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**.

**Date in Force: 27 October 2025**

**Date of Review: 27 October 2028**

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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**

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It is noted that this EI has been superseded by the Standard Operating Instruction (SOI) *NMD-ME-INS-538* and is to be withdrawn upon the expiry of the current review period.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

# 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.

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

Engineering System Integrity
Electrical Network Safety Rules

Engineering Procedure
Electrical Distribution Unit

Electrical Distribution Network Management

# PR D 78306

# 1500 Volt DC Overhead Wiring Structure to Rail Voltage Test

Version 1.2
Date in Force: 1 February 2022

Transport Sydney Trains

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|---|---|---|---|
| Approved by: | Associate Director<br>Electrical Distribution Unit<br>Engineering System Integrity | Authorised by: | Engineering Technical Publications Manager<br>System Integrity |

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# Document control

| Version | Date | Author/ Prin. Eng. | Summary of change |
|---|---|---|---|
| 1.0 | 11 December 2015 | Wayne Halls | First issue as a Sydney Trains document, rebranded from previous RailCorp SMS-06-EN-0571 V1.0 |
| 1.1 | 19 February 2019 | Nick Loveday | Updated PR D 78306 "Approved by" to Associate Director Electrical Distribution Unit |
| 1.2 | 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 reference documents | All |

# Table of Contents

# 1 Purpose and scope

This document describes the 1500 Volt DC Overhead Wiring (OHW) structure to rail voltage test and the circumstances under which it shall be carried out before work is performed on rail-connected 1500 Volt DC OHW. This document describes:

- situations that require such a voltage test to be carried out, and
- the equipment that shall be used to perform the voltage test, and
- the procedure to be used to carry out the voltage test.

# 2 Definitions

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

# 3 Situations that require the 1500 Volt DC OHW structure to rail voltage test

A 1500 Volt DC OHW structure to rail voltage test shall be carried out before work is performed by persons authorised to work on the 1500 Volt DC OHW and where the work to be performed involves:

1. Working at an 1500 Volt DC OHW structure that supports live 1500 Volt DC conductors, including any structure supporting both live and dead circuits (with work to be carried out on the rail-connected 1500 Volt DC OHW circuit only), and
2. Working at an 1500 Volt DC OHW structure that is not fitted with a spark gap, and
3. Simultaneous contact being made between the 1500 Volt DC OHW structure and rail connected equipment such as either an Approved rail mounted Elevating Work Platforms (EWP's) or rail connected 1500 Volt DC OHW.

The following example is a situation in which all 3 of the above dot points are satisfied and thus you shall conduct a structure to rail voltage test before commencing the work:

- *Under an Authority, OHW work is being performed at a 4 track portal structure that is not fitted with a spark gap.*

  See Item 2 above

- *The structure supports the OHW over all 4 tracks. The OHW on all 4 tracks is isolated under more than 1 Authority but the Permit you are working on covers only the OHW over the track that you are working on.*

  See Item 1 above

- *You are planning to work out of a rail mounted EWP and the work will require making simultaneous contact between this structure and the EWP.*

  See Item 3 above

# 4 Equipment to be used for the 1500 Volt DC OHW structure to rail voltage test

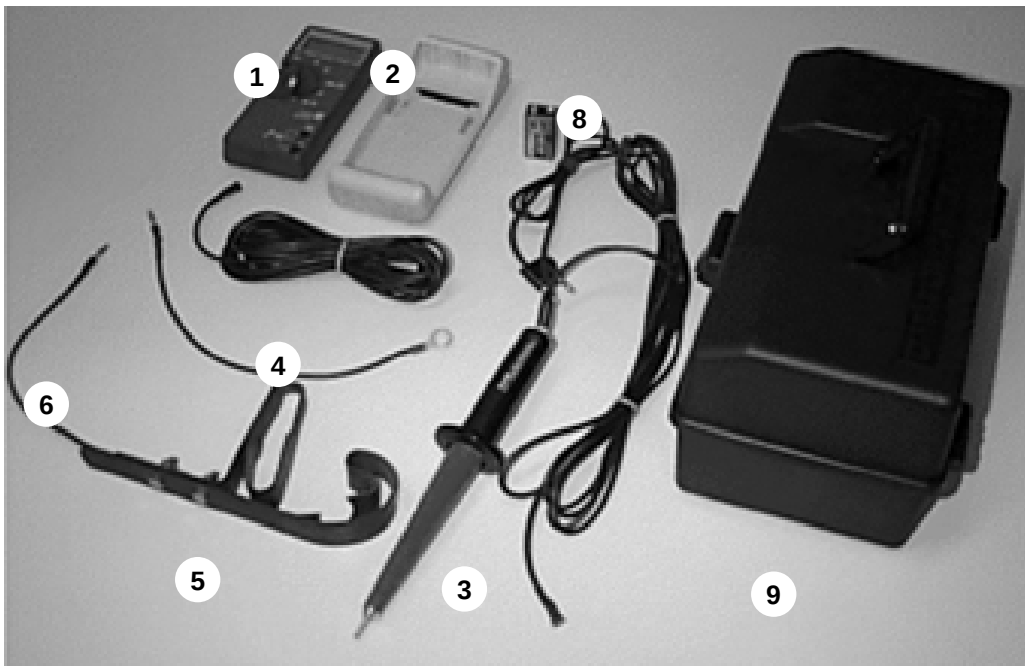
Two testers may be utilised to undertake the required 1500 Volt DC OHW structure to rail voltage tests:

a. The Test Kit comprising the 'Fluke' multimeter and accessories (hereafter abridged as the 'Fluke Tester'), or

b. The Hivotech DE-300/1 1500 Volt DC OHW Tester (hereafter abridged as the 'Hivotech Tester').

Refer to *SP D 79039 Electrical Tools and Test Equipment* for details.

## 4.1 The Fluke Tester




The equipment to be used comprises of the following:

1. Fluke series 170 digital multimeter

   **NOTE**
   Previous model series 70 is no longer available for purchase but is still suitable for use.

2. Fluke C70Y yellow holster.
3. Fluke 80K-6 high voltage probe (earth lead lengthened to 5 m).
4. 5m extension earth lead.
5. Rail clip with 300mm earth lead tail.
6. 300mm earth lead tail with 10mm termination eye for attachment to rail vehicles.
7. An uncontrolled copy of this Procedure (not shown in photo).
8. 9V Battery (Eveready No. 216 6F22 or similar).
9. Plastic tool box for storage of the test equipment.

## 4.2 The Hivotech Tester

Refer to SP D 79039 for more detailed description of this tester.

# 5 Procedure and 'safety' criterion common for using either tester

## 5.1 Common Procedure

The following shall be complied with for undertaking the 1500 Volt DC OHW structure to rail voltage test, irrespective of which tester is to be used:

a. Being hit by train is the most common hazard when working or even walking within the rail corridor. As such, all persons shall at least possess the Rail Industry Safety Induction (RISI) qualification.

b. Appropriate protection for working within the rail corridor shall be in place.

c. As one probe of the tester is to be attached to the rail, select the traction rail. (Refer to *PR D 78305 1500 Volt Operating Procedures* on how to identify the traction rail.)

d. Select the traction rail or portion of the traction rail which is reasonably clean and rust-free, otherwise clean the traction rail or remove rust to ensure good contact of the probe, which may be a rail clip or rail clamp.

e. Select the spot on the 1500 Volt DC OHW structure which is reasonably clean and rust-free. Otherwise scratch the surface with a long insulated screw driver or other insulated tool, as shown below.


**NOTE**

**Insulated gloves shall be worn if the screw driver or other tool is not insulated.**

## 5.2 Safety Criterion

The 1500 Volt DC OHW structure is considered safe to touch if the measured structure to rail voltage does not exceed 50 Volt DC.

**NOTE**

**If the measured voltage exceeds 50 Volt DC, seek advice from ICON Electrical.**

# 6 Procedure for measuring the 1500 Volt DC OHW structure to rail voltage from a rail vehicle by using the Fluke Tester

## 6.1 Connect the HV probe ③ lead socket to the rail vehicle lead ⑤ plug.

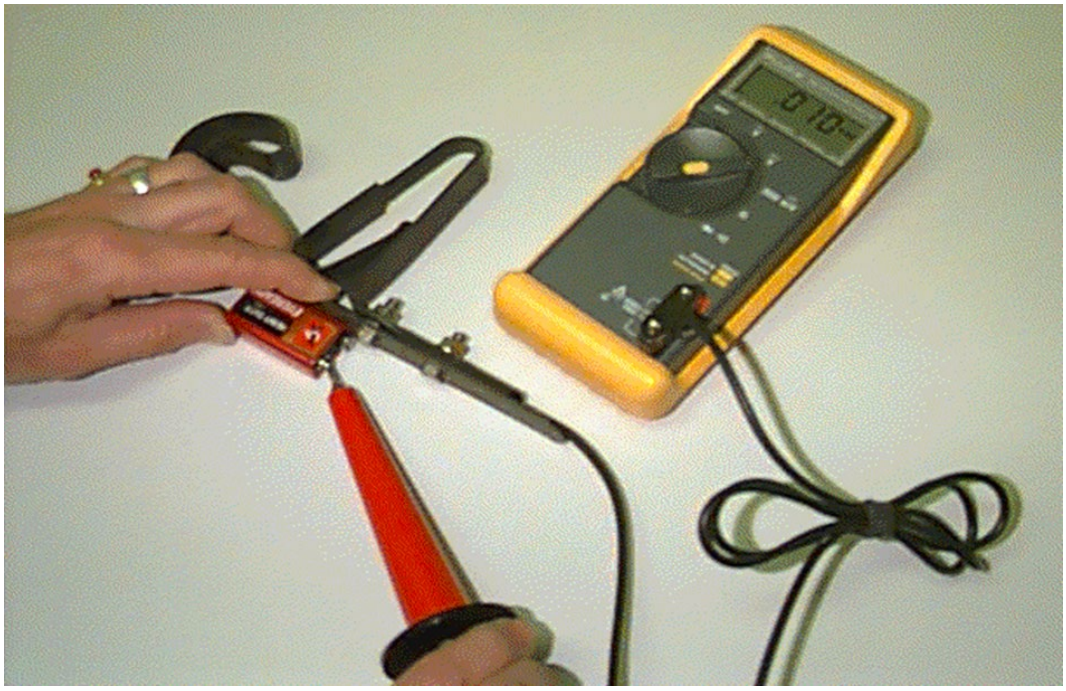
If the distance from the rail vehicle lead ⑤ to the 1500 Volt DC OHW structure is more than 5m, connect the 5m extension lead ④ between the rail vehicle lead ⑤ and the HV probe lead ③ socket.

## 6.2 Connect the HV probe lead plug ③ to the multimeter ① and switch the multimeter to the position for measuring DC voltages

This is illustrated below.


The plug pin next to the “GND” lug shall be in the ‘COM’ socket (the bottom hole). The lead plug housing will then be on the outside of the multimeter. The multimeter should show .000 VDC.

## 6.3 Functional Check of the Fluke Multimeter



Hold the HV probe (3) on to the +ve terminal of the 9V battery (8) and the eye of the rail vehicle lead (6) on to the -ve terminal of the battery. The multimeter (1) shall read between .011 and .007 VDC. The HV probe reduces the voltage 1000 times i.e. 9 V = .009 VDC on the multimeter.

**WARNING**

**If the multimeter (1) reading is not between .011 and .007 VDC, repeat the test with a new battery (8).**

**If the new reading is still not between .011 and .007 VDC, return the test kit to your supervisor. Obtain another test kit and redo the complete procedure.**

## 6.4 Bolt the rail vehicle lead (6) to the rail vehicle

All rail vehicles used for 1500 Volt DC OHW maintenance and construction shall have at least one attachment hole, 10mm stainless steel nut and bolt installed on their work platforms to connect the rail vehicle lead (6) to the rail vehicle.

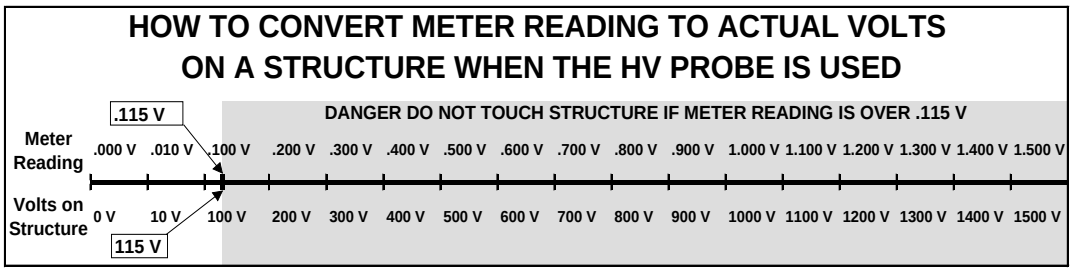
## 6.5 Measure the 1500 Volt DC OHW structure voltage

Select a spot on the 1500 Volt DC OHW structure which is reasonably clean and rust-free. Otherwise, scratch the surface with a screw driver or other tool as described in Section 6.1 (e).

Hold the HV probe (3) by the black handle and touch the point of the HV probe on the 1500 Volt DC OHW structure for at least 3 seconds.

Make sure that no part of the body touches the 1500 Volt DC OHW structure.

Use the conversion scale below to determine the actual voltages between the 1500 Volt DC OHW structure and rail.




**WARNING**

**If the multimeter (1) reads at or above 0.051 Volt DC (i.e. the actual voltage is equal to or above 51 Volt DC) the structure is at a potentially dangerous voltage.**

**Keep clear of the 1500 Volt DC OHW structure.**

**Warn every one in the vicinity of the danger.**

**Arrange for at least one staff member to stay at the 1500 Volt DC OHW structure to warn of the dangerous condition.**

**Notify your supervisor and the ICON Electrical as soon as practicable.**

**Do not proceed with work on the 1500 Volt DC OHW structure.**

## 6.6 Re-test the test arrangement

Repeat the test as described in Section 6.3 to verify that the tester was functioning for the duration of the test.

**WARNING**

**If the result of retest of the test arrangement is not satisfactory, then the entire procedure shall be repeated.**

# 7 Procedure for measuring the 1500 Volt DC OHW structure to rail voltage from ground by using the Fluke Tester

## 7.1 Connect the HV probe ③ lead socket to the rail clip lead ⑤ plug

If the distance from the rail to the 1500 Volt DC OHW structure is more than 5m connect the 5m extension lead ④ between the rail clip lead ⑤ plug and the HV probe lead ③ socket.

## 7.2 Connect the HV probe lead plug ③ to the multimeter ① and switch the multimeter to position for measuring DC voltages

This is the same as Section 6.2.

## 7.3 Functional Check of the Fluke Multimeter

Refer to Section 6.3 for the same test.

## 7.4 Attach the rail clip ⑤ to the traction rail

Refer section 5.1 (d) for details.

## 7.5 Measure the 1500 Volt DC OHW structure voltage

Select a spot on the 1500 Volt DC OHW structure which is reasonably clean and rust-free. Otherwise, scratch the surface with a screw driver or other tool, as described in Section 5.1 (e).

Hold the HV probe ③ by the black handle and touch the point of the HV probe on the 1500 Volt DC OHW structure for at least 3 seconds.

Make sure that no part of the body touches the 1500 Volt DC OHW structure.

Use the same conversion scale as shown in Section 6.5 to determine the actual voltage between the 1500 Volt DC OHW structure and rail.

If the multimeter ① reads below 0.115VDC, proceed to Section 7.6.

**WARNING**

**If the multimeter (1) reads at or above 0.051 Volt DC (i.e. the actual voltage is equal to or above 51 Volt DC) the structure is at a potentially dangerous voltage.**

**Keep clear of the 1500 Volt DC OHW structure.**

**Warn everyone in the vicinity of the danger.**

**Arrange for at least one staff member to stay at the 1500 Volt DC OHW structure to warn of the dangerous condition.**

**Notify your supervisor and ICON Electrical as soon as practicable.**

**Do not proceed with work on the 1500 Volt DC OHW structure.**

## 7.6 Re-test the test arrangement

Repeat the test as described in Section 7.3 to verify that the tester was functioning for the duration of the test.

**WARNING**

**If the result of re-test of the test arrangement is not satisfactory then the entire procedure shall be repeated.**

# 8 Procedure for measuring the 1500 Volt DC OHW structure to rail voltages by using the Hivotech Tester

a. Carry out the self-test to ensure that the Tester is ready for use.

b. Put the magnetic rail clamp onto the traction rail which is reasonably clean and rust-free. Refer to Section 5.1.

c. Attach an Approved insulated operating stick to the Tester and ensure that it is always firmly engaged during test.

d. Always hold below the hand guard of the Approved operating stick.

e. Place the knurled contact to the clean or rust-free spot of the 1500 Volt DC OHW structure.

f. Read the voltage reading on the LCD display.

g. Carry out the self-test to ensure that the Tester is ready for use in accordance with.

h. Refer to Section 5.2 to determine if the 1500 Volt DC OHW structure is safe to touch.

**WARNING**

**DO NOT touch the 1500 Volt DC OHW structure unless it is safe to touch.**

**WARNING**

**If the measured voltage is equal to or above 51 Volt DC, the structure is at a potentially dangerous voltage.**

**Keep clear of the 1500 Volt DC OHW structure.**

**Warn everyone in the vicinity of the danger.**

**Arrange for at least one staff member to stay at the 1500 Volt DC OHW structure to warn of the dangerous condition.**

**Notify your supervisor and ICON Electrical as soon as practicable.**

**Do not proceed with work on the 1500 Volt DC OHW structure.**

# 9 Reference documents

PR D 78305 1500 Volt Operating Procedures

SP D 79039 Electrical Tools and Test Equipment