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EP 15 00 00 02 SP

VOLTAGE TESTER FOR USE ON 1500V DC OVERHEAD WIRING

Version 1.0

Issued October 2012

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Engineering Specification

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Document control

Version	Date	Summary of change
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1 Introduction

This document describes the minimum technical performance requirements for 1500V DC voltage testers for use on overhead wiring.

Sections/subsections of RailCorp's 1500V DC overhead wiring (OHW) network that have been isolated for work must be tested and proven dead and/or rail connected using approved test equipment as part of RailCorp 1500V Operating Procedures (*SMS 06 EN 0570*).

2 Scope and application

This specification sets out specific design, acceptance testing and tender requirements for Resistive Type Voltage Testers for use on RailCorp's 1500V DC overhead wiring (OHW) network and primarily for outdoor applications.

Items covered by this Engineering Specification are listed as follows:

ITEM No.	ITEM DESCRIPTION
1	1500V DC OHW Tester
2	Silicone oil impregnated cloth
3	Contact electrode (removable pointed knurled type)
4	Instructions for Use
5	Carry case for voltage tester and all components

3 References

3.1 Relevant Standards

The following standards either are referenced in this document or can provide further information.

AS 60529:2004	*Degree of protection provided by enclosures (IP Code)*
IEC 60855-1: 2009-10	*Live working - Insulating foam-filled tubes and solid rods – Part 1: Tubes and rods of circular cross-section*
IEC 61235: 1993-08	*Edition 1.0 & Corrigendum 1 and 2 Live working – insulating hollow tubes for electrical purposes*
IEC 61243-2: 2002-06	*Edition 1.2 Live working – Voltage Detectors – Part 2: Resistive type to be used for voltages of 1 kV to 36 kV a.c.*
EP 90 20 00 02 SP	*1500V System Voltage Ratings*

Voltage testers complying with other regional or national standards may also be considered, subject to the provision of the English version of such standards and an engineering review and evaluation of the proposed equipment.

3.2 RailCorp Documents and Drawings

There are no drawings attached to this specification.

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4 Historical Information

4.1 General

Supply to sections of the OHW is isolated by opening links or switches. However, isolated sections often adjoin live sections. At many locations there are section insulators or insulated knuckles between sections. Most type 5 section insulators and some insulated knuckles use impregnated timber laminate as insulation material. As this type of material ages its electrical resistance falls. This, combined with leakage across polluted porcelain mid-track insulators, especially in wet conditions may result in isolated sections appearing live when tested with a high impedance voltmeter.

4.2 Voltage Live Line (VLL) Testers

VLL testers have been the primary voltage tester in use on the RailCorp OHW system for many years. The VLL tester is a low impedance meter and the assessment criteria was based upon the following:

> "Test Prior to Applying First Rail Connection to OHW Adjoining Live OHW
>
> A voltage tester shall indicate that it is safe to apply rail connections to the overhead wiring only if the resistance between the overhead wiring under test and live 1500V equipment is *greater* than 10 000 ohms. The voltage tester shall cause not less than 75% of the line voltage to be imposed across the insulation between live equipment and the OHW under test."
>
> Test Prior to Applying Rail Connections to Other OHW
>
> The test equipment for determining whether it is safe to apply rail connections to a section/subsection of OHW shall indicate a voltage of less than 200 volts between the OHW and rail. "

4.3 Line to Rail (LR) Testers

LR testers have been used on the RailCorp OHW system since the early 1990s and their primary purpose was to test whether OHW was live or was rail connected. Limited usage of these testers was permitted to test dead for the application of rail connections provided that the OHW sections adjacent to the points of isolation had been proved dead and rail connected.

5 Electrical Requirements

The voltage tester must satisfy the two major purposes as follows:

Purpose 1. To establish whether or not it is safe to apply rail connections to isolated 1500V OHW; and

Purpose 2. To establish whether 1500V OHW is safe to touch after rail connection has been effected.

To achieve purpose 1, the tester must be capable of indicating that a minimum of 3M-ohm insulation resistance exists between the isolated OHW under test and other live 1500V equipment whilst ensuring that the tester does not cause less than 75% of the line voltage to be imposed across this insulation between the isolated OHW under test and other live 1500V equipment. For the purpose of this test the live nominal 1500V equipment shall be assumed to be live at 1500 Volts.

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Tests have shown that "adequately isolated and able to be rail-connected" RailCorp OHW has a minimum insulation resistance of as low as 3M-ohms. The "75% of the line voltage" requirement therefore excludes high impedance testers (e.g. typically 50M-ohm) as the use of such a tester would result in less than 10% of the line voltage being imposed across the insulation between the isolated OHW under test and other live 1500V equipment. On the other hand, a low impedance tester (e.g. typically 1M-ohm) would mean that a 375V or less reading on the tester would indicate a minimum insulation resistance between the isolated OHW under test and other live 1500V equipment of 3M-ohms existed at a time when this insulation was being stressed at a minimum of 75% of line voltage i.e. rail connecting can proceed.

Refer Figure 1.

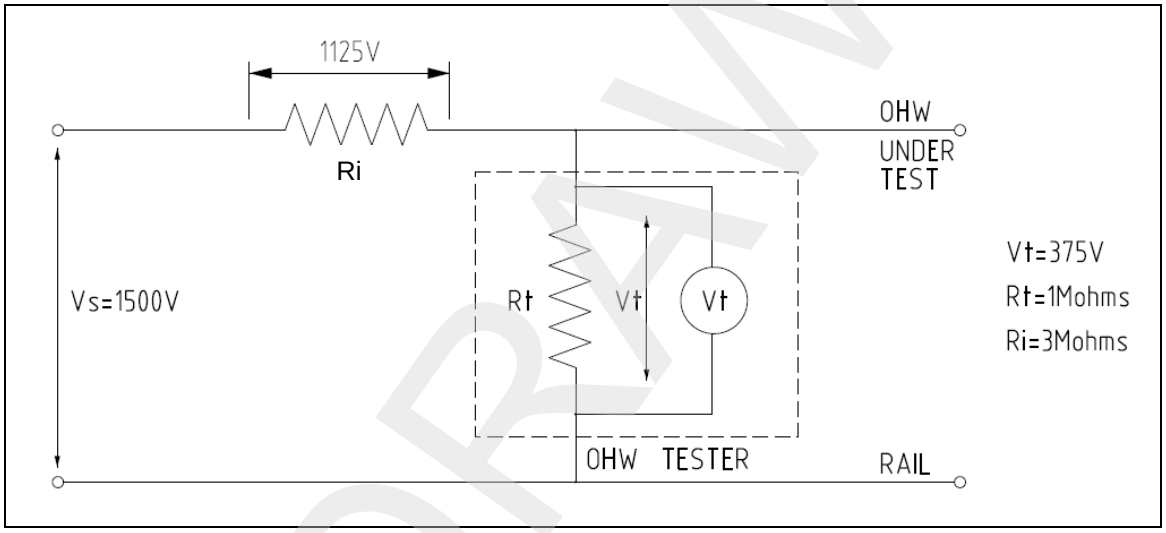

Figure 1

Legend: Rt = Resistance of tester Ri = Source insulation resistance

A 1M-ohm impedance tester with a voltage threshold of 25% (375/1500 = 25%) would thus meet the requirements of Purpose 1. However, to achieve Purpose 2, the tester must be able to indicate that a voltage of 50V *or less* exists on rail connected OHW, thus this testers voltage threshold would be <4%, (50/1500 = <4%). Combining the requirements of Purpose 1 and Purpose 2 means that the tester must have a continuous voltage output of 0 - 2050V and hence not operate on a threshold principle.

The voltage tester must use the traction rail as the reference and must be suitable for testing the voltage between unearthed rail and conductors at a maximum height of 5.8m above the rail. This is normally achieved by attaching the voltage tester to an insulated operating rod or stick currently used by RailCorp.

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6 Design and Construction

6.1 Design and Standard

The voltage tester shall be of the resistive detector type, to be used in contact with the conductor to be tested and shall be either:

- a single unit which shall include at least the following elements: earth lead, handle, hand guard, insulating element, resistive element, indicator, contact electrode and limit mark (refer *IEC 61243-2* Figure 1b), or
- a separate device which shall include at least the following elements: earth lead, adaptor (for connection to an insulating pole), resistive element, indicator, contact electrode and limit mark. Before use this voltage tester must be completed by attachment to an adaptable insulating pole (refer *IEC 61243-2* Figure 1c).

The voltage tester shall have the resistive element inbuilt i.e. not utilising an auxiliary separately installed resistance element between the tester and the OHW or rail.

The voltage tester shall meet the relevant requirements of *IEC 61243 – 2*.

6.2 Operating Voltage Range and Electrical Characteristics

The voltage tester shall be suitable for use with a system nominal voltage of 1500V DC, but must be able to perform satisfactorily for the maximum allowable system voltage of 2050V DC.

The voltage tester and its components must be rated for making contact with live 1500V (nominal) conductors continuously and with unlimited time duration. The maximum duration of live contact must be specified if this is not the case.

Nominal voltage, Un = 1500V dc

Maximum nominal voltage, Un max. = 2050V dc

Rated voltage, Ur = 3000V dc or greater

The accuracy of the voltage tester shall be 2% or better over the range of 50V to 2050V dc.

The voltage tester shall be able to withstand without damage and thus not affect its operational functionality, the transient voltages that may appear on RailCorp's OHW system as defined in Electrical Engineering Specification EP 90 20 00 02 SP.

The voltage tester shall have an internal impedance of 1M-ohm ± 2%

The voltage tester shall shut down after 3 minutes of inactivity i.e. enter a sleep mode.

The rail connecting cable lead shall be double insulated rated for a minimum of 3kV.

The voltage tester is to comply with the EMC compliance and labelling regulatory arrangements as administered by The Australian Communications and Media Authority, refer: www.acma.gov.au.

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6.3 Indication

The voltage tester shall provide:

- Clear perceptibility under normal light, dark and noise conditions
- Clear perceptibility when held with the electrode pointing to the sun, i.e. glare shall not prevent a person from reading the indicator.
- Continuous indication of the actual voltage detected when in direct contact with live exposed conductor
- The tester shall provide a digital voltage readout between 0 and 1,999 V DC
- The tester shall have both visual and audible indications
- An audible alarm shall be initiated when the detected voltage is 200V DC or more
- Low Battery warning indication
- Sleep Mode warning indication

6.4 Self-testing Facility

Self-testing facilities shall be provided to ensure that the voltage tester functions properly before and immediately after each voltage detection.

It is mandatory that an “in-built” self-testing function is utilised.

The self-test function must verify that all of the:

- connecting leads are tested for continuity,
- “Live” indications provided by the tester are activated and proved to be working.

6.5 Climatic Conditions

The voltage tester shall meet climatic category ‘normal’ (N) conditions of Section 4.2.3 of *IEC 61243 – 2* (-25°C to +55°C Temperature, 20% to 96% Relative Humidity).

6.6 Attachment to Rail and Machinery

The negative cable lead of the voltage tester shall be a minimum of 6 m in length and must be capable of being bolted onto, or making good electrical contact with, the rail and the body of an elevating work platform or overhead wiring machine, via the provision of a suitable cable termination lug and clamp.

The cable termination lug shall be suitable for bolts up to 13 mm diameter.

6.7 Attachment to Insulating Pole

The voltage tester shall be designed to mount onto RailCorp’s existing Catu operating stick, namely a Catu CM-4 operating stick utilising a male bayonet fitting which securely slots into the female bayonet fitting on the Catu stick.

6.8 Additional Requirements for a Single Unit Voltage Tester

A single unit voltage tester shall comply with the additional requirements of Sections 6.8.1 and 6.8.2 below.

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6.8.1 Insulating Medium and Handle

The insulating medium and handle shall be an insulating foam filled tube in accordance with *IEC 60855-1*, or hollow tube in accordance with *IEC 61235*, or partly foam-filled and partly hollow tube in accordance with *IEC 60855-1* and *IEC 61235* respectively.

The handle section may be of the same material as the insulating section and integrated with it, or may be separate. Hollow or foam-filled handles should be sealed at the end, with a rubber crutch tip or similar, to keep water out.

The handle shall not be less than 700 mm long.

A hand guard shall be provided and it shall constitute a raised physical lip or barrier of at least 20 mm in height.

6.8.2 Length

The insulating medium shall be of a length, which ensures that a minimum distance of 1000 mm is achieved between the hand guard of the voltage tester and the limit mark or contact electrode on the end of the voltage tester.

The limit mark shall be about 20 mm wide, permanent and clearly recognisable by the operator.

The voltage tester shall be so oriented that the measured voltage can be easily read by the operator holding the voltage tester or operating stick.

6.9 Contact Electrodes

6.9.1 General

The voltage tester shall be supplied complete with the required contact electrodes that enable their use on the following:

- Overhead wires.
- Exposed busbars of outdoor substations.

6.9.2 Overhead Wires

The contact electrode shall be a pointed knurled type, suitable for conductors up to 33 mm in diameter and be removable to allow replacement due to wear.

6.9.3 Exposed Busbars of outdoor substations

The same contact electrode for overhead wires can be used to make contact with exposed busbars for outdoor substations.

6.9.4 Mechanical Strength

The length and mass of all contact electrodes, in conjunction with the method of fixing the contact electrode to the tester case and internal circuits, shall be designed to ensure the integrity of the tester system under normal field use for a minimum of ten years.

The mechanical integrity of the tester system shall be tested for compliance to *IEC 61243-2* Section 5.4 Mechanical tests.

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6.10 Silicone Cloth

Each kit shall be supplied with a silicone oil impregnated cloth, which is to be used to keep the surface of the voltage tester and operating rods clean and hydrophobic. The cloth shall be reusable. The Supplier shall provide information regarding:

- The number of times the cloth may be re-used.
- Methods for cleaning and re-impregnating the cloths.

6.11 Carry Case

The voltage tester and contact electrodes shall be offered with a single highly durable carry case, which accommodates the tester, contact electrodes, handle section (if separate to the voltage tester), rail connection clamp and associated cable, silicone cloth, and preferably a spare battery.

The carry case must be suitable for allowing ease of removal and stowing of the tester and associated components without placing stress on the tester or components, e.g. no stress on the negative cable lead at the point of attachment to the tester when stowed

The durability of the carry case shall be such that it provides mechanical protection to the tester and contact electrodes from damage when subjected to 'typical' transportation modes i.e. in the back of a truck, driving along unsealed roads, over pot holes and mechanical impact from loose OHW fittings that may be in the back of the truck impacting against the carry case.

7 Wet Weather Use

The voltage tester shall be purposely designed to be used in outdoor wet weather conditions. In accordance with *AS/IEC 60529* the tester shall be rated as IP55 minimum; test reports shall be provided to substantiate the IP rating claimed. Full instructions shall be provided regarding any special procedures and conditions that may be required during wet weather use.

8 Tests

8.1 Tests – Voltage Tester

The voltage tester to be supplied must be tested, where appropriate to its design and construction methodology, in accordance with the relevant provisions of Section 5 of *IEC 61243-2*.

The tests shall include but not limited to the following Type, Sample and Routine tests of Sections 8.1.1, 8.1.2 and 8.1.3 below.

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8.1.1 Type Test

Type tests shall be carried out in accordance with Section 5.1.4 of *IEC 61243-2*.

For voltage testers that have been commercially available, a copy of the previous type test report* must be provided.

For a new voltage tester to be supplied, the required type test must be carried out, and the results of the test must be provided*.

Documented satisfactory performance by other users may be considered in lieu of the type test, at the discretion of RailCorp.

* Note: The report substantiating compliance is to be a NATA endorsed report or an endorsed report from a NATA recognised laboratory, i.e. a laboratory holding a mutual recognition agreement with NATA. Refer http://www.nata.asn.au

8.1.2 Sample Tests

Sample tests shall be carried out in accordance with Section 5.1.6 of *IEC 61243-2*.

Sample test certificates shall be available if requested.

8.1.3 Routine Test

Routine tests shall be carried out in accordance with Section 5.1.5 of *IEC 61243-2*, which includes the following aspects:

- Visual and dimensional inspection;
- Insulated lead;
- Leakage current; and
- Check of testing element.

Routine test certificates shall be supplied with each delivery.

8.2 Tests – Insulating Handle and Connecting Cable Lead

In addition to any relevant inspections and tests required by Section 8.1, the insulating handle and the connecting cable lead are required to be subjected to an insulation resistance (IR) test of 5 kV DC for a minimum duration of 60 seconds, and the measured insulation resistance is to be more than 50 Mega-Ohm.

IR test certificates shall be supplied with each delivery.

9 Maintenance Requirements

The Supplier shall advise the requirements in relation to:

- Before-use inspection; and
- Periodic maintenance and test including but not limited to the frequency and details of maintenance and test requirements of all components of the voltage tester.

It is mandatory that the battery be user replaceable without the need for special tools or re-calibration of the tester.

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10 Markings on the Tester

As a minimum, the markings on the tester shall address each of the issues listed in Section 4.5.1 of *IEC 61243-2* where relevant and the following:

- The voltage tester must be individually and uniquely numbered for easy identification and tracking of maintenance work carried out. RailCorp reserves the right to specify details of numbering if the Supplier's proposal is not satisfactory, and
- The voltage tester must be individually marked, "FOR TESTING OHW IN ACCORDANCE WITH RAILCORP SMS PROCEDURES. REFER TO INSTRUCTIONS FOR USE."

11 Instructions for Use

The Supplier shall provide comprehensive instructions, drawings and information for use of the tester its components and adaptors. As a minimum, the instructions shall address each of the issues listed in Annex B of *IEC 61243-2*, where relevant, and the following:

- Operation.
- In the case of a Low Battery warning indication whether or not the tester is deemed functional.
- In the case of a Sleep Mode warning indication how the operator is to return the tester to operational readiness.
- It is imperative that the test equipment must be connected to rail first, before the connection is made to the 1500V overhead wiring, and not disconnected from rail until after the connection is disconnected from the 1500V overhead wiring. The user instructions must include a clear warning to this effect.
- Care and maintenance by the operator.
- Service, testing and repair.

Where the manufacturer's standard brochures and instructions do not meet this requirement, the Supplier shall provide the necessary information as a supplement to that of the brochure.

12 Data Set associated with the Equipment

The data listed in Appendix A shall be supplied by the manufacturer / supplier and maintained for each voltage tester type. This data will remain the property of RailCorp.

13 Tender Evaluation

The Chief Engineers Electrical Unit must be involved in the tender evaluation process, if the voltage tester to be procured is currently not approved for use in RailCorp.

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Appendix A Technical Schedule

Item No.	.....	
Manufacturer's Name	.....	
Manufacturer's Address	.....	
Manufacturer's Contact details	.....	
Country of Manufacture	.....	
Manufacturer's Catalogue Number	.....	
Manufacturer's Drawing Number	.....	
Type Test Report Number * Refer Note 1	.....	
Is the Detector a complete unit in accordance with Fig 1b of *IEC 61243-2*?		Yes/No
Nominal Voltage Range	.....	V
Impedance of Voltage Tester	.....	Ohm
Threshold voltage (U_t) (*IEC 61243-2* Section 3.2.6)	.....	
Class (*IEC 61243-2* Section 4.2.1.1) - A, B, C or D	.....	
Indication Group (*IEC 61243-2* Section 4.2.2) - I, II or III	.....	
Climatic Category (*IEC 61243-2* Section 4.2.3) - C, N or W	.....	
Overall Length	.....	mm
Diameter	.....	mm
Total Mass (with battery and contact electrode)	.....	kg
Power Supply - Battery Class	.....	
Suitable for Wet Weather Use	.....	Yes/No
IP Rating (in accordance with *AS/IEC 60529*) Minimum protection requirement IP 55 - (please specify)		IP
* Refer Note 1	.....	

* Note 1: The report substantiating compliance is to be a NATA endorsed report or an endorsed report from a NATA recognised laboratory, i.e. a laboratory holding a mutual recognition agreement with NATA. Refer www.nata.asn.au

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Appendix B Request for Tender Checklist

Application

The following material is for guidance in the preparation of a Request for Tender for this type of equipment. This checklist itself is not intended to directly form part of any contract.

Information to be supplied to the Tenderer

Where this document is used as the basis for procurement of equipment for a particular location, in addition to the general requirements in this standard the following information will need to be supplied:

- A full list of deliverables required under the contract regarding the number of sets of equipment required, including:
  - Voltage testers;
  - Handle sections (if separate to the voltage tester);
  - Contact electrodes (removable pointed knurled type);
  - Silicone cloths;
  - Carry cases; and
  - Spares.
- The editions of reference standards indicated are the versions applicable at the time of publication of this document. Where there is any amendment to the reference standards without notice, the latest version shall apply.
- Requirements for the preparation of equipment for shipment or delivery. The main points are:
  - All equipment shall be suitably packed for protection against damage during loading, transport, storage and unloading.
  - Parts subject to damage due to vibration shall be removed and separately packed if necessary.
- The pricing methodology to be applied for selection of equipment. This must be made on the basis of minimising the whole-of-life cost. The following factors must be considered in determining this:
  - Initial purchase price [shall include all items listed in Section 2].
  - Cost of spares.
  - Discount rate.
  - Lifetime of equipment.

Information to be sought from the Tenderer

- Complete and submit the Technical Schedule in Appendix A.
- Submit all required tests reports associated with the voltage tester to be supplied.
- Provide a list of users and their contact details (name, e-mail address, postal address, contact phone number etc) that have been supplied with the same type of voltage tester

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Appendix C Requirements for Technical Aspects of Tender Evaluation

Evaluation of tenders

The Chief Engineer Electrical requires that persons evaluating the technical aspects of this tender have sufficient technical competence for the task.

Tender evaluation committees shall forward details of persons evaluating the technical aspects of the tender to the Chief Engineer Electrical for concurrence. This will normally be in the form of an email and is to include sufficient detail of the tender and the person to enable the Chief Engineer Electrical to satisfy themself of the merits of the evaluating person. A minimum of 4 weeks notice is required prior to the evaluation of the Tenders.

The Chief Engineer Electrical will advise only if the person is considered unsuitable for the technical evaluation.

Acceptance of product

A number of the specifications require acceptance of product at both the factory and at site. The purchaser is to advise the Chief Engineer Electrical the details of the person carrying out the acceptance testing for the concurrence of the Chief Engineer Electrical. A minimum of 4 weeks notice is required prior to the evaluation of the acceptance testing.

The Chief Engineer Electrical will advise only if the person is considered unsuitable for the acceptance testing.

The Chief Engineer Electrical reserves the right to nominate a representative to review and/or attend such acceptance.

Record Keeping

Where product is purchased against this specification, the Chief Engineer Electrical requires that relevant detail be provided so that it can be logged against this specification.

For RailCorp purchases, the tender evaluation committee shall advise the Chief Engineer Electrical the RailCorp registered file details containing the tender evaluation for future referencing. This is normally a TRIM reference.

Where this specification is utilised by parties external to RailCorp (Alliance parties, etc) then copies of all relevant technical information and evaluation shall be forwarded to the Chief Engineer Electrical for filing against the specification. In addition copies of selected commercial information pertaining to the ongoing support of the product as follows is also required.

- Warranty details
- Spare parts and associated availability
- Product support information.

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