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REVISION REGISTER

<table>
<thead>
<tr>
<th>Ed/Rev Number</th>
<th>Clause Number</th>
<th>Description of Revision</th>
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<tr>
<td>Ed 1/Rev 0</td>
<td></td>
<td>New specification with updated requirements, replacing spec SI/TCS/8 (withdrawn).</td>
<td>Manager TSI</td>
<td>Dec 18</td>
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<tr>
<td>(unpublished)</td>
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<tr>
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<td></td>
<td>Update requirements in Clauses 4.6.1, 4.7.1.3 and 6.6.</td>
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<td>Cabling rules expanded and clarified.</td>
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<td>9.2</td>
<td>Final inspection and commissioning tests clarified to be carried out jointly.</td>
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Specification TS101 replaces previous Specification SI/TCS/8 “Installation and Reconstruction of Traffic Light Signals”, which is now withdrawn.

Requests for clarifications, re-issue, or other questions regarding this document should be directed to: ITShelpdesk@rms.nsw.gov.au.
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FOREWORD

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REVISIONS TO PREVIOUS VERSION

This document has been revised from Specification RMS TS101 Edition 2 Revision 0.

All revisions to the previous version (other than minor editorial and project specific changes) are indicated by a vertical line in the margin as shown here, except when it is a new edition and the text has been extensively rewritten.

PROJECT SPECIFIC CHANGES

Project specific changes are not allowed to this document, except in Annexure TS101/A.

Requests for clarifications, re-issue, or other questions regarding this document should be directed to: ITShelpdesk@rms.nsw.gov.au.
RMS QA SPECIFICATION TS101

TRAFFIC CONTROL SIGNALS –
NEW INSTALLATION AND RECONSTRUCTION

1 GENERAL

1.1 SCOPE

This Specification sets out the requirements for installation of new, or reconstruction of existing, traffic control signals (TCS), including supply of materials and equipment through to final handover after commissioning.

The scope of this specification does not include the following:

- Ancillary works that are unrelated to traffic control or ITS field devices, e.g. drainage.
- Temporary systems using portable traffic signals, such as that for roadworks traffic control.
- ITS monitoring equipment that is not used for traffic control, e.g. pan–tilt–zoom video cameras.
- Tidal flow systems which are located at TCS sites.
- Other traffic devices which do not use traffic signal lanterns, e.g. lane open/closed displays, variable/changeable message signs, other types of signage or markings, moveable medians, and lane guidance in pavement lighting.
- Signals owned by other authorities, such as those at rail crossings.
- Tunnel control systems.
- Devices for regulatory enforcement, e.g. detectors for speeding vehicles, red light cameras, weighbridges etc.

1.2 STRUCTURE OF THE SPECIFICATION

This Specification includes a series of annexures that detail additional requirements and information.

1.2.1 Project Specific Requirements

Project specific details of work are shown in Annexure TS101/A.

1.2.2 Measurement and Payment

The method of measurement and payment is detailed in Annexure TS101/B.

1.2.3 Schedules of HOLD POINTS and Identified Records

The schedule in Annexure TS101/C lists the HOLD POINTS that must be observed. Refer to Specification RMS Q for definition of HOLD POINTS.

The records listed in Annexure TS101/C are Identified Records for the purposes of RMS Q Annexure Q/E.
1.2.4 Planning Documents

The PROJECT QUALITY PLAN must include each of the documents and requirements listed in Annexure TS101/D and must be implemented.

1.2.5 (Not Used)

1.2.6 Referenced Documents

Unless otherwise specified, the applicable issue of a referenced document, other than an RMS Specification, is the issue current at the date one week before the closing date for tenders, or where no issue is current at that date, the most recent issue.

Standards, specifications and test methods are referred to in abbreviated form (e.g. AS 1234). For convenience, the full titles are given in Annexure TS101/M.

1.3 DEFINITIONS AND ACRONYMS

1.3.1 Definitions

The terms “you” and “your” mean “the Contractor” and “the Contractor’s” respectively.

For the purpose of this specification, the term “the Principal” means “the RMS Representative” and vice versa, unless the context requires otherwise. Where the Principal is not “Roads and Maritime Services” (RMS), all the powers and duties of the Principal stated in this specification will be exercised by the RMS Representative.

The following definitions apply to this Specification:

**Acceptable Product**
ITS equipment or device that has been evaluated by RMS and considered acceptable for typical use, and registered in Specification RMS TS200.

**Type Approved Product**
ITS equipment or device that has been evaluated as compliant to RMS specifications, and provided with a RMS Type Approval Certification Number in accordance with Specification RMS TS201, and registered in RMS TS200.

**Extra Low Voltage**
Voltage not exceeding 50 V AC or 120 V ripple-free DC as defined in AS/NZS 3000.

**Low Voltage**
Voltage exceeding Extra Low Voltage, but not exceeding 1000 V AC or 1500 V DC as defined in AS/NZS 3000.

**Reconstruction**
Civil and/or electrical works executed for upgrade or change of existing arrangements at traffic signal site(s).

**TCS Site**
A site where traffic is controlled by a fixed installation of signal control equipment, such as traffic signal controller and lanterns.

**Work-As-Executed Drawings**
Drawings showing the actual completed installation/construction works.
1.3.2 Acronyms

The following acronyms apply to this Specification:

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>AC</td>
<td>Alternating current</td>
</tr>
<tr>
<td>DC</td>
<td>Direct current</td>
</tr>
<tr>
<td>ELV</td>
<td>Extra Low Voltage</td>
</tr>
<tr>
<td>FAT</td>
<td>Factory Acceptance Test</td>
</tr>
<tr>
<td>ITP</td>
<td>Inspection and Test Plan</td>
</tr>
<tr>
<td>ITS</td>
<td>Intelligent Transport Systems</td>
</tr>
<tr>
<td>LV</td>
<td>Low Voltage</td>
</tr>
<tr>
<td>MFP</td>
<td>Multi-function pole</td>
</tr>
<tr>
<td>NB</td>
<td>Nominal bore (i.e. internal diameter)</td>
</tr>
<tr>
<td>PJB</td>
<td>Pavement junction box (pit)</td>
</tr>
<tr>
<td>TCS</td>
<td>Traffic control signals</td>
</tr>
<tr>
<td>TMC</td>
<td>Transport Management Centre (TfNSW)</td>
</tr>
<tr>
<td>WAE</td>
<td>Work-As-Executed (drawings)</td>
</tr>
</tbody>
</table>

2 GENERAL REQUIREMENTS

2.1 CONTRACTOR PREQUALIFICATION AND RESPONSIBILITIES

2.1.1 Contractor Prequalification

The Contractor carrying out TCS/ITS site works must be prequalified under the RMS Prequalification Scheme for Traffic Signal Contractors. Details of the Prequalification Scheme is available at the RMS website at: http://www.rms.nsw.gov.au/business-industry/partners-suppliers/tenders-contracts/prequalification-scheme.html

2.1.2 Contractor’s Responsibilities

You are responsible under this Specification for the installation of new, and/or reconstruction of existing, TCS in accordance with this Specification and TCS design plans. It includes (but not necessarily be limited to) the following:

(a) supply of all of materials and equipment for the Works, unless stated otherwise in the contract documents;
(b) preparation and submission of the electrical design drawings (refer Clause 3.2);
(c) incidental works, such as relocation of minor traffic signs, as directed by the Principal (refer Clause 2.6.3);
(d) preparation and submission of all handover documentation, including Work-As-Executed (WAE) drawings.
2.1.3 Temporary Utility Services

You are responsible for arranging utility services for your own use at the Site.

2.2 WORK HEALTH AND SAFETY, TRAFFIC CONTROL AND ENVIRONMENT

2.2.1 Work Health and Safety

Comply with the requirements of Specification RMS G22 for work health and safety.

In addition, where you are the “principal contractor” under the Work Health and Safety Regulation 2017 (NSW), provide signs displaying the following legend:

<table>
<thead>
<tr>
<th>TRAFFIC SIGNAL WORKS BY</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Contractor’s name)</td>
</tr>
<tr>
<td>(Contractor’s 24 hour contact telephone number)</td>
</tr>
</tbody>
</table>

at the following locations for the duration of the Works:

(a) On at least one warning device (refer Clause 2.2.2) at a prominent location within the Site. The letters and numbers must be in black colour, of minimum height 75 mm, on a white background.

(b) On both sides of at least two barrier boards at the Site. The letters and numbers must be in yellow colour, of minimum height 15 mm, on a black coloured stripe in the middle of the barrier board.

2.2.2 Traffic Control

Comply with Specification RMS G10 and the Traffic Control at Work Sites Manual for the control of traffic at the Site during construction, including Road Occupancy Licence.

In addition, provide high visibility warning device(s) to alert road users to the presence of works ahead.

2.2.3 Environmental Protection

Comply with the requirements of Specification RMS G36, including working outside of normal working hours.

2.2.4 Materials and Equipment Storage

Comply with RMS G36 for storage of equipment and materials, which must not disturb the surrounding environment.

Obtain prior approval from the NSW Police and appropriate local Council to store materials on footpaths. When storing materials on footpaths, do not obstruct driveways or free passage of pedestrian traffic.

If you propose to store equipment or material on private property, obtain prior approval from the property owner(s).
2.3 EXISTING UTILITY INFRASTRUCTURE AND ROAD OPENING PERMIT

2.3.1 Existing Utility Infrastructure

Before commencing work at the Site, make all necessary enquiries, including Dial Before You Dig, and carry out the necessary inspections to make yourself familiar with the type and location of all existing utility infrastructure, whether surface, underground and overhead.

Take all necessary measures to avoid damage to the existing utility infrastructure.

In the event that you damage any utility infrastructure, contact the utility owner immediately, and in conjunction with the utility owner, arrange for the repairs as soon as practicable. You will bear the full cost of such repairs, including the cost of restoration of the surrounding area.

2.3.2 Space Allocation for Underground Utility Infrastructure

Comply, insofar as is practicable, with the requirements of the “Model Agreement for Local Councils and Utility/Service Providers” and the “Guide to Codes and Practices for Streets Opening” published by the NSW Streets Opening Coordination Council.

If the proposed installation cannot be carried out due to the presence of existing utility infrastructure, immediately seek direction from the Principal in relation to any changes required for the installation.

2.3.3 Road Opening Permit

Before commencing any excavation work involving existing road pavement or footpath, obtain first the Road Opening Permit from the relevant authority where so specified in Annexure TS101/A.

2.4 PROGRAM

If not already submitted as part of the Contract Program in accordance with GC21 General Conditions of Contract, submit to the Principal an installation program for the TCS works. The installation program must show the commencement date of excavations at each TCS location, and the completion date of all electrical works.

If the TCS works are carried out in several stages, show in the installation program the commencement and completion dates for each of the different stages.

Take particular care when programming TCS reconstruction work, to ensure that the new TCS are ready for use when existing TCS are switched off and taken out of service.

Keep the installation program updated and current throughout the duration of the Contract.

If there is a change in the installation program, immediately inform the Principal in writing and submit a revised updated program.

2.5 NOTICE FOR INSPECTION

Provide the Principal with at least 24 hour notice for inspection of the following:

(a) Conduits, after installation but before backfilling over the conduits.
(b) Footings for mast arms (all types) and Type 6 posts, and other special post footings, before placing concrete.
(c) Footing for controller, before placing concrete.
2.6 ASSOCIATED WORKS

2.6.1 Associated Roadworks

At some locations, commencement of TCS works is dependent upon prior completion of the associated roadworks, such as alterations to existing kerbs and islands, or asphalting.

Details of the associated roadworks will be shown on the relevant roadworks drawings showing details of the proposed traffic staging.

The party responsible for coordinating these works with RMS, local Councils and other relevant authorities/agencies where necessary, to prevent interruption to the works and consequent delay in the Program, is stated in Annexure TS101/A.

2.6.2 Conduits Installed by Others

At some locations, cable conduits have been or will be installed by others.

Details of the extent and location of these conduits will be provided by the Principal before commencement of the Works.

2.6.3 Incidental Works

Remove or relocate any minor traffic signs (e.g. parking signs) which are in the way of the TCS installation, where so shown on the Drawings or as directed by the Principal.

The party responsible for the relocation of existing traffic facilities such as bus stop shelters and carrying out other incidental works such as removal or trimming of trees, is stated in Annexure TS101/A.

3 DESIGN DRAWINGS

3.1 TCS DESIGN PLANS

The Principal will provide you with electronic copies (in CADD file format) of the project TCS design plans.

A typical design layout for a signalised intersection is shown on Drawing No. VD002-22, and a typical design layout for a mid-block crossing is shown on Drawing No. VD002-20.

Standard positioning of TCS components at intersections is shown on Drawing No. VD001-5.

Symbols and abbreviations used on traffic signal drawings are shown on Drawing No. VD003-6 (Sheets 1 - 7).

3.2 ELECTRICAL DESIGN DRAWINGS

3.2.1 General

All drawings submitted by you (including those prepared by your electrical designer) must comply with all relevant requirements of applicable specifications and standards and must carry the RMS title block.
Unless otherwise specified, drawings must comply with the requirements of AS 1100. Traffic signal and other symbols must comply with AS 1100.401 and Drawing No. VD003-6 (Sheets 1 - 7).

3.2.2 Cable Installation Drawings

Submit cable installation drawings for each site to the Principal for review and acceptance.

Show in the cable installation drawings the position and size of all conduits, pits, cables, signal posts/mast arms, vehicle loop detectors, control equipment (i.e. controller), electricity supply points and associated components, true to scale, including all relevant dimensions to enable the position of all items to be clearly and unambiguously determined. All such dimensions must relate to property and kerb alignments.

Typical cable layouts are shown on Drawing Nos. VD002-21 and VD002-23.

3.2.3 Cable Connection Chart

Complete the cable connection chart for each site. The chart must include a cable layout and signal phasing diagram and must give full details of connections of all cables to control equipment, post top terminals, vehicle loop detectors and pedestrian push-button assemblies.

A typical example of a cable connection chart is shown on Drawing No. VD002-37.

3.3 Non-Standard Designs

3.3.1 General

Where items such as post footings and pits cannot be constructed in accordance with the standard designs shown in the standard drawings, and if project specific details are not provided, modify the design of the footing shown in the standard drawings and submit details of the modification to the Principal for acceptance before commencing installation.

3.3.2 Bridging Over Utility Infrastructure

Where other utility infrastructure run below the proposed footing, modify the design of the footing to bridge across them, so that they can be repaired or removed at any time without damage to either the footing or the utility infrastructure.

3.3.3 Excavation Near Embankment, Trench or Drain

Where a mast arm, Type 6 post or other special post footing is to be installed within 3 m of the edge of an embankment, a trench or a drain, or in soft unstable or previously disturbed soil, notify the Principal.

The Principal will assess the site conditions and may provide you with a modified design of the footing with increased excavation and improved anchorage.

3.3.4 Location of Pits

Do not locate pits in roadways unless approved by the Principal.

Do not locate pits in kerb ramps unless approved or directed otherwise by the Principal.
3.4 ACCEPTANCE OF CONTRACTOR DRAWINGS

At least 10 working days before the scheduled date of commencement of work at any TCS site, submit to the Principal electronic copies (in CADD and pdf format) of the cable installation drawings and cable connection chart for acceptance.

The Principal will endeavour to provide the review outcome of these drawings within 10 working days. If these drawings are not acceptable, you will be notified and the drawings will be returned with the appropriate comments for amendment and resubmission.

HOLD POINT

Process Held: Commencement of work at any TCS site.
Submission Details: Cable installation drawings and cable connection chart, at least 10 working days prior.
Release of Hold Point: The Principal will consider the submitted documents, and may require further revised submissions, prior to authorising the release of the Hold Point.

3.5 EXISTING BRIDGE STRUCTURE

3.5.1 Approvals

Before carrying out any excavation near, or installing attachments to, an existing bridge structure, submit to the Principal full details of the proposed method, supported by dimensioned diagrams. The Principal will arrange to obtain the necessary approvals from the relevant authority/agency responsible for the bridge structure.

HOLD POINT

Process Held: Excavating near or installing attachments to existing bridge structure.
Submission Details: Details of proposed work, supported by dimensioned diagram(s).
Release of Hold Point: The Principal will arrange to obtain the necessary approval for the proposed work, and may seek further information from the Contractor, prior to authorising the release of this Hold Point.

Do not commence any such work until you have been formally notified by the Principal of the receipt of approval from the authority/agency responsible for the bridge structure to the proposed work, together with details of special conditions attached to such approval.

3.5.2 Type 2 Post Installation on Existing Bridges

For Type 2 posts on existing bridges, use the installation details shown on Drawing No. VC002-45 and associated Drawing No. VM202-31. Do not use this detail for bridges to be constructed as part of the Works.
3.6 COMMENCEMENT OF CONSTRUCTION

Do not commence TCS work at any site until your submitted electrical design drawings have been accepted, unless approved otherwise by the Principal.

For the purposes of staging the Works, you may commence the associated civil works as soon as your proposed cable installation plan is accepted. However, do not commence the actual wiring of the cables until the proposed cable connection chart is accepted.

Construct the TCS works only in accordance with the accepted drawings.

4 MATERIALS AND EQUIPMENT

4.1 CONCRETE AND STEEL REINFORCEMENT

4.1.1 Concrete

Unless shown otherwise on the Drawings, concrete must be grade N25 with maximum aggregate size of 20 mm, complying with Specification RMS R53.

As shown on the Standard Drawings, concrete for footings for traffic signal posts or mast arms Types 5, 6, 9, 10 and 11 must be grade N32.

4.1.2 Steel Reinforcement

Steel reinforcement must comply with RMS R53.

4.2 CONDUITS AND ASSOCIATED ITEMS

4.2.1 Conduits

Conduits for electrical cabling must be orange rigid plastic heavy duty grade to AS/NZS 2053.

4.2.2 Couplings and Bends

Couplings must have a moulded stop in the centre to ensure equal engagement of pipes from both ends.

Bends must have a minimum internal radius of 230 mm and no sharp internal ridges.

4.2.3 Polymeric Cable Cover and Marker Tapes

Polymeric cable cover strip (orange colour) over conduits must comply with AS 4702 and be at least 3 mm thick.

Orange marker tape for laying above conduits must comply with AS 2648.1.
4.3 CABLES

4.3.1 General

All cables (whether multi-core cable, detector loop cable or detector feeder cable) must comply with Specification RMS TSI-SP-046.

4.3.2 Sealant for Cable Joints

Sealant for sealing cable joints must be “Type Approved” under Specification RMS TSI-SP-056.

4.4 EQUIPMENT SUPPLY

4.4.1 General

Supply all equipment and material required for the Works, except the site personality card for traffic signal controllers, which will be provided by the Principal. Where so stated in Annexure TS101/A, the Principal will also supply the controller.

All equipment supplied must comply with this Specification and other applicable RMS equipment specifications and drawings. Where RMS specifications and drawings do not exist, the equipment and material must comply with the relevant Australian Standards or, in their absence, the appropriate ISO or IEC standards.

4.4.2 Condition of Supplied Equipment

All equipment and material supplied by you must be brand new, unless stated otherwise in the Contract. Drawings for some of the major items of equipment are listed in Appendix TS101/M.

You may use recycled material and reconditioned equipment, where so stated in the Contract. Obtain approval from the Principal for the use of such material and equipment before commencing any work.

4.4.3 Care of Equipment Supplied

Where you have taken possession of equipment supplied by the Principal, you are responsible for their care until the TCS works has passed all relevant tests and handed over to the Principal.

Until this is done, make good any damage caused to the equipment during the time that they are in your possession at your own cost.

4.5 EQUIPMENT SELECTION

The critical TCS/ITS equipment selected for use, and installed for the Works, must be either RMS “Type Approved” or “Acceptable” items, as described below.

4.5.1 Equipment Listed in RMS TS200

The ITS equipment listed in RMS TS200 is considered to be suitable for this purpose, either under the “Type Approved” or “Acceptable” categories.

For some items such as traffic signal controllers, the manufacturer’s name as marked on the equipment is insufficient to determine their model and approval status. In some instances, the hardware’s firmware version may need to be identified. Such information may be found in the particular item’s type approval certificate.
4.5.2 Mechanical Items Shown on RMS Drawings

Mechanical parts/components that are fully described in the RMS Drawings listed in Annexure TS101/M are considered to be “Acceptable” items.

4.5.3 Project Specific Approval

For device(s) which are not “Type Approved” or “Acceptable” items under Clauses 4.6.1 and 4.6.2, you may seek approval for their use in accordance with the process stated in Specification RMS TS202.

Be aware that the assessment process for approval may require some considerable time, without any guarantee that a positive outcome will result at the end of the assessment process. Any delays arising from this approval process will not be a cause for an extension of time.

As part of the assessment process, provide any additional information from the manufacturer as requested by the Principal.

4.6 TRAFFIC SIGNAL POSTS, MAST ARMS AND LANTERNs

4.6.1 Traffic Signal Posts and Mast Arms

Traffic signal posts and mast arms must comply with Specifications RMS TSI-SP-043 and RMS TSI-SP-054 respectively and be an “Acceptable” item listed in RMS TS200.

4.6.2 Traffic Signal Lanterns

Traffic signal lanterns must comply with Specification RMS TSI-SP-045, which must be a “Type Approved” item listed in RMS TS200.

4.7 MISCELLANEOUS ITEMS

4.7.1 Mounting Brackets

(a) For Type 2 posts

Mounting brackets for Type 2 posts must be in accordance with Drawing Nos. VM200-14 and VM200-15.

(b) For mounting traffic signs


4.7.2 Offset Bracket Plates

Offset bracket plates for Type 2 post must be as shown on Drawing Nos. VM202-16 and VM202-17.

4.7.3 “Z” Brackets

“Z” brackets must comply with Drawing Nos. VM012-8, VM012-12, VM012-13 and VM012-20, as appropriate.
4.7.4 Mounting Straps

Mounting straps for the lanterns, complying with Drawing No. VM012-7, are normally supplied together with the lanterns.

4.7.5 Fuse Enclosure

Pole mounted fuse enclosure must comply with Drawing No. VM007-2.

Underground fuse enclosure must comply with Drawing No. VE500-10 and Specification RMS TSI-SP-061.

4.7.6 Lock Washers

Lock washers (in pairs) for use to lock lanterns in position must be in accordance with Drawing No. VM200-24.

4.7.7 Lantern Covers

Yellow lantern covers for use for new installations must be in accordance with Drawing No. VM418-1.

Black lantern covers for use on reconstruction sites must be in accordance with Drawing No. VM418-3.

4.7.8 Reflectorised Bands Around Signal Posts

Reflectorised bands applied around signal posts must be yellow pressure-sensitive Class 1 retro-reflective material in accordance with AS/NZS 1906.1.

5 IN-GROUND WORKS

5.1 Excavation

5.1.1 General

Use trenchless methods for the purpose of conduit installation wherever practicable and avoid trench excavations in roadways. Where use of trenchless methods is not possible, consult the Principal before commencing any trench excavation in the roadway.

The width of trenches for conduits must not exceed 0.4 m, as shown on Drawing Nos. VC001-8 and VC001-9.

Carry out trench excavations such that any disruption to vehicular and pedestrian traffic is kept to a minimum, and comply with the conditions of your Road Occupancy Licence.

Keep to a minimum the time each excavation is left open.
5.1.2 Saw Cutting of Existing Concrete Pavement

Where trench excavation is to be carried out on an existing concrete pavement, before commencing excavation, saw cut the edge of the trench to a depth of not less than 50 mm. Do not carry out the saw cutting until you have established that there is no existing utility infrastructure within the trench area.

For saw cutting and removal of parts of the existing pavement slab, comply with the Standard Drawings for rigid pavement maintenance. These Standard Drawings are available on the RMS website at:


Where excavation for post footing is to be carried out on an existing pavement, the edge of the pavement above the post footing excavation must be neatly and squarely trimmed.

5.2 BACKFILLING AND SPOIL DISPOSAL

5.2.1 Backfilling

Backfilling and compaction must comply with the relevant specifications and/or, where applicable, the conditions of the Road Opening Permit.

Backfill the excavations in accordance with Clause 5.3.6.

If excavated material is used to backfill footway excavations, it must be free from rocks, stones, pavement material or organic matter.

5.2.2 Spoil Removal

Remove excess spoil before the end of each day’s work. Prevent stockpiled spoil from being washed down nearby drains in accordance with RMS G36.

5.3 CONDUIT INSTALLATION

5.3.1 Conduit Sizes

The size of conduits must be such that they provide adequate clearance for pulling of cables without risk of damage during installation. Drawing No. VR007-6 shows the number of cables which can be safely accommodated in various size conduits.

The size of the conduits for their intended use must be in accordance with Table TS101.1.
### Table TS101.1 – Minimum Conduit Sizes

<table>
<thead>
<tr>
<th>Permitted Use</th>
<th>Nominal Bore (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>In footways and roadways</td>
<td>80 (2)</td>
</tr>
<tr>
<td>In roadways for mid-block pedestrian signal installations</td>
<td>50 (3)</td>
</tr>
<tr>
<td>Underground power supply, or underground section of overhead power supply</td>
<td>25</td>
</tr>
</tbody>
</table>

**Notes:**
1. Excludes telecommunications conduit to network connection points (refer Clause 5.11).
2. Where it is impractical to install an 80 mm NB conduit by trenchless methods, obtain approval from the Principal for smaller bore conduits.
3. All roadway conduits must be 80 mm NB, except for mid-block pedestrian signal installations where 50 mm NB conduits are permitted.

### 5.3.2 Installation

When installing conduits in the vicinity of existing utility infrastructure, comply with the requirements of the utility owners.

For conduits under roadways and footways installed by open trenching, install a minimum of two 80 mm NB conduits laid side-by-side. If more than two conduits are to be provided, stack the additional conduits on top of the lower layer.

Do not install more than two 90° bends between any two junction pits and/or footings.

Provide polyethylene rope of 10 mm minimum circumference inside the full length of all conduits (whether under roadway or footway) for use to draw cables.

### 5.3.3 Minimum Cover for Conduits

For new installation, provide a minimum cover over the conduits as follows:

(a) **in roadways:**
   i. 0.75 m when installed by open trenching;

(b) **in footways:**
   i. 0.5 m.

For conduits running along the length of the median, provide a minimum cover of 300 mm as measured from the original road surface, and the concrete medians, islands or blisters must be at least 75 mm thick.
5.3.4 Joints

When jointing conduits, before insertion, clean thoroughly the interior of the fitting (whether coupling or bend) and the external end of the conduit, and coat the surfaces to be jointed with an approved bonding agent.

Except where fully encased in concrete, such joints must have an overlap equivalent to the nominal bore of the conduit.

5.3.5 Terminations

Terminate all conduits either at a junction pit or footing. Always terminate conduits crossing multiple carriageways at junction pits.

Where two or more conduits cross multiple road carriageways, only one conduit can be interrupted at the junction pit located in the median or island. Where this is not practical, consult with the Principal to confirm if additional conduits can be interrupted.

5.3.6 Backfilling

Backfill around the conduits with clean sand up to at least 50 mm above the conduits.

For trenches in roadways, backfill over the sand surround with a 14:1 sand/cement mixture and install orange marker tape, as shown on Drawing Nos. VC001-8 and VC001-9.

For trenches in footways, install polymeric cable cover at approximately 60 mm above the conduit when backfilling with sand, then backfill with ordinary fill over the sand surround and install orange marker tape as shown on Drawing Nos. VC001-8 and VC001-9.

Compact the backfill before applying the temporary or permanent pavement restoration.

5.3.7 Steel Plate Protection

Where the cover over the conduits:

(a) installed by open trenching is less than 0.5 m in roadways;
(b) is less than 0.3 m in footways;

place hot-dip galvanized steel plates measuring 0.6 m x 0.3 m x 12 mm thick, on the top of conduits but under the polymeric cable cover strip, for additional protection as directed by the Principal.

Record details of the position of steel plates and show the details on the Work-As-Executed drawings (refer Clause 10.3).

Payment for this work will be made under Pay Item TS101P2, where such a pay item is provided.

5.4 Temporary Pavement Restoration

This Clause 5.4 is applicable only if final restoration is to be carried out by others (refer Clause 10.1.2).

After backfilling in accordance with Clause 5.3.6, seal the surface with a temporary layer of approved asphaltic material of minimum thickness 150 mm in roadways (asphalt pavements only) and 50 mm in footways, as shown on Drawing Nos. VC001-8 and VC001-9.
In footways paved with paving blocks, do not use asphallic material, but replace with paving blocks placed on compacted and levelled sand unless otherwise shown on the Drawings or directed by the responsible authority/agency.

5.5 FOOTWAY PITS

5.5.1 Pavement Junction Box Pits

Use pavement junction box (PJB) pits in footways to protect and provide access to vehicle detector cable joints, earth electrodes (where these cannot be installed in the controller footing), and at an acute angle change of direction of conduits.

PJB pits must be in accordance with Drawing No. VC007-4.

The sizes of PJB pits used must be in accordance with Table TS101.2.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Size of PJB Pit</th>
</tr>
</thead>
</table>
| Maximum of two 29-core cables passing through pit  
Maximum of four conduits entering pit | Small |
| Maximum of four 29-core cables passing through pit  
Maximum of five conduits entering pit | Large |
| Five or more 29-core cables passing through pit  
Six or more conduits entering pit | Extra large |

Note:

(1) Refer Drawing No. VC007-4.

The open ends of conduits must be at least 150 mm from the bottom of the pit as shown on Drawing No. VC007-4.

Where the depth (measured from the top of the footway) of the entering conduit exceeds 820 mm, entry into the pit must be via a bend, to ensure that the opening is at least 150 mm above the bottom of the pit.

5.5.2 Large Footpath Cable Junction Pit

In special situations, the Principal may direct that a large footpath cable junction pit be constructed in place of a PJB pit. Large footpath cable junction pits must be in accordance with Drawing No. VC007-5.

5.6 ROADWAY PITS

5.6.1 General

Do not locate pits in roadways unless approved by the Principal (refer Clause 3.3.4).

Pits in roadways must be capable of withstanding traffic wheel loading in accordance with AS 5100. The roadway pit design must be approved by RMS, and such pits must be provided with a heavy-duty cover and frame complying with Specification RMS TSI-SP-055.
5.6.2 **Drainage**

You may drain roadway pits into the stormwater drainage system, subject to the approval of the relevant authority.

5.7 **TRAFFIC SIGNALS ON MULTI-FUNCTION POLES**

Where traffic signals are installed on multi-function poles (MFPs), the conduit connecting from the junction pit to the MFP footing for use by RMS must be 80 mm NB complying with Clause 4.2.1, and extending to the centre of the pole. This will allow for the temporary replacement of the MFP with a standard Type 2 traffic signal post mounted on an adaptor stool in the event of an accident or relocation.

Each MFP must have an adjacent pit installed for traffic signal cable storage and access. This pit must be a PJB pit, extra large size, in accordance with Drawing No. VC007-4.

5.8 **CONCRETE WORK - GENERAL**

5.8.1 **Concrete Work**

Concrete work, including formwork and steel reinforcement, must be in accordance with RMS R53 unless specified otherwise in this Specification.

5.8.2 **Sampling and Testing**

Sampling and testing must be in accordance with RMS R53.

Provide a copy of the test reports to the Principal.

The cost of sampling and testing will be borne by you.

5.9 **POST AND MAST ARM FOOTINGS**

5.9.1 **General**

Post and mast arm footing and associated holding down bolt assembly must be in accordance with the details shown on the Drawings listed in Table TS101.3.
Table TS101.3 – Post and Mast Arm Footing and Associated Holding Down Bolt Details

<table>
<thead>
<tr>
<th>Type</th>
<th>参考图号</th>
<th>扩展螺栓图号</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type 2 post</td>
<td>VC002-71</td>
<td>VC002-27</td>
</tr>
<tr>
<td>Type 6 post</td>
<td>VC002-72</td>
<td>VC002-38</td>
</tr>
<tr>
<td>Type 7 and 8 posts</td>
<td>VC002-59</td>
<td>VC002-60</td>
</tr>
<tr>
<td>Type 13 post</td>
<td>VC002-66</td>
<td>VC002-67</td>
</tr>
<tr>
<td>Mast Arm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type 4 mast arm</td>
<td>VC002-75</td>
<td>VC002-50</td>
</tr>
<tr>
<td>Type 5 and 9 mast arms</td>
<td>VC002-72</td>
<td>VC002-38</td>
</tr>
<tr>
<td>Type 10 and 11 mast arms</td>
<td>VC002-65</td>
<td>ME10728 Sheet 4</td>
</tr>
</tbody>
</table>

5.9.2 Setback Distances

Unless shown otherwise on the relevant TCS design plan, do not install post or mast arm on a footway (except for Type 10 posts) closer than 0.6 m in from the face of the kerb.

Comply with Drawing No. VD001-5 for minimum setback distances.

The Principal may vary the position and shape of the footings, where the underground services or the overhead awning prevent it from being installed in the nominated position. Where necessary, offset bracket plates (refer Clause 4.7.2) may be used to offset a Type 2 post on a standard footing (in situations such as reconstruction of existing signals).

Do not install post or mast arm footing above a joint, valve or similar device located within any service mains running below the footings.

5.9.3 Concrete Footing Construction

Construct concrete footings for all types of mast arm and Type 6 posts and other special posts on previously well compacted soil, within excavations specially carried out for these footings. Do not install these footings within excavations carried out for other purposes (e.g. under-road boring).

Place concrete for the footing directly in contact with the sides of the excavation. Where this is not practical, construct the footing using formwork, and backfill the space between footing and the adjacent ground and compact fully.

Where formwork is used, it must be removed on completion of the work.

Grease the exposed threads of holding down bolts and protect them with a suitable cap or sleeve, before placing concrete.

5.9.4 Footing Construction to Modified Design

Before commencing construction of footings to a modified design (refer Clause 3.3), submit details of the modified design for the Principal’s consideration.
5.10 CONTROLLER HOUSING FOOTINGS

5.10.1 Ground Mounted Controller

Footing for ground mounted standard controller housing must be in accordance with Drawing No. VC002-73.

Footing for ground mounted small controller and CCTV housing must be in accordance with Drawing No. VC002-76.

Ensure that the 20 mm NB conduit for the telecommunications line into the controller is aligned correctly during construction of the footing.

Holding down bolts for housing footing must be in accordance with Drawing No. VC002-56.

5.10.2 Post Mounted Controller

Where so shown on the relevant TCS design plan, simple controllers may be accommodated in weatherproof housings fastened to one of the signal posts, in accordance with Drawing No. VM625-17.

Footing for Type 2 post with post mounted controller must be in accordance with Drawing No. VC002-43.

Construct a concrete slab to connect the post footing, the PJB pit containing the earth electrode, and the telecommunication line access pit (refer Clause 5.10.3) such that they are all integral with each other, as shown on Drawing No. VC002-43.

5.10.3 Jointing Pit

Unless otherwise shown on the TCS design plan, each controller footing must incorporate a precast jointing pit, to connect with the telecommunications line conduit (installed by others, refer Clause 5.11), in accordance with Drawing Nos. VC002-73 or VC002-43.

Install an insulated draw-wire inside the 20 mm NB conduit between the terminal box on the side of the controller housing and the precast jointing pit.

5.10.4 Holding Down Bolt Installation

Use a template during construction of the controller footing to ensure that the bolt centres of the holding down bolts are installed at their correct positions, in order to fit holes in the frangible plates supplied with the controller housing.
5.11 TELECOMMUNICATIONS LINE CONDUIT

RMS will apply to the telecommunications service provider for the provision of a telecommunications line connection to the controller (where required).

The telecommunications service provider (or its contractor) will install the telecommunications line within a 20 mm NB conduit, up to the jointing pit located next to the controller housing (refer Clause 5.10.3).

Coordinate with the telecommunications service provider (or its contractor) for this work.

6 ABOVE GROUND WORKS

6.1 SIGNAL POSTS AND MAST ARMS

6.1.1 General

Unless otherwise directed or approved by the Principal, do not commence erection of signal post or mast arm, unless all other equipment needed for the completion of the traffic light signal installation is available, and until the necessary traffic staging has advanced to a stage where all components can be installed without creating a traffic hazard, and conduit and pit installation is complete.

Do not erect mast arms, Type 6 posts and other special posts on a footing until at least 7 days have elapsed after placing of the concrete, or the concrete has achieved the specified strength, whichever occurs first.

HOLD POINT

Process Held: Erection of signal post(s) or mast arm(s) on site.

Submission Details: Evidence that all needed equipment is available and necessary traffic staging is complete, and concrete strength test results where appropriate.

Release of Hold Point: The Principal will consider the submitted details, prior to authorising the release of the Hold Point.

6.1.2 Assembly and Erection

Assemble mast arms in accordance with the details shown on the Drawings listed in Table TS101.4.

Table TS101.4 – Mast Arm Assembly

<table>
<thead>
<tr>
<th>Mast Arm Type</th>
<th>Reference Drawing No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 5 (1) mast arm</td>
<td>VM211-26</td>
</tr>
<tr>
<td>Type 9 mast arm</td>
<td>VM215-1</td>
</tr>
<tr>
<td>Other types (2)</td>
<td>Relevant design drawings and assembly instructions</td>
</tr>
</tbody>
</table>

Notes:

(1) Type 5 (tapered) mast arm must have an overlap at the joint of at least 360 mm.
(2) Drawings for Types 10 and 11 mast arms can be obtained from the Principal.
Erect the posts and mast arms vertically.

Take all necessary precautions to prevent damage to the galvanising coating of the mast arm sections during assembly and erection.

Maintain the safety clearances shown on Drawing No. VM211-20 for mast arms and Type 6 posts from overhead power lines and communications cables. Promptly notify the Principal if these safety clearances cannot be achieved.

### 6.1.3 Erection of Special STOP Signs

Where shown on the TCS design plan for new installation, attach special STOP signs (R1-4N) in accordance with Drawing No. VM202-12, to those posts located on each of the minor approaches.

Erect the signs at the same time as when lanterns are installed. Temporarily cover up the special STOP signs if they conflict with existing traffic signs during construction.

### 6.1.4 Installation of Post/Mast Arm through Awning

Where a post/mast arm cannot be relocated and it is necessary for a post/mast arm to pass through an existing awning, consult with the owners of the affected property and obtain their approval to undertake modifications to the awning. Make good any hole created in the awning, to the satisfaction of the property owner and the Principal.

Provide a clearance of 25 mm all around between the post/mast arm and the awning, and a gutter to prevent rainwater from the awning flowing into the opening. Comply with any other requirements (such as provision of flashing) which are specified by the local Council.

### HOLD POINT

<table>
<thead>
<tr>
<th>Process Held:</th>
<th>Making any opening or hole through an awning.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Submission Details:</td>
<td>Evidence that the necessary approvals have been obtained from the owner(s) of the affected property.</td>
</tr>
<tr>
<td>Release of Hold Point:</td>
<td>The Principal will review the documents provided, and inspect the preparation work completed, prior to authorising the release of this Hold Point.</td>
</tr>
</tbody>
</table>

### 6.2 TRAFFIC SIGNAL LANTERNS

#### 6.2.1 Mounting Arrangement

Mount traffic signal lanterns in accordance with the details shown on the Drawings listed in Table TS101.5.
Table TS101.5 – Traffic Signal Lantern Mounting Arrangement

<table>
<thead>
<tr>
<th>Post and Mast Arm Type</th>
<th>Reference Drawing No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 2 post</td>
<td>VM202-8</td>
</tr>
<tr>
<td>Type 6 post</td>
<td>VM212-2 and VM211-17</td>
</tr>
<tr>
<td>Type 5S (short) mast arm</td>
<td>VM211-6 Sheet 1</td>
</tr>
<tr>
<td>Type 5L (long) mast arm</td>
<td>VM211-21</td>
</tr>
<tr>
<td>Type 5XL (extra-long) mast arm</td>
<td>VM211-17</td>
</tr>
<tr>
<td>Type 9 mast arm</td>
<td>VM215-1</td>
</tr>
</tbody>
</table>

Mount vehicle lanterns on Type 2 posts at the top of such posts, unless otherwise shown on the relevant TCS design plan.

Provide below any target board (refer Clause 6.2.6) a clearance of 2.4 m where practical, but in any case provide a clearance of not less than 2.0 m.

Mount pedestrian lanterns such that the top of such lanterns is approximately 3 m above pavement level.

Install pedestrian lanterns on the pedestrian crossing side of the post/mast arm/pole, unless directed otherwise by the Principal.

Provide below any pedestrian and bicycle lanterns a minimum clearance of 2.4 m.

6.2.2 Attachments to Wooden Poles

For attachments of lanterns to an existing wooden pole, comply with the arrangement shown on Drawing Nos. VM015-16 and VM015-18.

Vehicle lanterns on wooden poles must be mounted at approximately 4 m above pavement level.

Provide the special terminal box assembly as shown on Drawing No. VM015-21.

6.2.3 Aim Point

(a) Vehicle Lantern

Attach vehicle lanterns (except overhead lanterns on mast arms) to the post/mast arm/pole such that it is aimed at a point located at a height of 1.4 m within 150 m of the stop line on the approach to which the signal is directed. For primary lanterns located at the stop line, this point will be located at a minimum distance of 15 m from the stop line.

(b) Pedestrian Lantern

Attach pedestrian lantern to the post/mast arm/pole such that it is aimed at the centre of the appropriate pedestrian crossing at the opposite side of the roadway, at a height of 1.5 m above the kerb.

6.2.4 Mounting Using Mounting Strap

Mount the required number of lanterns neatly and compactly on the post/pole using mounting straps (refer Clause 4.7.4).
Mount lanterns and ancillary attachments as far back as practicable from the front face of the kerb.

Maintain the minimum distance between any part of a lantern, its visors, or target board and the roadway as shown on Drawing No. VM202-8.

You may use “Z” brackets (refer Clause 4.7.3) to raise the height of a lantern under an awning.

Install only one lantern strap on each lug screw at the TCS post/mast arm/pole.

During installation, space (vertically) the mounting straps to suit the mounting distances of the lanterns to avoid subjecting the lantern bodies to bending stresses, which can cause cracking of the lanterns in the long-term and impair the weatherproofing qualities. Where necessary, provide spacers or offset brackets to satisfy this requirement.

### 6.2.5 Locking Using Lock Washer

Lock all lanterns in position using lock washers (refer Clause 4.7.6) as shown on Drawing No. VM200-28.

Install all dual lanterns using the tee-bar method of mounting with lock washers as shown on Drawing No. VM200-27.

### 6.2.6 Target Boards

Fit all vehicle lanterns with target boards in accordance with the requirements of AS 2144.

### 6.2.7 Obstruction to Lantern Mounting and Target Board

Notify the Principal if local obstruction(s) is found to prevent mounting of lantern(s) in the stipulated position(s).

#### HOLD POINT

<table>
<thead>
<tr>
<th>Process Held:</th>
<th>Mounting lantern(s) in the stipulated position(s) due to local obstruction.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Submission Details:</td>
<td>Proposal to overcome local obstruction.</td>
</tr>
<tr>
<td>Release of Hold Point:</td>
<td>The Principal will examine the proposal and may require additional details or amendments to the proposal, prior to authorising the release of the Hold Point.</td>
</tr>
</tbody>
</table>

You may cut away target boards to avoid local obstructions, such as awnings, so that the traffic signal may be located and aimed in the required manner. Where you consider that the cutting of the target board is extensive or impractical, you may omit the target board with the approval of the Principal.

### 6.2.8 Lantern Leads

Trim lantern leads to form a drop below the entry point and tie them neatly to the post or mast arm as shown on Drawing Nos. VM202-8, VM211-21, VM211-17 and VM015-16.

Maintain every part of the flexible, exposed cable at least 2.5 m above pavement level.
6.2.9 Covering of Lanterns

Immediately after erection of signal lanterns at new sites and until the traffic light signals are commissioned, cover the street-level primary lanterns facing each approach and any lanterns on median/island posts with yellow lantern covers (refer Clause 4.7.7).

Attach the covers neatly and tie them securely to the lanterns so that they remain in position under all weather conditions.

For TCS reconstruction, cover the lanterns with black lantern covers (refer Clause 4.7.7) if the installation must be left blacked-out for more than two hours or such other period as determined by the Principal.

6.3 Pedestrian Push-button Assemblies and Audio-tactile Facilities

6.3.1 General

Attach pedestrian push-button assemblies to posts/mast arms as shown on the TCS design plan.

Install audio-tactile push-button assemblies (and associated electronic driver units) only where specified on the TCS design plan.

6.3.2 Push-button Assembly Set Up

Orientate the arrow disc on pedestrian push-button assemblies as shown on Drawing No. VD001-7.

For push-button assemblies on median posts, replace the standard single-headed arrow disc with a two-headed arrow disc, as shown on Drawing No. VD001-7.

The mounting height and alignment of push-button assemblies must be as shown on Drawing Nos. VD001-5 and VD001-6.

Where shown on the TCS design plan, mount push-button assemblies on wooden poles, attached to the 65 mm NB mild steel pipe as shown on Drawing No. VM015-16.

6.3.3 Audio-tactile Facilities

Comply with Drawing No. VE530-8 for installation of audio tactile facilities.

Where the audio-tactile push-button assembly is installed on a traffic signal post or mast arm, mount the associated weatherproof housing for the electronic driver unit at normal pedestrian lantern height, so that convenient access can be obtained from a ladder placed on the footpath (refer Drawing Nos. VE530-8 and VM202-8).

6.4 Traffic Signal Controller

6.4.1 Ground Mounted Controller

Install ground mounted controllers on concrete footings constructed in accordance with Clause 5.10.1.

Check that the 20 mm NB conduit for the telecommunications line into the controller has been aligned correctly, and position correctly the frangible mounting plates of the housing during installation.

Install the controller strictly in accordance with the manufacturer’s installation instructions. Any variation from the manufacturer’s instructions must be approved by the Principal.
6.4.2 Post Mounted Controller

In accordance with RMS Technical Direction TDT 2010/06, do not install post mounted controllers at new sites or for major upgrade of sites which have existing post mounted controllers.

Where the controller housing is mounted on the signal post, position it so that access to the plug-in modules is from the footpath side.

Install the controller housing generally as shown on Drawing No. VM625-17.

6.5 SPECIAL FACILITIES

Where specified on the TCS design plan, provide special facilities, such as auxiliary signals in Fire/Ambulance stations. Typical connections are show on Drawing No. VE535-1. Provide conduits to fully enclose all cables to this auxiliary equipment.

For other special requirements such as signals linking to other signal installations or railway level crossing equipment, comply with the requirements shown on the TCS design plan where applicable.

6.6 SURFACE TREATMENT

6.6.1 Protective Surface Treatment

Make good any damage caused to the equipment, and in particular its protective surface treatment, during transport, storage or installation.

You do not need to paint signal posts and mast arms which have been hot-dip galvanized, but repair any areas where the protective coating has been damaged during transport, storage or installation by recoating them with a cold-curing galvanizing paint conforming to AS/NZS 3750.9.

6.6.2 Reflectorised Bands

For all posts located on medians, and those located in exposed positions on other islands, apply 1.2 m wide reflectorised bands complying with Clause 4.7.8 around the entire circumference of the post, with the lower edge at 0.75 m from ground level.

Apply the reflectorised bands immediately after erection of the post on site.

6.7 TRAFFIC SIGNS ON SIGNAL POSTS

Where traffic signs are to be installed on signal posts as shown on the TCS design plan, mount them using standard mounting brackets (refer Clause 4.7.1(b)). Install lock washers at each hinged joint (refer Drawing No. VT006-60).

Do not attach the signs directly to the lantern target board or bracket. Do not attach the sign brackets to the same mounting points as that for lanterns or other traffic signal equipment.

Mount the signs in such manner that they do not restrict observation of the traffic signals by drivers and pedestrians, or block access to the lanterns by preventing full opening of the lantern doors.

Do not use bands for mounting signs permanently, but you may use bands to mount signs temporarily for a period of up to one month, unless otherwise approved by the Principal.
7 Cabling Works

7.1 General

7.1.1 Quality Documentation

Before installing any cable, submit documentation verifying that the cable has been tested and complies with the requirements of RMS TSI-SP-046.

7.1.2 Cable Types

Cabling between the controller and signal posts/mast arms must be 29-core cable complying with RMS TSI-SP-046 (refer Clause 4.3).

Cabling between loop detector junction points and the associated controller sensor unit (known as detector feeder cable) must be single or multi-pair screened cable complying with RMS TSI-SP-046.

Cabling to posts used solely for provision of pedestrian push-button facilities must be standard 7/0.40 gauge (1.5 mm²) insulated cable, complying with AS/NZS 3808, with four insulated cores in addition to an earthing conductor.

Cables carrying the incoming electricity supply must be 6 mm² single double-insulated 240V AC grade cable, unless specified otherwise by the local Electricity Supply Authority or the Principal.

For all 29-core cables, provide at least three spare cores in each cable.

7.2 Cable Layout (Cabling Rules)

Each cable must only have a single circuit back to the controller; i.e. ring circuits or overlapping circuits are not permitted.

Run cables from the controller to a mast arm first before connecting to other types of posts, unless otherwise directed or approved by the Principal.

For all cases (except as provided in the next paragraph below), a maximum of two 29-core cables may connect to a signal post/mast arm, unless otherwise directed or approved by the Principal. This restriction does not apply to 5-core cables.

For a single post located on a median, only one 29-core cable may connect to the post. This restriction does not apply to 5-core cables.

This requirement for a single cable connection may be relaxed for extra wide medians (i.e. wider than 3 m) where there are two or more posts, and for TCS reconstruction sites (refer Clause 8) where capacity of the existing conduit (crossing the road) precludes installation of any extra cables. The cables connecting to the second and subsequent posts may be a 5-core cable.

Where the size of the existing road crossing conduit precludes the installation of an additional 29-core cable within the existing conduit, a 5-core cable may be installed instead, but only for connection to pedestrian push-button assemblies mounted on a short post, where approved by the Principal.

At each TCS site, run separate cables directly from the controller to posts/mast arms located at each corner (including triangular islands and slip lanes) and medians. The cable for the post on a median may be connected to a post at a corner as long as the cable is not connected to the cable run for the adjacent primary post on the same approach.
7.3 CABLE INSTALLATION

7.3.1 General

Install all TCS cables inside conduits acting as protective cover for the cables.

7.3.2 Pulling Cables

When pulling cables through conduits, implement the following measures to avoid damage to the cables:

(a) Do not use ratchets, levers, winches or other mechanical devices of any kind to pull the cables.
(b) Feed the cable manually into the conduit when the cables are being pulled through the conduits.
(c) Do not allow any cable to bear on any sharp edge of a pit or concrete footing while being fed into a conduit or being pulled out of a conduit.
(d) Pull the cables only through one conduit section at a time. For the purposes of this Specification, one conduit section is the length of conduit between two successive access points along a given cable route.
(e) Ensure that the cable is not twisted or kinked as it is being fed into the conduit.

7.3.3 Maximum Number of Cables in Conduits

The maximum number of cables which can be installed in underground conduits must be in accordance with Drawing No. VR007-6, except where the conduits are existing.

Where the underground conduits are existing, the maximum number of cables allowable must be such that it will permit the installation of the cables without damage.

7.3.4 Provide Additional Length of Cable

Provide, where applicable, at least an additional one metre of cable coiled within the footing for each traffic signal post/mast arm and controller, and in each PJB or access pit.

Where traffic signals are installed on MFP (refer Clause 5.7), provide an additional 3 metres (4 metres in total) of each 29-core traffic signal cable stored in each pit adjacent to the MFP, to enable installation of a Type 2 traffic signal post on an adaptor stool.

7.3.5 Cable Arrangement Inside Pit

Position each cable inside a pit such that it causes the minimum obstruction to other cables already installed and conduit entries into the pit.

7.4 CABLE JOINTS

7.4.1 General

Except where shown otherwise on the Drawings, do not make joints in cables without the prior approval of the Principal.

For reconstruction sites where cables are directly buried in the ground without conduits, avoid jointing cables where practicable. Do not make more than one joint in any cable run.

Do not place joints in cables inside conduits.
7.4.2 Jointing Method

Carry out jointing of cables in accordance with Drawing No. VM417-3. Do not carry out jointing of cables when any trace of water/moisture is present on the cable to be jointed.

7.4.3 Protection from Environment

Where jointing is not carried out immediately after cable installation, seal the ends of the cable to prevent entry of moisture into the interstices of the cable.

Before completion, protect temporary cable joints with a suitable IP68 rated enclosure.

7.5 CABLE TERMINATION

7.5.1 General

All cable termination work must be carried out by a licensed electrician qualified to perform electrical installation work as required under the *Home Building Act 1989 (NSW)*.

Cable termination work includes, but is not limited to:

(a) removal of sheathing,
(b) stripping of conductors,
(c) fitting of lugs,
(d) soldering of conductors,
(e) application of heat-shrink insulation,
(f) securing of lugs in the terminal block, and
(g) looming and tying of cores.

All cable termination work must comply with the requirements of AS/NZS 3000 and AS/NZS 3100 except where amended by this Specification.

7.5.2 Termination Procedure - General

Connect the individual conductors within the cable cores to the appropriate numbered terminal in accordance with the approved cable connection chart. Individual cores may be disconnected from any terminal if convenient for subsequent maintenance.

Bunch together and lace (without using cable ties) the cable cores in a tidy manner, and such that all terminal labelling remains visible.

Terminate the conductor using an approved type pre-insulated double grip (PIDG) lip blade crimp lug that grip the cable insulation as well as the copper strands, using a ratchet type crimping tool.

Insert lip blade crimp lugs correctly in the terminals in accordance with Drawing No. VM417-5. Do not use solder type terminations, except for the inter-connection of the detector loop cable and the feeder cable within the pavement junction box.

7.5.3 Controller

Securely support all cables entering the controller housing at their outer sheath to ensure that mechanical strain is not transmitted to the electrical connections.
For post mounted controller, the cables must enter the housing through a support post as shown on Drawing No. VM623-2.

Neatly form and tie the individual cores together, and position them such that access to housing terminals is not obstructed and terminal designations are not obscured.

Individually label each cable in accordance with its designation as shown on the approved cable connection chart. Identify clearly all cables using approved cable markers or approved, non-fading insulated tags securely tied to the cable in a readily visible position.

Terminate each conductor of the cable with a crimp type PIDG lip blade terminal (refer Clause 7.5.2).

7.5.4 Traffic Signal Post or Mast Arm

Bring the cables up the interior of the signal post or mast arm, and terminate them on the top terminal assembly. Do not lace together the cores of different cables in the same loom.

Firmly support all cables such that the weight of the cable does not impose mechanical strain on the electrical connections.

Clearly tag each cable with an approved type of permanent marker appropriate to its identification on the approved cable connection chart.

Clamp the lantern conduits on the post top assembly in accordance with Drawing No. VR017-11.

7.5.5 Pedestrian Push-button Assemblies

Connect the cabling as shown on Drawing No. VE530-7.

Connect the 2-core cable (white colour figure 8) directly to and terminate at the transducer in the push-button assembly. Terminate the remaining cable cores from the driver unit at the terminal assembly.

The standard colours for the insulated cores must be allocated as follows:

<table>
<thead>
<tr>
<th>Colour</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>Push-button active</td>
</tr>
<tr>
<td>Black</td>
<td>Common (ELV) Return</td>
</tr>
<tr>
<td>Green Yellow</td>
<td>Earth</td>
</tr>
<tr>
<td>White</td>
<td>Audio-tactile transducer</td>
</tr>
<tr>
<td>Blue</td>
<td>Audio-tactile transducer</td>
</tr>
</tbody>
</table>

7.6 DETECTOR LOOPS

7.6.1 General

The six types of inductive loop detectors currently in use are as follows:

(a) 4.5 m long stop-line detector;
(b) 11 m long turning-lane detector;
(c) queue detector;
(d) counting detector;
(e) advance detector;
(f) bicycle stop-line detector.

Run loop feeder cables directly from the loop detectors back to the sensor unit, normally located in the controller housing, through conduits and pits without passing through post footings.

### 7.6.2 Feeder Cable Layout

Typical installation of detector loops at intersections is shown on Drawing No. VC001-9.

Stop-line detector loops in each lane must be connected individually to the sensor unit to enable traffic in each lane to be detected separately. Each 2-loop section of 11 m turning-lane detectors must be separately connected to the sensor unit.

Advance detector loops are normally combined in series to provide two lanes per sensor.

Typically, two detector loops located for one bicycle lane must be connected into detector input channel separately.

### 7.6.3 Installation Procedure

Install the various types of detector loops in accordance with the Drawings listed in Table TS101.6 at the positions shown on the relevant TCS design plan.

#### Table TS101.6 – Detector Loop Installation

<table>
<thead>
<tr>
<th>Detector Loop Type</th>
<th>Reference Drawing No. for</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Installation Method</td>
</tr>
<tr>
<td>Stop-line (presence) detector</td>
<td>VC005-17</td>
</tr>
<tr>
<td>Advance (passage) detector</td>
<td>VC005-18</td>
</tr>
<tr>
<td>Bicycle stop-line detector</td>
<td>VC005-36</td>
</tr>
</tbody>
</table>

If installing by sawcutting the pavement, clear the saw-slots of debris and moisture before installation of the loop cable.

Joint the loop cables to single or multi-pair screened feeder cables, and run them directly back to the controller housing.

Before jointing the loop cables and application of sealant to the saw-slots, carry out a wiring check.

### 7.6.4 Pre-formed Detector Loops

Use approved pre-formed vehicle detector loops for new concrete pavements.

The recommended default installation depth is 40 mm to 50 mm (measured from the finished pavement surface) for concrete pavement with asphalt overlay to achieve reliable detection.

### 7.7 Electricity Supply

#### 7.7.1 General

The Principal will apply for the permanent electricity supply for the TCS operation. The Principal will notify you as soon as a reply is received from the relevant Electricity Supply Authority. Do not
commence any work on excavation for installation of electricity supply cables until you have been so notified.

The point and method of connection of the electricity supply shown on the TCS design plan is preliminary only, and is subject to confirmation.

Cables carrying the incoming electricity supply must comply with Clause 7.1.2.

### 7.7.2 Conduits and Sleeves

Where the conduit is pre-existing, the supply cable may be installed inside a common conduit together with the signal cables.

Where the supply cable passes through an PJB pit, it must be sleeved with (flexible) conduit and clearly and durably labelled “DANGER: TRAFFIC SIGNAL 240V SUPPLY” (refer Drawing No. VM416-2).

Within the controller, the electricity supply cable must be enclosed within a (flexible) conduit and must be sleeved up to and under the supply cable clamp in the controller housing.

### 7.7.3 Above-ground Electricity Supply

Where the electricity supply is from overhead mains, comply with Drawing No. VE500-1 for the connection to the controller, including installation of a pole mounted fuse box.

### 7.7.4 Underground Electricity Supply

Connect from the underground mains to the controller via an underground fuse installed in a PJB pit in accordance with Drawing No. VE500-11. The PJB pit must be located near the point of connection to the Electricity Supply Authority’s mains.

Install the underground fuse box in accordance with Drawing No. VE500-11.

### 8 ADDITIONAL REQUIREMENTS FOR TCS RECONSTRUCTION SITES

#### 8.1 DRAWINGS OF EXISTING FACILITIES

In addition to the project TCS design plans provided under Clause 3.1, the Principal will also provide you with electronic copies (in pdf and/or CADD file format) of the TCS design plans, cable installation drawings and cable connection chart that were implemented for the existing TCS site.

#### 8.2 NOTIFICATION TO TRANSPORT MANAGEMENT CENTRE

Upon arrival each day at any existing live TCS site, immediately notify the TMC and the Traffic Signal Service Provider’s contact room (or the Principal) by telephone of the following details:

(a) time of arrival on site;
(b) brief description of the work to be carried out on the site;
(c) details of existing equipment to be altered or removed.
Before leaving the site each day, notify the TMC by telephone of the following details:
(d) time of departure from the site;
(e) any alterations and removal carried out on existing equipment.

Record the information notified to the TMC, including the date of each notification, in a logbook. The logbook must be made available to the Principal upon request. Submit a copy of the logbook to the Principal at the time of Commissioning tests as an accurate and complete record of the work carried out on site.

8.3 TRAFFIC SIGNAL BLACKOUT

Where reconstruction of an existing live TCS site requires the traffic signal blackout of the site, obtain first the necessary Road Occupancy Licence for the times when the signal installation will be taken out of service.

Arrange for Police attendance where necessary. Inform the Principal, TMC and the Police prior to the blackout.

Prior to the traffic signal blackout, carry out all necessary preparatory work including having all necessary materials and equipment available at the site, to minimise the duration of the traffic signal black-out and, whenever practicable, to be able to restore traffic service during peak hours and overnight.

<table>
<thead>
<tr>
<th>HOLD POINT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process Held:</td>
</tr>
<tr>
<td>Submission Details:</td>
</tr>
<tr>
<td>Release of Hold Point:</td>
</tr>
</tbody>
</table>

If the traffic signals are expected to be out of service, and where directed by the Principal, install covers over the signal lanterns.

8.4 REQUIRED WORK AT RECONSTRUCTION SITES

8.4.1 Existing Post Mounted Loop Detector

Replace all existing post mounted vehicle loop sensor unit, if any, with integral detectors in the controller housing and install new detector feeder cables to connect the existing detector loops to the controller housing.

8.4.2 Existing Porcelain Type Terminal Blocks

Replace all existing post top assemblies containing porcelain type terminal blocks, with new assemblies which are “Type Approved”.
8.4.3 Existing Signal Controller

Unless approved otherwise by the Principal, replace the site’s existing controller with a brand new controller unless the existing controller is compliant with TSC/4 or a later version.

8.4.4 Disposal of Used Equipment

Dispose of all obsolete equipment, and prepare a record of the disposal substantiated by the recycle settlement summary as a record of disposal.

The Principal may direct that certain serviceable equipment be returned to the nominated RMS or Service Providers’ workshop for use as spare parts during future maintenance work.

8.4.5 Removal Procedure

In removing existing equipment from an installation, disconnect the lantern cables from post top terminals by loosening the terminal screws and pulling out the conductor wires from the terminals.

Disassemble all mast arms and posts, except Type 1 posts from their footings.

Type 1 posts may be sawn or cut off below the footway or paving level.

8.5 DAMAGE IN EXISTING INSTALLATION

If, during the traffic signal reconstruction work, you discover any damage in the existing installation, promptly notify the Principal in order that the Principal can determine the appropriate remedial action.

8.6 OTHER REQUIREMENTS

8.6.1 Conduits

Install all new underground cables in conduits.

Where existing directly buried cables are disturbed, reinstall these cables inside conduits as part of the reconstruction. At the point where the conduits terminate and (undisturbed) directly buried cables continue, install a PJB pit in accordance with Clause 5.5.1.

Where new cables are to be installed, and the existing conduits are made from asbestos cement (fibro), do not disturb any of the existing conduits, but install the new cables in new underground conduits.

8.6.2 Cabling

Where the number of spare cores in an existing multi-core cable is less than three, you do not need to replace such cables provided that there are sufficient cores to perform all the required functions. For sites requiring new posts and cables, provide the minimum number of spare cores (refer Clause 7.1.2) for all cables, except for those existing cables on the end of the cable run.

Reinstate all existing cabling of other systems if disturbed. Where the location of the control equipment is changed, extend to the new location all existing cabling of other systems that terminate in the existing controller housing and re-terminated.
9 TESTING AND COMMISSIONING

9.1 CONTRACTOR’S PRELIMINARY INSPECTIONS AND TESTING

Before handing over the TCS Works to the Principal, carry out all inspections and electrical tests as necessary so that the installation complies fully with the requirements of the Contract, including those of the local Electricity Supply Authority.

Carry out the loop testing in accordance with Annexure TS101/E.

On completion of the inspection and tests based on your Inspection and Test Plan (ITP), and following rectification of any deficiencies found, inform the Principal that the supply is connected and that the installation is ready for commissioning tests.

Provide the ITP test results to the Principal before commencement of the commissioning tests.

When the Works are carried out in stages, before conclusion of each stage of the Works, conduct test(s) in accordance with the ITP, resolve any identified issues and provide records of the tests to the Principal for review.

9.2 FINAL INSPECTION AND COMMISSIONING TESTS

Upon receipt of notice from you that the installation is ready for final inspection and commissioning tests, the Principal will carry out jointly with you the final inspection and tests. Give the Principal at least 5 working days’ notice that the TCS works at a site are ready for the tests.

Provide the Principal with details of WAE details marked on the TCS design plan, cable installation drawings and cable connection chart, as appropriate, and the results of the ITP tests.

For reconstruction works, submit a certified copy of the logbook referred to in Clause 8.2 to the Principal before commencing the commissioning tests. The tests will only be considered upon the receipt of an acceptable copy of the logbook by the Principal.

Record and submit to the Principal the results of the final inspection and commissioning tests.

10 COMPLETION AND HANDBACK

10.1 FINAL RESTORATION

10.1.1 General

Restore all excavated grassed areas with turf on 50 mm of topsoil.

Restore any excavated pavement areas in accordance with the Drawings, or where applicable the conditions of the Road Opening Permit.

Restore any excavated concrete pavement areas in accordance with the Drawings, or if not shown on the Drawings, in accordance with the Standard Drawings for concrete pavement maintenance specified in Clause 5.1.2.
10.1.2 Final Restoration by Others

When the temporary restoration is complete, inform the Principal and the responsible authority/agency who will undertake the final restoration.

Maintain the restored areas until final restoration is carried out by the responsible authority/agency.

10.2 USE OF TCS WORKS BY PRINCIPAL

When the majority of the Works is complete and tested, and the commissioning results have been accepted by the Principal, the Principal may make use of the TCS works even though minor defects and omissions may exist and require rectification.

The Principal will issue you with a list of defects and omissions, and the dates by which these defects and omissions must be rectified. Advise the Principal of your program for carrying out the required rectification.

The rectification work must not cause any obstruction at the TCS site occupied by the Principal.

10.3 DRAWINGS

10.3.1 Work-As-Executed Details

Progressively, mark clearly any work-as-executed variation details on copies of the accepted drawings. Make these copies available for review by the Principal upon request.

Transfer all such WAE variation details recorded to the Work-As-Executed (WAE) drawings to be submitted at handover (refer Clause 10.4).

Demonstrate to the Principal, at the time of the tests for the final inspection and commissioning, that all WAE information has been accurately and legibly recorded.

Store copies of drawings, marked up with variations where relevant, in the controller housing in the document holder on the door.

10.3.2 Work-As-Executed Drawings

After completion of the final inspection and commissioning tests (refer Clause 9.2), submit to RMS copies of the WAE drawings, which must include:

(a) TCS design plan showing all WAE details;
(b) cable installation plan;
(c) cable connection chart;
(d) drawings of any non-standard designs.

Record the actual mains supply connections, and associated work, on the WAE drawings.

WAE drawings must state the actual cover over the conduits, and locations of protective steel plates (if used) and cable joints (if used).

The WAE drawings must be in CADD file format, complying with the requirements set out in the RMS CADD Manual and must be compatible with the CADD program Micro-station.
The Principal will not accept any CADD files from you which do not comply with the requirements of this Specification, or are incorrect, or incomplete in respect of WAE information.

10.4 HANDOVER

After the final inspection and commissioning tests, and all required rectification has been carried out, submit to the Principal all handover documentation in electronic format by email, which must include:

(a) all WAE drawings (refer Clause 10.3.2);
(b) all Identified Records (refer Clause 1.2.3);
(c) an asset spreadsheet listing all equipment and devices applied on the TCS/ITS site.

The Principal will issue you with a notice of nonconformity if the handover documentation is not submitted within 5 working days from the date of completion of the final inspection and commissioning tests, or if the documentation submitted is incomplete.

You will not be given Completion if you do not submit the above documents.

After Completion, RMS is responsible for the site’s TCS maintenance.
ANNEXURE TS101/A – PROJECT SPECIFIC REQUIREMENTS

NOTES TO TENDER DOCUMENTER: (Delete this boxed text after customising Annexure TS101/A)

Complete the table below by filling in the required details. Where “Yes / No” or other options are shown, delete whichever is not applicable.

Refer to Clause 1.2.1.

<table>
<thead>
<tr>
<th>Clause</th>
<th>Description</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.3.3</td>
<td>Road Opening Permit required before excavation involving existing road pavement or footpath</td>
<td>Yes / No</td>
</tr>
<tr>
<td>2.6.1</td>
<td>Party responsible for coordinating associated roadworks with RMS, local Councils and other relevant authorities/agencies</td>
<td>Principal(1) / Contractor</td>
</tr>
<tr>
<td>2.6.3</td>
<td>Party responsible for relocating existing traffic facilities such as bus stop shelters and carrying out other incidental works such as removal or trimming of trees</td>
<td>Principal(1) / Contractor</td>
</tr>
<tr>
<td>4.4.1</td>
<td>Controller supplied by Principal</td>
<td>Yes / No</td>
</tr>
</tbody>
</table>

Notes:
(1) Notwithstanding Clause 1.3.1, Roads and Maritime Services (RMS) will not be responsible for coordinating the associated roadworks (Clause 2.6.1) or relocating existing traffic facilities (Clause 2.6.3) when the Principal is not RMS.
ANNEXURE TS101/B – MEASUREMENT AND PAYMENT

Refer to Clause 1.2.2.

Payment will be made for all costs associated with completing the work detailed in this Specification in accordance with the following Pay Items.

Where no specific pay items are provided for a particular item of work, the costs associated with that item of work are deemed to be included in the rates and prices generally for the Work Under the Contract.

The costs of making all necessary enquiries and carrying out the necessary inspections to familiarise yourself with the type and location of all existing utility infrastructure, and implementing measures to avoid damage to the existing utility infrastructure, are deemed to be included in the rates and prices generally for the Work Under the Contract.

Pay Item TS101P1 - Traffic Control Signals Works

This is a Lump Sum item.

The Lump Sum covers all costs associated with the traffic control signal works as detailed in the Drawings and this Specification.

Where specified in Annexure TS101/A that the Contractor is the party responsible for coordinating associated roadworks, and/or relocating existing traffic facilities and carrying out other incidental works, the Lump Sum must include the respective costs of this work.

Unless a separate Pay Item TS101P3 is provided to cover the costs of removing or relocating existing minor traffic signs where shown on the Drawings or directed by the Principal, the Lump Sum must also include the cost of this work

Pay Item TS101P2 - Steel Plate Protection

Refer Clause 5.3.7.

The scheduled quantity is a provisional quantity.

The unit of measurement is the “square metre” of galvanized steel plate protection installed.

The rate must include all costs associated with the supply and installation of the steel plates, but excluding backfilling over the steel plates.

Pay Item TS101P3 - Minor Traffic Sign Removal or Relocation

Refer Clause 2.6.3.

The scheduled quantity is a provisional quantity.

The unit of measurement is “each” minor traffic sign removed or relocated, as directed by the Principal.

The following Pay Items TS101P3, etc are applicable only for TCS works which are carried out under a Minor contract using C41 Minor Physical Works and Services contract terms. They are not applicable for GC21 or D&C contracts and do not use them on such contracts.
Pay Item TS101P3.1  Minor Traffic Sign Removal

The rate includes all costs associated with the removal and disposal off site of the traffic sign.

Pay Item TS101P3.2  Minor Traffic Sign Relocation

The rate includes all costs associated with the removal and re-installation of the traffic sign at a different location.
ANNEXURE TS101/C – SCHEDULES OF HOLD POINTS AND IDENTIFIED RECORDS

C1 SCHEDULE OF HOLD POINTS

<table>
<thead>
<tr>
<th>Clause</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.4</td>
<td>Submission of cable installation drawings and cable connection chart</td>
</tr>
<tr>
<td>3.5.1</td>
<td>Submission of details of excavation near, or installing attachments to, an existing bridge structure</td>
</tr>
<tr>
<td>5.1.1</td>
<td>Submission of details of open trenching work</td>
</tr>
<tr>
<td>5.9.4</td>
<td>Submission of details of modified footing design</td>
</tr>
<tr>
<td>6.1.1</td>
<td>Submission of evidence that all requirements have been satisfied prior to erection of signal post or mast arm</td>
</tr>
<tr>
<td>6.1.4</td>
<td>Submission of evidence that all necessary approvals have been obtained prior to making any opening or hole through awning</td>
</tr>
<tr>
<td>6.2.7</td>
<td>Submission of proposal to overcome local obstruction to mounting of lanterns or target boards</td>
</tr>
<tr>
<td>8.2</td>
<td>Submission of required details prior to traffic signal blackout at TCS reconstruction site</td>
</tr>
</tbody>
</table>

C2 SCHEDULE OF IDENTIFIED RECORDS

<table>
<thead>
<tr>
<th>Clause</th>
<th>Description of Identified Records</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.2</td>
<td>Logbook containing notified information to TMC</td>
</tr>
<tr>
<td>8.4.4</td>
<td>Disposal records of obsolete equipment (including recycle settlement summary)</td>
</tr>
<tr>
<td>9.1</td>
<td>Results of inspections and tests based on Contractor’s ITP</td>
</tr>
<tr>
<td>9.2</td>
<td>Results of final inspection and commissioning tests</td>
</tr>
<tr>
<td>10.3</td>
<td>WAE drawings</td>
</tr>
</tbody>
</table>
ANNEXURE TS101/D – PLANNING DOCUMENTS

Refer to Clause 1.2.4.

The following documents are a summary of documents that must be included in the PROJECT QUALITY PLAN. Review the requirements of this Specification and other contract documents to determine any additional documentation requirements.

<table>
<thead>
<tr>
<th>Clause</th>
<th>Description of Document</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>TCS design plans</td>
</tr>
<tr>
<td>3.2.2</td>
<td>Cable installation drawings</td>
</tr>
<tr>
<td>3.2.3</td>
<td>Cable connection chart</td>
</tr>
</tbody>
</table>
ANNEXURE TS101/E – LOOP TESTING

E1 TIMING

Carry out vehicle detector loop testing after the on-road loop(s) has been connected to its feeder cable(s) at PJB pit.

E2 TESTING POINT AND PRELIMINARY CHECKS

The testing point is at the end of the detector loop’s feeder cable, located inside the TCS site’s controller housing.

Before testing, check that the loop to be tested has been properly connected to its feeder cable at PJB pit, and that the other end of the feeder cable has been disconnected from its loop terminals inside the controller housing.

E3 TEST PARAMETERS AND ACCEPTABLE RESULTS

Test parameters and acceptable ranges of test results are shown in Table TS101.E1.

<table>
<thead>
<tr>
<th>Test Parameter</th>
<th>Acceptable Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC resistance</td>
<td>1 – 3 (1)</td>
</tr>
<tr>
<td>Inductance</td>
<td>50 – 700</td>
</tr>
<tr>
<td>Quality Factor</td>
<td>&gt; 3 (3)</td>
</tr>
<tr>
<td>Insulation resistance</td>
<td>&gt; 200 (4)</td>
</tr>
</tbody>
</table>

Notes:

(1) Suggested range.
(2) Resonant frequency must be recorded.
(3) Voltage (> 500 V) used for the measurement must be recorded.

E4 TEST INSTRUMENTS

(a) Vehicle Detector Loop Tester

The loop tester used must be capable of measuring the test parameters with an operating frequency of between 20 kHz to 150 kHz for the “Inductance” and “Quality Factor” test.

Before the test, the officer conducting the test must check that the testing instrument has been calibrated in accordance with the manufacturer’s recommendation.

The following loop testers may be used:

- XL-LTM 100, or XL-LTM 1000, made by Excel Technology Co.
- HILT 9000, made by Athens Technical Specialists, Inc (ATSI)

Other loop testers may be used subject to approval by RMS.
(b) Megohm-meter for Insulation Resistance Measurement

The meter must be suitable for measurement Category III, able to apply a measurement voltage of at least 500V and designed for outdoor use.

E5 TEST PROCEDURE

Carry out testing as follows:

(a) DC Resistance, Inductance and Quality Factor

Refer to Figure TS101/E.1.

(i) Connect the loop to be tested with its 2-core feeder cable at the PJB pit.

(ii) Disconnect the two cores of the feeder cable from their terminals inside the TCS site controller housing.

(iii) Connect each probe of the loop tester to the individual cores of the feeder cable.

(iv) Press the “DC Resistance” button and record the value shown.

(v) Press the “Inductance” button and record the value shown.

(vi) Press the “Frequency” button to obtain the resonant frequency of the loop, and record the value shown.

(vii) Press the “Quality Factor” button and record the value shown.

(viii) Connect back the two cores of the feeder cable to its terminals after completion of testing.

**General Test Setup for Loop Testing**

Figure TS101/E.1 – Measurement for DC Resistance, Inductance and Quality Factor of Loops
(b) **Insulation Resistance**

Refer to Figure TS101/E.2.

(i) Connect the loop to be tested with its 2-core feeder cable at PJB pit.

(ii) Disconnect the two cores of the feeder cable from their terminals inside the TCS site controller housing.

(iii) Connect the test probe of the megohm-meter to one of the feeder cable’s two cores and the earth probe to the TCS site controller’s earthing.

(iv) Apply the measurement voltage and record the insulation resistance shown.

(v) Connect back the two cores of the feeder cable to its terminals after completion of testing.

**Figure TS101/E.2 – Testing for Loop Insulation Resistance**

**E6 RECORDING OF TEST RESULTS**

Record the test results on a form similar to that shown below.

Submit the test results to the Principal in accordance with Clause 9.1.
### Record Sheet for Loop Testing Results

<table>
<thead>
<tr>
<th>Contractor</th>
<th>Testing Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Testing Organisation</td>
<td>Signature</td>
</tr>
<tr>
<td>Site No.</td>
<td>Site Location</td>
</tr>
<tr>
<td></td>
<td>Weather &amp; Floor Condition</td>
</tr>
</tbody>
</table>

### Test Instruments:

<table>
<thead>
<tr>
<th>Loop Tester</th>
<th>Make</th>
<th>Model</th>
<th>Serial No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Megohm-meter</td>
<td>Make</td>
<td>Model</td>
<td>Serial No.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Lane</th>
<th>Loop</th>
<th>Resistance (Ω)</th>
<th>Inductance (µH)</th>
<th>Quality Factor</th>
<th>Resonant Frequency</th>
<th>Insulation Resistance (MΩ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lane 1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lane 2</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lane 3</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>2</td>
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<tr>
<td>Lane 4</td>
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<tr>
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<tr>
<td>Lane 5</td>
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<td>2</td>
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</tr>
<tr>
<td>Lane 6</td>
<td>1</td>
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<tr>
<td></td>
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<tr>
<td>Lane 7</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>2</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lane 8</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Measurement Voltage for Insulation Resistance (V):

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**ANNEXURES TS101/F TO TS101/L – (NOT USED)**
ANNEXURE TS101/M – REFERENCED DOCUMENTS

M1 REFERENCED DOCUMENTS

RMS Specifications
RMS G10 Traffic Management
RMS G22 Work Health and Safety (Construction Work)
RMS G36 Environmental Protection
RMS Q Quality Management System
RMS R53 Concrete for General Works
RMS TS200 Register of ITS Field Equipment
RMS TS201 Approval of ITS Field Equipment
RMS TS202 Approval of ITS Solution for Projects
RMS TSI-SP-043 Traffic Signal Posts
RMS TSI-SP-045 Traffic Signal Lanterns
RMS TSI-SP-046 Cables for Traffic Signal Installations
RMS TSI-SP-048 Pedestrian Push-Button Assembly and Audio Tactile Facility
RMS TSI-SP-054 Traffic Signal Mast Arms
RMS TSI-SP-055 Pit Covers and Frames
RMS TSI-SP-056 Slot Sealant for Vehicle Detector Loops
RMS TSI-SP-061 Underground Mains Fuse
RMS TSI-SP-069 Control Equipment for Road Traffic Signals

RMS Manuals
Traffic Control at Work Sites Manual
CADD Manual

Australian Standards
AS 1100 Technical drawing
AS 1100.401 Engineering survey and engineering survey design drawing
AS/NZS 1906.1 Retroreflective materials and devices for road traffic control purposes - Retroreflective sheeting
AS/NZS 2053 Conduits and fittings for electrical installations
AS 2144 Traffic signal lanterns
AS 2276 Cables for traffic signal installation
AS 2339 Traffic signal posts and attachments
AS 2648.1 Non-detectable tape
AS 2703 Vehicle loop detector sensors
AS/NZS 3000 Electrical installations (known as the Australian/New Zealand Wiring Rules)
<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS/NZS 3100</td>
<td>Approval and test specification - General requirements for electrical equipment</td>
</tr>
<tr>
<td>AS/NZS 3750.9</td>
<td>Paints for steel structures - Organic zinc-rich primer</td>
</tr>
<tr>
<td>AS/NZS 3808</td>
<td>Insulating and sheathing materials for electric cables</td>
</tr>
<tr>
<td>AS 4702</td>
<td>Polymeric cable protection covers</td>
</tr>
<tr>
<td>AS 5100</td>
<td>Bridge Design</td>
</tr>
</tbody>
</table>

**M2  TRAFFIC SIGNAL INSTALLATION STANDARD DRAWINGS**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>VC001-4</td>
<td>Precaution against obstruction of water mains</td>
</tr>
<tr>
<td>VC001-8</td>
<td>Typical excavations and installation of components for mid-block locations</td>
</tr>
<tr>
<td>VC001-9</td>
<td>Typical intersection excavations and installation of component parts</td>
</tr>
<tr>
<td>VC002-43</td>
<td>Footing for type 2 post and post-mounted controller</td>
</tr>
<tr>
<td>VC002-45</td>
<td>Installation and mechanical details of special type 2 post with shallow cover</td>
</tr>
<tr>
<td>VC002-59</td>
<td>Footing for type 7 &amp; 8 posts</td>
</tr>
<tr>
<td>VC002-65</td>
<td>Footing for type 10 and type 11 mast arms</td>
</tr>
<tr>
<td>VC002-66</td>
<td>Footing for type 13 Short push button post</td>
</tr>
<tr>
<td>VC002-71</td>
<td>Footing for type 2 post</td>
</tr>
<tr>
<td>VC002-72</td>
<td>Footing for type 5 &amp; 9 mast arms &amp; type 6 post</td>
</tr>
<tr>
<td>VC002-73</td>
<td>Footing for ground-mounted controller housing</td>
</tr>
<tr>
<td>VC002-75</td>
<td>Footing for type 4 mast arm</td>
</tr>
<tr>
<td>VC002-76</td>
<td>Footing for ground-mounted small Controller and CCTV housings</td>
</tr>
<tr>
<td>VC002-78</td>
<td>Alternative footing for type 13 post with exposed base plate on final surface</td>
</tr>
<tr>
<td>VC002-82</td>
<td>Method of Installation of Adaptor Stool to Suit Type 7, 8 &amp; 13 Posts on an Existing Type 2</td>
</tr>
<tr>
<td>VC005-17</td>
<td>Method of installation of stop line detectors</td>
</tr>
<tr>
<td>VC005-18</td>
<td>Method of installation of advance detectors</td>
</tr>
<tr>
<td>VC005-19</td>
<td>Symmetripole loop detector wiring guide</td>
</tr>
<tr>
<td>VC005-36</td>
<td>Method of installation of bicycle stop line detectors</td>
</tr>
<tr>
<td>VC005-37</td>
<td>Quadruple type bicycle loop detector wiring guide for a possible entry positions</td>
</tr>
<tr>
<td>VC005-38</td>
<td>Sample of bicycle stop line loop detector to suit bicycle lanes from 1.2m to 2.0m wide</td>
</tr>
<tr>
<td>VC007-4</td>
<td>General arrangement of a pavement junction box pit (small, large and extra-large types)</td>
</tr>
<tr>
<td>VC007-5</td>
<td>Large footway cable junction pit</td>
</tr>
<tr>
<td>VD001-5</td>
<td>Standard positioning of traffic signal components at intersections</td>
</tr>
<tr>
<td>VD001-6</td>
<td>Standard positioning of traffic signal components at mid-block locations</td>
</tr>
<tr>
<td>VD001-7</td>
<td>Orientation of pedestrian push-button arrow disc</td>
</tr>
<tr>
<td>VD002-20</td>
<td>Typical traffic signal design plan for mid-block location</td>
</tr>
<tr>
<td>VD002-21</td>
<td>Typical cable installation plan for mid-block location</td>
</tr>
<tr>
<td>VD002-22</td>
<td>Typical traffic signal design plan for intersection location</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
</tr>
<tr>
<td>--------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>VD002-23</td>
<td>Typical cable installation plan for intersection location</td>
</tr>
<tr>
<td>VD002-25</td>
<td>Traffic signal post top assembly-suggested terminal allocations</td>
</tr>
<tr>
<td>VD002-37</td>
<td>Typical cable connection chart for intersection location</td>
</tr>
<tr>
<td>VD003-6</td>
<td>Symbols and abbreviations</td>
</tr>
<tr>
<td>VD006-20</td>
<td>Standard cable chart for mid-block pedestrian-actuated signals</td>
</tr>
<tr>
<td>VE500-1</td>
<td>General arrangement of consumer mains for overhead supply</td>
</tr>
<tr>
<td>VE500-11</td>
<td>Installation of underground fuse box</td>
</tr>
<tr>
<td>VE530-7</td>
<td>Standard connection chart for post-mounted audio-tactile equipment</td>
</tr>
<tr>
<td>VE530-8</td>
<td>Method of installation of audio-tactile signal facilities</td>
</tr>
<tr>
<td>VE535-1</td>
<td>Connection diagram for Fire/Ambulance station signals</td>
</tr>
<tr>
<td>VM015-16</td>
<td>Assembly details of terminal box, lanterns and pedestrian push buttons on wooden poles</td>
</tr>
<tr>
<td>VM015-18</td>
<td>General arrangement of traffic signals on wooden poles</td>
</tr>
<tr>
<td>VM200-27</td>
<td>Assembly details for dual lanterns using lock washers</td>
</tr>
<tr>
<td>VM200-28</td>
<td>Assembly details of lock washers</td>
</tr>
<tr>
<td>VM202-8</td>
<td>Traffic signal lantern and accessories assembly on standard type 2 post</td>
</tr>
<tr>
<td>VM202-12</td>
<td>Installation of traffic signal priority sign (R1-202)</td>
</tr>
<tr>
<td>VM203-13</td>
<td>General arrangement for type 4 mast arm</td>
</tr>
<tr>
<td>VM211-6</td>
<td>General arrangement of type 5 mast arms</td>
</tr>
<tr>
<td>VM211-17</td>
<td>Lower assembly details of terminal box and lanterns for mast arms and type 6 post</td>
</tr>
<tr>
<td>VM211-20</td>
<td>Safety clearances from overhead power lines and communications cables for traffic signals and signs</td>
</tr>
<tr>
<td>VM211-21</td>
<td>Assembly details of upper lanterns to type 5 mast arms</td>
</tr>
<tr>
<td>VM211-26</td>
<td>Assembly details of type 5L and 5S mast arms</td>
</tr>
<tr>
<td>VM212-2</td>
<td>General arrangement of type 6 post</td>
</tr>
<tr>
<td>VM215-1</td>
<td>General arrangement of type 9 mast arms</td>
</tr>
<tr>
<td>VM417-3</td>
<td>Method of jointing multi-core traffic signal cables</td>
</tr>
<tr>
<td>VM417-4</td>
<td>Method of protection for two-core screened detector feeder cable</td>
</tr>
<tr>
<td>VM417-5</td>
<td>Method of inserting lip blade crimp lugs into terminals</td>
</tr>
<tr>
<td>VM625-17</td>
<td>Outline and arrangement of post-mounted controller</td>
</tr>
<tr>
<td>VR007-6</td>
<td>Maximum allowable cable combination in ducts for traffic signal installation</td>
</tr>
<tr>
<td>VR007-7</td>
<td>Table showing conduit and excess lead lengths for lanterns and audio-tactile housing</td>
</tr>
<tr>
<td>VR017-11</td>
<td>Method of clamping conduits on post top assemblies</td>
</tr>
<tr>
<td>VT006-60</td>
<td>Assembly details for traffic signs using lock washers</td>
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</table>
## M3 Applicable Materials Drawings

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<tr>
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<tbody>
<tr>
<td>VC002-27</td>
<td>L bolt used for Type 2 post footing</td>
</tr>
<tr>
<td>VC002-38</td>
<td>Holding-down bolt assembly for type 5 and type 9 mast arms and type 6 post</td>
</tr>
<tr>
<td>VC002-50</td>
<td>Holding-down bolt assembly for type 2 post (alternative method)</td>
</tr>
<tr>
<td>VC002-56</td>
<td>Holding-down bolt assembly for ground mounted controller</td>
</tr>
<tr>
<td>VC002-60</td>
<td>Holding-down bolt assembly for type 7 &amp; 8 post</td>
</tr>
<tr>
<td>VC002-67</td>
<td>Holding-down bolt assembly for type 13 short push</td>
</tr>
<tr>
<td>VE500-10</td>
<td>Underground fuse box</td>
</tr>
<tr>
<td>VM007-2</td>
<td>Pole mounting fuse box</td>
</tr>
<tr>
<td>VM012-7</td>
<td>Lantern mounting straps</td>
</tr>
<tr>
<td>VM012-8</td>
<td>Adjustable &quot;Z&quot; bracket for 200 mm lanterns</td>
</tr>
<tr>
<td>VM012-12</td>
<td>Fixed &quot;Z&quot; bracket for 200 mm lanterns</td>
</tr>
<tr>
<td>VM012-13</td>
<td>Fixed &quot;Z&quot; bracket for 300 mm lanterns</td>
</tr>
<tr>
<td>VM012-14</td>
<td>Tee-bar strap for dual 200 mm lanterns</td>
</tr>
<tr>
<td>VM012-15</td>
<td>Tee-bar strap for dual 300 mm lanterns</td>
</tr>
<tr>
<td>VM012-20</td>
<td>Special fixed Z bracket for Illuminated Authorised Vehicles Excepted sign</td>
</tr>
<tr>
<td>VM015-21</td>
<td>Terminal box for mounting on wooden poles</td>
</tr>
<tr>
<td>VM015-22</td>
<td>Terminal box for mast arms and type 6 posts</td>
</tr>
<tr>
<td>VM015-41</td>
<td>Mechanical details of terminal box for type 8 post</td>
</tr>
<tr>
<td>VM015-42</td>
<td>Assembly details of terminal box for type 8 post</td>
</tr>
<tr>
<td>VM016-10</td>
<td>Small pavement junction box casting</td>
</tr>
<tr>
<td>VM016-11</td>
<td>Large pavement junction box casting</td>
</tr>
<tr>
<td>VM016-12</td>
<td>Extra-large pavement junction box casting</td>
</tr>
<tr>
<td>VM041-32</td>
<td>Direction arrow/transducer disc for pedestrian push-button assemblies</td>
</tr>
<tr>
<td>VM052-5</td>
<td>Support cradle and securing bracket for underground fuse box</td>
</tr>
<tr>
<td>VM200-10</td>
<td>Lantern mounting bracket for wooden poles</td>
</tr>
<tr>
<td>VM200-14</td>
<td>Lower mounting bracket</td>
</tr>
<tr>
<td>VM200-15</td>
<td>Post top assembly</td>
</tr>
<tr>
<td>VM200-24</td>
<td>Standard lock washer</td>
</tr>
<tr>
<td>VM200-29</td>
<td>Special lock washer for T-bar assemblies for dual lanterns</td>
</tr>
<tr>
<td>VM202-1</td>
<td>Type 2 post (mechanical details)</td>
</tr>
<tr>
<td>VM202-10</td>
<td>Type 2 adaptor plate for type 5 or 6 footing</td>
</tr>
<tr>
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