

### Approval

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### Amendment Record

<table>
<thead>
<tr>
<th>Approval Date</th>
<th>Version</th>
<th>Description</th>
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<tbody>
<tr>
<td>11/11/2016</td>
<td>1</td>
<td>Initial Issue</td>
</tr>
<tr>
<td>10/07/2017</td>
<td>2</td>
<td>Revision to include details on cable routes</td>
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1 Purpose

The Signal Cable Management Strategy forms part of the overall MTM cable management strategy and provides the approach to managing signal cables within the MTM network. It pertains to preventative, reactive and corrective maintenance, signal renewals and contract project works.

2 Scope

This document shall define the strategy for the management of Signal Cables on the MTM network.

The management strategy shall consist of:-

1) A regime to identify, repair or replace signal cables in need of repair.
2) The Signal Delivery Infrastructure groups are responsible for implementing the above regime.
3) New works implemented by Projects or Signal Renewals.

3 Abbreviations and Acronyms

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>CBI</td>
<td>Computer Based Interlocking</td>
</tr>
<tr>
<td>C/TC</td>
<td>Compliance/Test Certificate</td>
</tr>
<tr>
<td>MTM</td>
<td>Metro Trains Melbourne</td>
</tr>
<tr>
<td>OIC</td>
<td>Officer In Charge</td>
</tr>
<tr>
<td>SER</td>
<td>Signal Equipment Room</td>
</tr>
<tr>
<td>SMT</td>
<td>Signal Maintenance Technician</td>
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<tr>
<td>TMP</td>
<td>Technical Maintenance Plan</td>
</tr>
<tr>
<td>VRIOGS</td>
<td>Victorian Rail Industry Operators Group Standards</td>
</tr>
<tr>
<td>TANC</td>
<td>Temporary Approved Non-Compliance</td>
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</table>
4 Definitions

<table>
<thead>
<tr>
<th>Definition</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>Cable Test</strong></td>
<td>Cable continuity and insulation tests in compliance with VRIOGS 012.5 Rev A (i.e. continuity resistance, core to core and core to earth insulation resistance values). &quot;Compliance/Test Certificate Cable Variance C/TC-4 shall be used for test results. Also known as a “Megger” test.</td>
</tr>
<tr>
<td><strong>Corrective Maintenance</strong></td>
<td>Maintenance repair actions performed to restore the system to a safe working condition as an additional outstanding task arising from either preventative or reactive maintenance works.</td>
</tr>
<tr>
<td><strong>Defective Signal Cable List</strong></td>
<td>Spreadsheet that manages the repair of the signal cabling and wiring that is required to be renewed and tested by the Signals Delivery Renewals Group.</td>
</tr>
<tr>
<td><strong>Preventative Maintenance</strong></td>
<td>Scheduled maintenance tasks performed on a piece of equipment to lessen the likelihood of it failing.</td>
</tr>
<tr>
<td><strong>OIC</strong></td>
<td>Minimum Signal Delivery supervisory staff member authorised to carry out the duties as described in this document. May be replaced by a higher level of Signal Delivery Supervisory staff.</td>
</tr>
<tr>
<td><strong>Reactive Maintenance</strong></td>
<td>Unscheduled maintenance actions that are performed on equipment which has already broken down to enable restoration of the system to operating order.</td>
</tr>
<tr>
<td><strong>TANC</strong></td>
<td>Temporary Approved Non-Compliance, notating the identified defect(s) and agreed mitigation that has been determined through consultation with Signal Engineering and Signal Delivery, to manage the issue until it is rectified.</td>
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5 References & Legislations

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<thead>
<tr>
<th>Reference</th>
<th>Description</th>
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<tbody>
<tr>
<td>L0-SQE-PRO-006</td>
<td>Records Management Procedure</td>
</tr>
<tr>
<td>L1-CHE-WOI-003</td>
<td>Testing Repaired Multicore Cables</td>
</tr>
<tr>
<td>MSMP 000000-01 (L2-SIG-PLA-001)</td>
<td>Signals Technical Maintenance Plan</td>
</tr>
<tr>
<td>L2-SIG-INF-001</td>
<td>Technical Maintenance Plan Schedule</td>
</tr>
<tr>
<td>MSMI 029900-02 (L2-SIG-MAI-002)</td>
<td>Signal Maintenance Instruction Interlocking Enclosures Cable &amp; Wire Insulation Condition This is the Maintenance Instruction that describes how to carry out cable maintenance.</td>
</tr>
<tr>
<td>MSSS 029900-03 (L2-SIG-SCH-001)</td>
<td>Signal Service Schedule Interlocking Enclosure Cable &amp; Wire Insulation Condition Survey This is the Service Schedule that defines the TMP requirement for cable maintenance. This document references L4-SIG-FOR-025/MSMF 029900-01</td>
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<tr>
<td>MSMF 029900-01 (L4-SIG-FOR-025)</td>
<td>Signal Maintenance Form Cable &amp; Wire Insulation Condition Survey Record Sheet</td>
</tr>
<tr>
<td>L4-TRK-FOR-106</td>
<td>Temporary Approved Non-Compliance Form</td>
</tr>
<tr>
<td>VRIOGS 012.2</td>
<td>Specification for Signalling Supply, Construction and Installation</td>
</tr>
<tr>
<td>VRIOGS 012.2.1</td>
<td>Standard for Construction of Cable Route and Signalling Civil Works</td>
</tr>
<tr>
<td>VRIOGS 012.5</td>
<td>Testing and Commissioning of Safety Related Railway Signalling Services</td>
</tr>
<tr>
<td>VRIOGS 012.6</td>
<td>Suite of Standards For The Various Signalling Cables</td>
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6 Safety & Environmental

<table>
<thead>
<tr>
<th>Reference</th>
<th>Description</th>
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<tbody>
<tr>
<td>L0-SQE-PLA-009</td>
<td>Occupational Health and Safety Management Plan</td>
</tr>
<tr>
<td>L0-SQE-PRO-014</td>
<td>Safety and Environmental Requirements for Contractors Working On MTM Premise</td>
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<tr>
<td>L0-SQE-PLA-005</td>
<td>Environmental Management Plan</td>
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</table>
7 Background

The MTM network has a diverse range of Signalling Systems which use a large quantity of signal cabling and wiring. These systems are not earth referenced (floating) and so it is essential that signal cable cores are isolated from earth potential. Earth faults on cable cores introduce the risk of wrong side failures of the signalling system.

Cable screens and armour may be earthed when required as they don’t carry vital signalling circuits.

7.1 Cable Types

This document relates to:

- Main Run signal cables between SER and location enclosures
- Main Run signal cables between SER and signal panels
- Main Run signal cables between location enclosures
- Tail Cables between location enclosures and trackside equipment such as signals, point machines, trainstops, level crossings, track circuit and axle counters.
- Main Run power cables between SER and location enclosures
- Main Run power cables between location enclosures
- Data links between CBI locations
- Signal telemetry cables used for control & indications of Signalling equipment
- High voltage cables (i.e. from secondary side of 22KV/2.2KV, 1KV or 650V transformers)

This document excludes:

- Internal signal wiring. This will be the subject of a separate strategy document.
- Track circuit connections and traction bonding cables

Signalling cables come in various types including:-

- Single core solid conductor
- Single core multi strand conductor
- Multicore solid conductor
- Multicore multi strand conductor
They also come with various types of insulation. Many of the older types of insulation have broken down and caused insulation resistance issues in places across the MTM network. These older types of insulation include:

- Kerite
- Plastic Insulated (Single 16)
- Cotton Covered, Rubber Insulated
- Vulcanised Indian Rubber
- Rubber Insulated Plastic
- Cloth Covered with White Rubber Insulation
- Rubber/Neoprene Insulated Cables

7.2 **Cables with these types of insulation should be prioritised for replacement. Cable Failure**

As mentioned above, cable insulation resistance is critical to the non-earthed nature of the signalling system. Low insulation resistance can result in wrong side, unsafe faults.

Cable failure can be caused by:

- ageing and degradation of the insulation
- less than adequate installation practices
- mechanical damage.

7.3 **Cable Maintenance**

Cable management to ensure safe operation shall ensure:-

- Cables are in good physical condition via compliance with the Signal Technical Maintenance (TMP) Plan.
- Cable cores have not become earthed via specific cable tests detailed in this document.
- Cable cores have not short circuited to each other via specific cable tests as detailed in this document.
8 Identification, Repair or Replacement of Signal Cables and Wiring

1) The Signals Delivery Manager shall be responsible for the implementation of this document L3-SIG-PLA-004 “Signal Cable Management Strategy”.

2) Suspected faulty signal cables may be identified by the Preventative Maintenance works, Reactive Maintenance works, Signals Delivery Renewals Group works, or Projects works.

3) Where practical, minor repairs are to be carried out by Preventative or Reactive Maintenance works as well as Project and Signal Renewal works.

4) Cables requiring major repairs or further investigation are to be brought to the attention of the Signals Delivery Renewals Group for their action, as described in the following sections.

5) Where cables are to be replaced and the cable route does not meet the requirements set out in VRIOGS 012.2.1, the cable route is to be either repaired or replaced.

8.1 Signals Delivery Group - Preventative Maintenance

1) The Signals Delivery Group is responsible for performing preventative maintenance in accordance with Service Schedule MSSS 029900-03 (L2-SIG-SCH-001) and Maintenance Instruction MSMI 029900-02 (L2-SIG-MAI-002). MSMF 029900-01 (L4-SIG-FOR-025) is used to record the visual condition of Signal Cables and Wiring. This documentation shall be used to determine the physical condition of Signal Cables and Wiring.

2) Additional general equipment and environmental inspections of other signalling equipment including cable routes, may also identify cable defects.

3) If the SMT considers further investigation of a cable that has not caused a signal fault is required, the OIC shall confirm the cable requires investigation or not. If confirmed, the OIC shall generate a Corrective Workorder for the suspect cable to be fully tested.

4) A full cable test in compliance with VRIOGS 012.5 (i.e. continuity resistance, core to core and core to earth insulation resistance values) of the whole suspect cable shall be performed by the Signals Delivery Group to confirm if the cable is defective or not. The results of the cable test shall be recorded using the “Compliance/Test Certificate Cable Variance C/TC-4”.

5) The signed and dated Cable Test Certificate (C/TC-4) shall be stored in accordance with section 9 of this document.

6) The results of the full cable test shall be assessed against the requirements Appendix 1 to determine the course of action to be taken.

7) Signal Delivery staff may perform cable repairs to rectify any issue found with the cable.

8) If the cable is repaired, the cable shall be fully tested and the signed and dated Cable Test Certificate (C/TC-4) shall be stored in accordance with section 9 of this document and the Corrective Workorder is closed.

9) If the cable cannot be repaired by the Signal Delivery Group, the Corrective Workorder shall be reassigned to the Signals Delivery Renewals Group for them to arrange for the cable to be repaired or replaced.
8.2 **Signals Delivery Group - Reactive Maintenance**

1) Shall perform Reactive Maintenance on cables when a fault is reported.

2) Suspect cables shall be managed in accordance with the process described in section 8.1 items 3 to 9 inclusive.

8.3 **New Works**

Projects shall perform New Works on the following basis:-

1) A minimum of 20% spares shall be maintained in new or existing through cables, in accordance with VRIOGS12.1 section 6.10.11 (a).

2) Where a Project proposes to install a new cable, they shall conform to the requirements of this document, VRIOGS 012.5 and L1-CHE-WOI-003.

3) Where a Project proposes to utilise spare cores in an existing signal cable, the Project shall perform the following:-

   a) Ensure that after modifications for new works there are 20% spares or for altered works there are 10% spare cores, as per VRIOGS 012.6.39, sections 3.7 & 3.8.

   b) A full cable test of the entire cable in compliance with VRIOGS 012.5 shall be performed to identify the condition of the cable before the spare cores are used.

   c) The original Cable Test Certificate (C/TC-4) shall be issued to the Signals 3rd Party Works Manager who shall ensure it is stored in accordance with section 9 of this document.

   d) The Project shall, in consultation with the Signals 3rd Party Works Manager, assess the results of the full cable test against the requirements Appendix 1, to determine the course of action to be taken.

   e) If the repair of the cable is possible, the Project Manager shall arrange for the repairs to be performed at their cost.

   f) If the repairs are not possible, the Signals 3rd Party Works Manager shall generate a Corrective Workorder for the suspect cable to the Signals Delivery Renewals Group who shall add the defective cable to the “Defective Signal Cable List” at the assessed priority.

   g) The defective cable shall be repaired or replaced by the Signals Delivery Renewals Group in accordance with the updated “Defective Signal Cable List” and associated timescales.

   h) If the targeted defective cable repair or replacement date is not acceptable to Projects, Projects shall then perform the works at their cost. If the cable is to be replaced and the cable route does not meet the requirements set out in VRIOGS 012.2.1, the Project Manager shall arrange for the repair or replacement of the cable route to be performed at their cost.
4) At the completion of a cable repair or replacement, the following shall be performed:-
   a) The cable shall be fully tested and the signed and dated Cable Test Certificate (C/TC-4) shall be stored in accordance with section 9 of this document.
   b) For new works, the spare cores in the cable may be used subject to maintaining a minimum 20% cores in through cables.
   c) If a minimum of 20% spare cores cannot be maintained in through cables, a new cable shall be installed and a minimum of 20% spare cores shall be ensured in the new cable.
   d) If Signal Renewal Works are maintaining less than 20% and greater than 10% spare cores in through cables, dispensation can be sought from the Head of Engineering – Signals.

5) Where a Project propose to relocate or divert existing cables, the Project shall perform the following at the Project’s cost:-
   a) A new or repaired cable route shall be installed in compliance with VRIOGS 012.2.1.
   b) New cables shall be installed in compliance with the existing As In Service drawings, ensuring 20% spares are provided in each through cable.
   c) Where, the existing cables to be relocated or diverted shall be de-commissioned and removed, the new cables shall then be terminated, dressed, and fully cable tested in compliance with VRIOGS 012.5.
   d) The original Cable Test Certificate (C/TC-4) shall be issued to the Signals 3rd Party Works Manager who shall ensure it is stored in accordance with section 9 of this document.

8.4 Signals Delivery Group - Renewals

The Signals Delivery Renewals Group shall:-

1) Create and maintain a Master list of confirmed defective signal cables for MTM that require further investigation and renewing by the Signals Delivery Renewals Group. The master list shall be called the “Defective Signal Cable List”.
   a) Ensure all required repairs are entered into Ellipse as a Signals Renewal Corrective Workorder.
   b) Upon receipt of advice from any of the above sources, the “Defective Signal Cable List” shall be updated with the details of the information received.

2) Determine the electrical condition of the suspected faulty cable by:-
   a) Using the original Cable Test Certificate (C/TC-4) previously stored by the Preventative or Reactive Maintenance OIC or Signals 3rd Party Works Manager as defined in Sections 8.1, 8.2 and 8.3 above.
   b) If the documentation in item 2) a) does not exist, the signal cable condition shall be positively determined for the cable added to the “Defective Signal Cable List”. The determination of the cable condition shall be performed by a full cable test, in compliance with VRIOGS 012.5 Rev A (i.e. continuity resistance, core to core and core to earth insulation resistance values).
c) The original Cable Test Certificate (C/TC-4) shall be stored in accordance with section 9 of this document.

d) The “Defective Signal Cable List” shall be cross referenced to the electronically stored Cable Test Certificate (C/TC-4).

e) The cable results shall be used in accordance with Appendix 1 to define corrective actions and priority category required.

f) The “Defective Signal Cable List” shall be updated with the corrective actions and priority category for the cable.

g) Use the priority category to prioritise and plan for cable renewal works.

3) Perform the corrective action and test the cable for the prioritised faulty cable by:-

a) The corrective actions shall be performed.

b) The repaired or replacement cable shall be fully cable tested in accordance with VRIOGS 012.5 Rev A.

c) The original Cable Test Certificate (C/TC-4) shall be stored in accordance with section 9 of this document.

d) The cable test results shall be used in accordance with Appendix 1 to define corrective actions required, if any.

e) The “Defective Signal Cables List” shall be updated with details of the status of the corrective actions.

f) The “Defective Signal Cable List” shall be updated with cable test results and a cross reference to the electronically stored Cable Test Certificate (C/TC-4).

g) The Corrective Workorder shall be closed when the corrective actions have been completed.

4) Where the cable route is to be either repaired or replaced, it is to be brought up to standard as per VRIOGS 012.2.1 by:-

a) Including in the renewal works to install a new cable which may include, but is not limited to, new cable routes where the existing cable is direct buried; repair to existing metal or concrete troughing, or the requirement of a new route due to lack of available space in the existing route.

9 Records

Corrective Workorders shall be generated as defined in the sections above.

Corrective Workorders shall be closed when the cable has been repaired or replaced.

A high resolution scanned copy of the original completed, signed and dated Cable Test Certificate (C/TC-4) shall be created. Both the original and scanned copies of the Cable Test Certificate (C/TC-4) shall be stored in a central location for future reference.

Any documentation required by PTV for verifications of the works shall be as agreed to by PTV and MTM.
10 Appendix 1 – Cable Insulation Values and Associated Actions

Tables 1 and 2 below shall be used to determine the actions to be performed on cables that have core to core and/or core to earth insulation values that fall within the values shown.

Note:-

1) Test at 500v for cables with greater than 600V grade insulation or test at 250V for cables with 250/440v grade insulation. For High Voltage cables, this requirement is in addition to the high pressure tests that are required to be performed no greater than 24 hours before the cable is commissioned.

2) Where the tests for new cables fail the minimum values stated in the table, the cable shall not be commissioned. This includes any variance (difference) of greater than 10% between the cores of the cable, even if those cores test greater than the minimum value.

3) Ensure measured cable insulation values are re-calculated on a kilometre basis for comparison analysis with the minimum core insulation and cable variance (i.e. new cable to be tested is 400m in length, for a length of 400m the minimum new cable insulation resistance is 150 MΩ. (60 MΩ /0.4 km = 150 MΩ)).

Table 1 – Cable Insulation Values and Associated Actions

<table>
<thead>
<tr>
<th>Cable Condition</th>
<th>Core to Core &amp; Core to Earth Insulation Values</th>
<th>Action</th>
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</table>
| New Value >60MΩ/km | 1) New cable is acceptable for use.  
2) A minimum of 20% spare cores shall be maintained in through cables. |
| Existing Value >30 MΩ/km | 1) Existing cable is acceptable for continued use.  
2) Spare cores may be used for any new works or alterations whilst maintaining a minimum of 20% of spare cores for through cables. |
| Existing 30MΩ/km >= Value >= 1MΩ/km | 1) Cable shall not be used any new works or alterations.  
2) Cable repairs shall be performed where possible using the Corrective Workorder process.  
3) If not possible to repair, add existing cable to Signals Delivery Renewals Group’s “Defective Signal Cable List” for repair or replacement at priority number 3. The OIC that identified the defective cable shall generate a Corrective Workorder for the Signals Delivery Renewals Group to action.  
4) Existing cable may continue to be used in the interim period. |
### Table 2 – Priority Definitions

<table>
<thead>
<tr>
<th>Priority Number 1</th>
<th>Highest Priority – The cable to be replaced or repaired shall be completed as soon as practicable, taking into account safety &amp; service criticality to allow the signalling system to be returned to service.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Priority Number 2</td>
<td>Second Highest Priority – Cable to be replaced or repaired shall be scoped within one (1) month. The Works shall be completed as soon as practical.</td>
</tr>
<tr>
<td>Priority Number 3</td>
<td>Third Highest Priority – Cable to be replaced or repaired after priority 1 and 2 cables have been completed.</td>
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</table>