt OHW may only be made using the knurled test contact.

The Hivotech OHW Tester knurled test contact is a 60mm long cylindrical shaft with a threaded end which screws into the 1500 Volt probe stick and allows the test contact to be removed and replaced if necessary. The knurling forms a series of sharp ridges that assist the test contact to grip the contact wire. The knurled test contact should be installed finger tight and without the use of any tool.



Knurled Test Contact

7.4.6. Rail connecting clamps

The insulated cable negative lug can be attached to:

- (a) an approved Welder's Magnetic clamp for use on clean rail, or
- (b) an approved Pfisterer rail clamp for use on rusty rail, or
- (c) a bolt on stud on a designated test rail or
- (d) an approved rail connection bolt on an EWP.

Refer photos below.



Negative Lug Attached to Welder's Magnetic Clamp



Negative Lug Attached to Pfisterer Rail Clamp on Rusty Rail

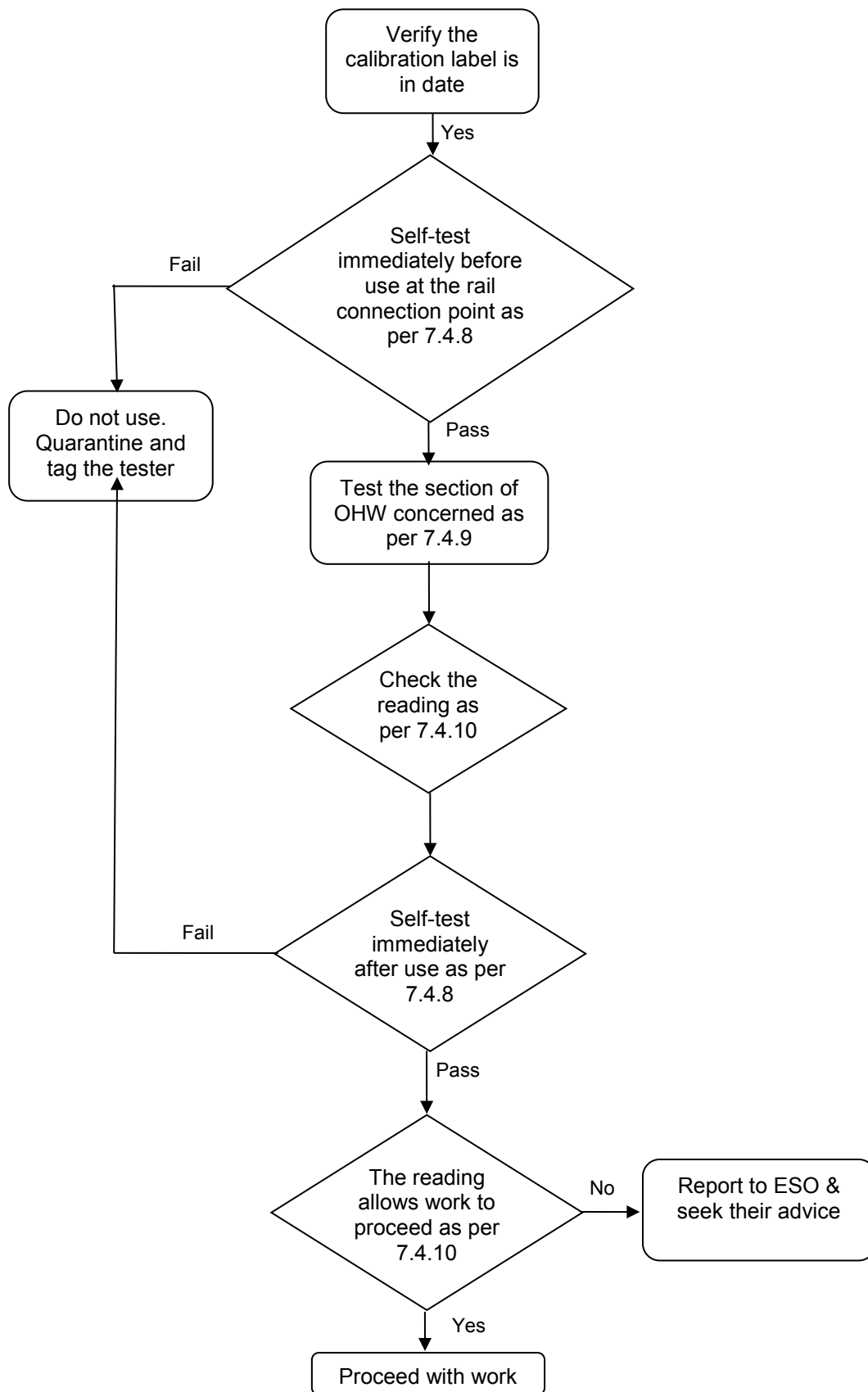


Negative Lug Attached to a Bolt on Test Rail



Negative Lug Attached to an Approved Rail Connection Bolt on an EWP

Hivotech OHW Tester Operating Procedure “Overview” Flow Chart



7.4.7. Correct/Adequate Rail Connection (negative return) for Hivotech OHW Tester

For the duration of use of the Hivotech OHW Tester adequate rail connection (negative return) shall be provided via connection of the insulated cable negative lug. Accordingly, the insulated cable negative lug shall be firmly and securely connected to the Traction Rail via the use of a:

- Welder's Magnetic Clamp attached to the Traction Rail, only if the rail connection point is a clean metallic surface without any rust or paint or,
- Pfisterer Rail Clamp on the Traction Rail, which can be used on a rusty/painted metallic surface if sufficient torque is applied to remove surface rust when connecting,
- Bolt onto a test rail, or
- Approved rail connection bolt on a EWP.

Irrespective of the connection method utilised, the connection made shall ensure good electrical connectivity.

When the Hivotech OHW Tester is used from a hi-rail/EWP, the frame/body of the vehicle is not to be used as part of the negative return for the tester unless the hi-rail/EWP has been specifically approved for this function by the Rail Infrastructure Manager (RIM).

7.4.8. Self Test

Immediately before and after the use of the Hivotech OHW Tester, self testing shall be carried out in the following sequence:

- Apply appropriate rail connection as per 7.4.7
- Turn the 'OFF/ON' switch to the 'ON' position
- Place the knurled test contact onto the same Traction Rail/test rail



Warning

The knurled test contact shall not be placed on the clamp/lug for self test as the conductivity of the rail connecting point shall also be tested.

When pressing the yellow 'TEST' button on the panel, a Hivotech OHW Tester is only considered safe and hence OK to use if all of the following occur, simultaneously:

- The audible alarm oscillates
- The white LED indicating 'VOLTS DETECTED' shall flash on and off
- The green LED indicating 'TEST OK' shall illuminate with a steady glow
- The LCD screen indicates a reading between 195 and 206 volts
- A steady triangular self test symbol is displayed on the bottom left hand side of the LCD screen.

If any one (or more) of these indications does not occur during self testing, then the Hivotech OHW Tester concerned is not to be used for testing.

7.4.9. Operation of the Hivotech OHW Tester

In general, the Hivotech OHW Tester can be operated by 1 person. However, consideration of risks may require additional staff to ensure adequate control of risks such as the:

- Risk of being hit by a train whilst testing. Safe working requirements, re: working in the Danger Zone may require additional persons to control this risk.
- Risk of damage to the Hivotech OHW Tester and associated operating sticks due to being placed on the ground unprotected. Additional staff may be required to hold the Hivotech OHW Tester whilst, for example, the rail connection is applied or removed.

The following sequence shall be followed when operating the Hivotech OHW Tester:

- (a) Verify that a "Defect / DANGER" tag is not attached to the equipment and the equipment is in a serviceable condition.
- (b) Verify the calibration label indicates the equipment is still within the next due calibration date.
- (c) Ensure the knurled test contact is screwed into the Hivotech OHW Tester 1500 volt probe stick; if it is not, the knurled test contact should be installed finger tight and without the use of any tool.
- (d) Attach the Hivotech OHW Tester to the Bayonet Head of an approved operating stick.
- (e) Apply an adequate rail connection as per 7.4.7.
- (f) Self test the tester as per 7.4.8.
- (g) Ensure the Hivotech OHW Tester is switched on and not in the 'sleep mode'. (To re-activate from 'sleep mode', switch the tester off and back on, and then self test again.)
- (h) Contact the 1500V OHW conductor (at a clean spot) with the knurled test contact.
- (i) Check the Reading as per 7.4.10.
- (j) Lower the Hivotech OHW Tester.
- (k) Immediately recheck the Hivotech OHW Tester as per 7.4.8.
- (l) Remove the rail connection.



Warning

The negative lug shall be connected to the Traction Rail before the test probe is raised to make contact with live OHW conductor otherwise the negative lug may become live.

The Hivotech OHW Tester shall never be hand-held whilst touching the OHW to be tested. Hold only the approved operating stick fitted to the tester.

(Remainder of page left intentionally blank)

7.4.10. Check the Reading

If the Voltage measured is below 200 Volts:

- the “Voltage Detected” LED will not illuminate, and
- the audible alarm will remain silent, and
- the detected voltage will be shown on the LCD screen.

If the Voltage measured is 200 Volts or more:

- the “Voltage Detected” LED will flash on and off, and
- the detected voltage will be shown on the LCD screen, and
- the audible alarm will oscillate



Warning

If the Voltage on the conductor is above 1999 Volts:

- *the “Voltage Detected” LED will flash on and off, and*
- *a steady “1” will be displayed on the left hand side of the LCD screen, and*
- *the audible alarm will oscillate.*



Note 10: A reading of “1” on the left hand side of the LCD screen is not to be confused with a reading of 1 Volt which would be displayed as “001”.

A conductor shall not be rail connected unless:

- the conductor has been isolated, and
- the Voltage measured is less than 375 Volts d.c.

A conductor shall not be considered safe to work on unless:

- the conductor has been isolated, rail-connected, is included in the Safe Work Area defined by an Electrical Permit to Work, and
- the Voltage measured was less than 50 Volts d.c.

7.4.11. How to proceed if a voltage greater than 375V is measured:

- In the event that a Hivotech tester being used to prove dead an isolated section / sub-section of OHW reads more than **600V** then the matter shall be reported to the ESO and their advice sought prior to the application of rail connections on the OHW sub-section concerned. The ESO shall complete an Electrical Irregularity (IFMS Report) concerning this event.
- In the event that a Hivotech tester being used to prove dead an isolated section / sub-section of OHW reads more than **375V but less than 600V**, the Authorised Person is to obtain a second Hivotech tester and simultaneously prove dead using both testers at the same location. Note that with both Hivotech testers in parallel they will have similar readings.
 - a) If the voltage measured on both testers is greater than 375V then the matter shall be reported to the ESO and their advice sought prior to the application of rail connections on the OHW sub-section concerned.

The ESO shall complete an Electrical Irregularity (IFMS Report) concerning this event. In addition the District concerned shall:

- Raise a defect in Teams 3 against the OHW section concerned.
- Carry out an inspection of the OHW as soon as practical in accordance with insulator inspection requirements contained in Service Schedules E08014 (for open track), E08032 (for tunnels) and E08012 (for section insulators) for those insulators separating different electrical sections to identify the degraded insulation.
- Carry out all actions necessary to remove the defect from Teams 3.

The technical maintenance plan shall be updated to reflect the above inspection trigger

- b) If the voltage measured is **less than 375V** then rail connecting may proceed without further direction from ESO.

In his event, it will not be necessary to notify ESO of the voltage reading in excess of 375V nor of the need to use a second Hivotech tester. However, the matter (including the initial single Hivotech voltage reading and final double Hivotech voltage readings) shall be reported to the Regional Electrical Engineer responsible for the OHW concerned as soon as practical during normal weekday business hours. Records of such test results shall be kept by the Regional Electrical Engineer and should be used to assist in determining priority for OHW maintenance work.

(Remainder of page left intentionally blank)

Table 8 – Voltage Reading and Subsequent Action Using a Hivotech 1500V DC OHW Tester

Voltage Reading on isolated OHW	Action
> 600V	Report to ESO and seek advice
$375 > x \leq 600V$	Get 2nd Hivotech Tester and simultaneously prove dead at same location. If voltage measured on both testers is > 375V, report to ESO and seek advice If voltage measured on both testers is $\leq 375V$, proceed with rail connection, report to MEE during normal business hours
$\leq 375V$	If conductor is isolated, proceed with rail connection where required
$\leq 50V$	If conductor is isolated, rail-connected, is included in the Safe Work Area defined by an EPTW, then conductor is safe to work on

7.4.12. Testing When Working From Elevating Platforms or Buckets

Refer to section 6.5.

7.5. Portable Insulated Operating Sticks

Portable insulated operating sticks shall be:

- (a) Labelled as suitable for 1500 Volts dc or 11kV ac or higher.
- (b) Labelled as being within the next due test date.
- (c) Inspected for defects prior to use by the Authorised Person in accordance with *PR D 78107 Insulated Sticks, Tools and Equipment used for work On, Near or In the Vicinity of Exposed Electrical Equipment – Inspection, Testing, Care and Maintenance*.
- (d) Held below the hand guard or mark.
- (e) Stored correctly after use in accordance with *PR D 78107 Insulated Sticks, Tools and Equipment used for work On, Near or In the Vicinity of Exposed Electrical Equipment – Inspection, Testing, Care and Maintenance*.

(Remainder of page left intentionally blank)

7.6. Rail Clamp Specification

In the situation where a magnetic clamp is permitted to be used, Electrical Distribution Unit has approved the use of the following magnetic rail clamp with either the LR Tester or Hivotech 1500V DC OHW Tester:



Welder's Magnetic Clamp
(This assembly is for use with both the LR Tester & Hivotech 1500V DC OHW Tester)

When used with the LR Tester the magnetic rail clamp is connected to the tester using the following cable arrangement:



Welder's Magnetic Clamp Assembly
(This assembly is for use with the LR Tester, NOT the Hivotech 1500V DC OHW Tester.)

Where a magnetic rail clamp is not permitted to be used the following Pfisterer rail clamp can be used:



Pfisterer Rail Clamp (Thew & McCann Type No. 360 628 002)

The cable used to attach above clamps onto the LR Tester is specified as follows:

- Cable type - 25 mm², Olex Versolex HD s/c power/welding cable, 0.6/1 kV, flexible XLPE insulated and TPE sheathed to AS/NZS 5000.1 and AS/NZS 1995, preferably with the clear and transparent cable sheath.
- Cable lug - 25 mm², Utilux copper crimp lugs, M12 stud size, Catalogue No. H1416B/50, Tooling #20 38-77CU.
- Cable length - sufficient length to allow the use the LR Tester from ground level and suitable for easy storage.

(Remainder of page left intentionally blank)

8. Rail Connecting Equipment

8.1. Where Rail Connections Shall Be Applied

8.1.1. Adjacent Live Sections or Subsections

A rail connection shall be applied between the worksite and each point of isolation. If there is a live section or subsection of OHW adjoining the section/subsection to be rail connected such that a pantograph could bridge between live and rail connected OHW, then the rail connections shall be placed as close as possible to the points of isolation. This is to ensure the quick and proper operation of the protection equipment should faults occur between the live and rail connected sections.

Additional rail connections shall be applied, if necessary, to ensure that each section of the overhead wiring is rail connected on both sides of the worksite, except for:

- (a) Dead-end sidings.
- (b) Electric Vehicle Maintenance Centres where special instructions apply.

8.1.2. Multiple Feeders

Multiple feeders to a section of OHW from the one substation that attach at different locations (for example at a junction) are to be treated as separate sources of supply. Rail connections shall be applied between the worksite and all sources of supply.

8.1.3. Sectioning Hut Between Worksite and Point Of Isolation

Where there is a Sectioning Hut between the worksite and a point of isolation, rail connections shall be applied to each section/subsection concerned at the Sectioning Hut or between the worksite and the Sectioning Hut.

8.1.4. Break in Overhead Wiring

Additional rail connections shall be applied on each side of a break, if a section of OHW will become discontinuous during the course of work. Alternatively, temporary connections shall be made prior to the work in order to provide a continuous path. These measures are necessary to protect persons against a difference in remote rail potentials transferred to the worksite and persons being exposed to touch potentials.

8.1.5. Rail connecting pantographs on rail mounted Overhead Wiring Maintenance Vehicles

The rail connecting pantograph of a rail mounted OHW maintenance vehicle, where fitted, shall be raised if the wire is "runnable" and it is otherwise practical to do so.

8.1.6. Insulated Track Joints

Rail connections shall not cause insulated track joints to be short-circuited via the OHW.

8.1.7. Lightning

Please refer to *PR D 78101 General Requirements for Electrical Work*, section 17 "Precautions to be undertaken when lightning is imminent" for further information.

8.1.8. 1500 Volt Positive Feeders (Cable Or Aerial) Originating From Substations Or Section Huts

When working on 1500 Volt positive feeders (cable or aerial) originating from Substations or Sectioning Huts, the OHW end of the feeder shall be rail connected. The Substation or Sectioning Hut end of the feeder should be rail connected if switches or links are provided and it is otherwise practicable.

When working on a cable feeder and the work may result in persons or equipment bridging between the core and the screen, the Rail Earth Contactor (REC) shall also be closed for the duration of the work.

8.1.9. Equipment Within A Substation

For work on 1500 Volt equipment within a Substation it is not necessary to rail connect the equipment except in the case of feeders extending outside the Substation. In this case, only the OHW to which the feeder is connected shall be rail connected as close as practicable to the worksite. (Refer to *PR D 78301 Removal and Restoration of 1500 Volt Supply* section 4.1.)

The REC shall also be closed for the duration of work on a cable feeder if the work may result in persons or equipment bridging between the core and the screen.

8.2. Methods of Rail Connecting

Prior to rail connecting, each section/sub-section of the OHW which is to be rail connected shall be isolated (refer section 2) and proved dead (refer section 6).

Rail connecting shall be carried out by either:

- (a) The operation of rail connecting links (refer section 8.7) or switches (refer section 8.6), or
- (b) The application of portable rail connection equipment (refer section 8.4), or
- (c) The installation of temporary rail connections (refer section 8.5).

Where rail connecting links or switches are provided, they shall be used in preference to portable rail connection equipment and temporary rail connections.

Exception: Portable rail connection equipment shall be used in situations where work is to be carried out on the rail connecting links or switches which requires the rail connecting links or switches to be opened.

Switches used to rail connect 1500 Volt equipment shall be DANGER tagged and secured with a special lock (refer section 4).



Warning

In order to prevent an undesirable electrolysis situation, overhead wiring "dead legs" or "pennants" which, by design, are directly connected to an OHW structure (i.e. without insulation) shall not be rail connected to the traction rail for an extended period of time as the "dead leg" or "pennant" is earthed via the overhead wiring structure.

Unless working in accordance with *PR D 78702 Guide for the Stringing of 1500V OHW Conductors in the Vicinity of Existing Electrical Equipment*, rail connected overhead wiring shall not be connected to an earth stake or electrode.

8.3. Rail Connection Application Guide

This section provides a guide to selecting the appropriate method of rail connection. Use the table below to select the particular type(s) of rail connection for a particular application.

Rail Connection Application	Minimum Requirement
Daily/Week-End Isolations - with no requirement for traction return current via rail connected OHW.	Rail connecting links (refer section 8.7) or switches (refer section 8.6), and Portable rail connection equipment (refer section 8.4)
Any isolation with a requirement for traction return current via rail connected OHW.	Rail connecting links (refer section 8.7) or switches (refer section 8.6), and / or Portable rail connection equipment (refer section 8.4) supplemented by Temporary rail connections (refer section 8.5) as required by Electrical Distribution Unit.
Isolations where long sections of rails (> 200m) are removed - Traction return current via rail connected OHW.	Rail connecting links (refer section 8.7) or switches (refer section 8.6), and / or Temporary rail connections (refer section 8.5)

The above table represents the minimum requirement.

Alternative connection methods that differ from the minimum requirements described in the table above shall be approved by Electrical Distribution Unit.

Approved alternative arrangements may be substituted if convenient. For example:

- An arrangement which is mandatory where a requirement exists to carry traction return currents may be used where no such requirement exists.
- An arrangement that is mandatory for a longer time may be used for a shorter time.

8.4. Portable Rail Connecting Equipment

8.4.1. Description of Equipment

The equipment consists of an OHW connection clamp, a rail clamp and approximately 12m of 120mm² flexible insulated cable for connection between the two clamps.

The cable and clamps are used in conjunction with a 4m fibreglass two piece stick fitted with a bayonet socket for attachment and detachment of the OHW connection clamp to the stick. The OHW connection clamp is a screw type, operated by rotating the insulated stick.

A second OHW connection clamp may be connected to the first by a short length of 120mm² insulated cable to allow two sections of overhead wiring over the same track to be rail connected via the one rail clamp. Two sets of fibreglass sticks will be required.

Portable bridging equipment shall not be used at feeding air gaps, to provide continuity of rail connection between sections. If this were done, the equipment could be inadvertently left in place at the end of the job resulting in pantograph damage and preventing the protection system from operating effectively.

For details of the engineering requirements for Portable Rail Connecting Equipment, refer to standard EP 95 20 00 06 SI Methods of Rail Connecting 1500 Volt Overhead Wiring.

8.4.2. Rail Connection Procedure

Portable rail connections shall only be applied at the point of the 1500 Volt OHW that has been proved dead immediately prior to rail connecting. The rail connections shall be applied strictly in the following order:

- (a) Inspect the equipment for no defects, and the condition of the clamp itself to ensure there is no deterioration, overheating or discharge mark.



Condition of a Good Clamp

- (b) Verify that a "Defect / DANGER" tag is not attached to the equipment and the equipment is in a serviceable condition.
- (c) Verify the inspection label indicates the equipment is still within the next due inspection date.
- (d) Check that the cable connections on the OHW connection clamp and the rail clamp are tight.

- (e) Attach the OHW connection clamp to the insulated stick.
- (f) Inspect the condition of the rail, and report any suspected damage, or abnormal condition to the track discipline representative. Proceed if all is OK.
- (g) Remove the ballast underneath the rail to ensure that the rail connection clamp can be properly fitted.
- (h) Connect the rail clamp to the outside of the foot of the Traction Rail, or to the stud that is attached to the rail for that purpose.

Where the rail connection is made to the second rail, the cable shall be run under both rails.

Refer to section 5 for Identification of Traction Rail.

In audio frequency track circuit areas, connect the cable to the point nominated by the Signals Discipline.

- (i) Ensure that the clamp is fully, rather than partially engaged onto the rail. Refer photos following.



Fully Engaged Clamp



Partially Engaged Clamp (no good)

- (j) Tighten the clamp onto the rail firmly and check the firm connection by pulling it to ensure that it does not come loose.
- (k) Connect the OHW connection clamp to the contact wire. This shall be done by drawing the hooked section of the clamp firmly and smartly onto the contact wire. The person applying the rail connections shall maintain the SADs from other conductors to which rail connections are not to be applied, as specified in PR D 78700 Working around Electrical Equipment.
- (l) Tighten the OHW connection clamp by rotating the insulated stick in a clockwise direction.
- (m) Detach the insulated stick from the OHW connection clamp. If the track is to be available for non-electric train running, the cable shall be secured clear of rolling stock. The cable connection plate of the OHW clamp shall be positioned in the same direction as the cable when the cable is to be secured clear of the track.
- (n) Where possible, the portable rail connection shall be secured to the OHW structure, or other suitable structure, clear of the track to permit the clear passage of diesel hauled trains and work trains.

8.4.3. Removal of Rail Connections

The 1500 Volt OHW to rail connections shall be removed strictly in the following order:

- (a) Detach the portable rail connection from the OHW structure, or other applicable structure.
- (b) Attach the insulated stick to the OHW connection clamp.
- (c) Loosen the OHW connection clamp by rotating the insulated stick in an anti-clockwise direction.
- (d) Disconnect the OHW connection clamp from the contact wire.
- (e) Disconnect the rail clamp or cable connection.
- (f) Inspect the equipment for damage as the clamps and lead may have been carrying traction return currents.
- (g) Inspect the rail and report any damage or discharge mark to the track discipline representative.

8.5. Temporary Rail Connections

This section describes the rail connection method for situations where provision shall be made for traction return current to flow via rail connected OHW.

8.5.1. Arrangement of Temporary Rail Connections

Temporary rail connections are those connections that are made via an appropriate bolted clamp arrangement to the catenary **and** a corresponding bolted connection, i.e. not a Pfisterer rail clamp, to either:

- (a) The neutral point of an impedance bond, or
- (b) The trackside negative bus rail at a substation or section hut, or
- (c) Directly to the Traction Rail in a single Traction Rail return area.

For details of the engineering requirements for Temporary Rail Connections, refer to standard EP 95 20 00 06 SI Methods of Rail Connecting 1500 Volt Overhead Wiring.

8.5.2. Installation and Removal of Temporary Rail Connections

This type of connection shall be installed and removed by persons who have signed on to an Electrical Permit.

8.5.3. Installation of Temporary Rail Connections

In order to allow for the erection of the temporary rail connection, the following steps shall be carried out in sequence:

- (a) Portable Rail Connecting Equipment, (refer section 8.4), is erected.
- (b) A Permit is issued to allow for the erection of temporary rail connections.
- (c) Temporary rail connections are then installed immediately adjacent to the portable rail connection equipment (i.e. at the locations listed on the Permit).

The temporary rail connection shall be secured to the OHW structure, or other suitable structure, clear of the track to permit the clear passage of diesel hauled trains and work trains.

When using the direct rail connection to a single traction rail, the rail connection shall be either to a tapered bolt connection (see note 1 of Drawing EL 0011876) or to a welded stud. Only one cable may be terminated to each tapered bolt or stud. The cable shall be connected to the outside of the rail web. Under no circumstances may any form of rail clamp be used.

When connecting to the neutral point of an impedance bond, prior confirmation shall be received from the Signals Engineer that the particular impedance bond(s) to be used are suitably rated to provide an adequate rail connection.

If it is necessary to pass the cable under one rail to connect to the neutral point of the impedance bond, the cable shall be double insulated at the point where it passes under the rail.

- (d) The portable rail connection equipment is removed.
- (e) The Permit issued for installation of the temporary rail connections can then be cancelled.

8.5.4. Removal of Temporary Rail Connections

In order to allow for the removal of the temporary rail connection the following steps shall be carried out in sequence:

- (a) Portable Rail Connecting Equipment (refer section 8.4.3) is erected immediately adjacent to the temporary rail connections.
- (b) A Permit is issued to allow for the removal of temporary rail connections.
- (c) Temporary rail connections are then removed.
- (d) The portable rail connection equipment is removed.
- (e) The Permit issued for removal of the temporary rail connections can then be cancelled.

8.6. Rail Connecting Switches

Rail connecting switches, typically installed outside substations, are of a pivoted blade construction, are operated by a hand lever and have two positions labelled "OPEN" and "TO RAIL". The 1500 Volt OHW section is rail connected with the switch in the "TO RAIL" position.

The switches are fitted with a locking pin for locking the switches in either position by a padlock.

8.6.1. Rail Connecting Switch Operating Procedure

- (a) The ESO shall instruct the Authorised Person which rail connecting switch is to be operated and the action that is required.
- (b) The Authorised Person shall ensure that the rail connecting switch is the correct one, by checking the location and the label on the switch with the program or written instruction. The Authorised Person shall also ensure that the rail connecting switch is in the correct position by checking the blade and handle positions.
- (c) To operate the rail connecting switch from the "OPEN" position to the "TO RAIL" position the Authorised Person shall:
 - i. Check that the rail connecting cables are connected to the rail. This may be done, either by an end to end visual inspection or by testing from the rail connecting jaw using the LR Tester.
 - ii. Check that the 1500 Volt OHW section to be rail connected has been proved dead.
 - iii. Remove the padlock and locking pin from the rail connecting switch handle. Where required, use the locking pin to secure the sections of the hinged type handle.
 - iv. Move the switch handle vertically from the "OPEN" to the "TO RAIL" position, with a single unhesitating movement.
 - v. Check that the switch blade has moved to the "TO RAIL" position.
 - vi. Lock the switch in the "TO RAIL" position by inserting the locking pin and Special Lock in the switch handle.
 - vii. Place a DANGER tag on the operating handle, refer section 4 Danger Tags.
- (d) To operate the rail connecting switch from the "TO RAIL" position to the "OPEN" position, the Authorised Person shall:
 - i. Remove the padlock and locking pin from the rail connecting switch handle. Where required, use the locking pin to secure the sections of the hinged type handle.
 - ii. Move the switch handle from the "TO RAIL" position to the "OPEN" position.
 - iii. Check that the switch blade has moved to the "OPEN" position.
- (e) The Authorised Person shall then advise the ESO of the rail connection switch operation that has been carried out.

8.7. Rail Connecting Links

8.7.1. Description

Rail connecting links are used to rail connect the 1500 Volt OHW for work at locations where use of the portable rail connection equipment is difficult.

The links, of a pivoted blade construction, are operated manually using an operating stick and have two positions labelled "OPEN" and "TO RAIL". The 1500 Volt OHW section is rail connected with the link in the "TO RAIL" position.

8.7.2. Rail Connecting Link Operating Procedure

- (a) The ESO shall instruct the Authorised Person, which rail connecting link is to be operated and the action required.
- (b) The Authorised Person shall ensure that the rail connecting link is the correct one, by checking the location and the label on the link with the program or written instruction. The Authorised Person shall also ensure that the rail connecting link is in the correct position by checking the blade and handle positions.
- (c) To operate the rail connecting link from the "OPEN" to the "TO RAIL" position the Authorised Person shall:
 - i. Prove dead the jaw of the link, refer section 6 Proving Dead 1500 Volt Equipment, then

- ii. Using the operating stick, move the blade of the link from the "OPEN" to the "TO RAIL" position with a single unhesitating movement, and then
 - iii. The Operator shall advise the ESO of the rail connecting link operation carried out.
- (d) To operate the rail connecting link from the "TO RAIL" position to the "OPEN" position, the Authorised Person shall:
- i. Use the operating stick and move the blade of the link from the "TO RAIL" to the "OPEN" position, and then,
 - ii. The Authorised Person shall advise the ESO of the rail connecting link operation carried out.

8.8. Equipment Subject to Fault Currents

Portable rail connection equipment clamps and associated connecting cables shall be inspected for effective operation after use, due to the possibility of damage from fault or traction return current.

Rail connecting links or switches and associated connecting cables shall be inspected for effective operation after being subjected to fault currents.

Defective components shall be replaced.

9. References

EP 95 20 00 06 SI	Methods of Rail Connecting 1500 Volt Overhead Wiring
PR D 78101	General Requirements for Electrical Work
PR D 78102	Electrical Hazards and Warnings
PR D 78104	Locking Systems for Electrical Equipment
PR D 78107	Insulated Sticks, Tools and Equipment used for work On, Near or In the Vicinity of Exposed Electrical Equipment – Inspection, Testing, Care and Maintenance
PR D 78301	Removal and Restoration of 1500V Supply
PR D 78302	1500 Volt Authority
PR D 78307	Inspection and Care of Portable Rail-Connecting Equipment for 1500 Volt Overhead Wiring
PR D 78105	DANGER Tags for Electrical Equipment
PR D 78103	Electrical Operational Communication and Records
PR D 78700	Working around Electrical Equipment
PR D 78702	Guide for the Stringing of 1500V OHW Conductors in the Vicinity of Existing Electrical Equipment

{Remainder of page left intentionally blank.}