

TRANSPORT FOR NSW (TfNSW)

SPECIFICATION D&C TS101

TRAFFIC SIGNALS – NEW INSTALLATION AND RECONSTRUCTION

NOTICE

This document is a Transport for NSW D&C Specification. It has been developed for use with Design & Construct roadworks and bridgeworks contracts let by Transport for NSW. It is not suitable for any other purpose and must not be used for any other purpose or in any other context.

Copyright in this document belongs to Transport for NSW.

REVISION REGISTER

Ed/Rev Number	Clause Number	Description of Revision	Authorised By	Date
Ed 1/Rev 0		First issue, based on (non-D&C) Specification TS101 Ed 2 Rev 1, and incorporating changes to clauses 7.2 and 9.2 in non-D&C TS101 Ed 2 Rev 1.	MCQ	25.10.19
Ed 1/Rev 1	Global	Updated to accord with base (non-D&C) Specification TS101 Ed 2/Rev 2. References to “Roads and Maritime Services” or “RMS” changed to “Transport for NSW” or “TfNSW” respectively. References to “RMS Representative” changed to “Principal”.	MCQ	24.07.20
Ed 1/Rev 2		Updated to accord with base (non-D&C) Specification TS101 Ed 2/Rev 3.	SMCSp	23.02.21

GUIDE NOTES
(Not Part of Contract Document)

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



TRAFFIC SIGNALS – NEW INSTALLATION AND RECONSTRUCTION

Copyright – Transport for NSW
IC-DC-TS101

VERSION FOR: DATE:

CONTENTS

CLAUSE	PAGE
FOREWORD	III
TfNSW Copyright and Use of this Document.....	iii
Base Specification.....	iii
1 GENERAL	1
1.1 Scope	1
1.2 Structure of the Specification.....	1
1.3 Definitions and Acronyms	2
2 GENERAL REQUIREMENTS.....	3
2.1 Contractor Prequalification and Responsibilities.....	3
2.2 Work Health and Safety, Traffic Control and Environment.....	3
2.3 Existing Utility Infrastructure	4
2.4 Program	5
2.5 Notice for Inspection.....	5
2.6 (Not Used)	5
3 DESIGN DRAWINGS	5
3.1 Traffic Signal Design Plans	5
3.2 (Not Used)	6
3.3 Non-standard Designs	6
3.4 (Not Used)	7
3.5 Existing Bridge Structure	7
3.6 Commencement of Construction.....	7
4 MATERIALS AND EQUIPMENT.....	7
4.1 Concrete and Steel Reinforcement.....	7
4.2 Conduits and Associated Items	8
4.3 Cables.....	8
4.4 Equipment Supply.....	8
4.5 Equipment Selection.....	9
4.6 Traffic Signal Posts, Mast Arms and Lanterns	10
4.7 Miscellaneous Items.....	10
5 IN-GROUND WORKS	11
5.1 Excavation	11
5.2 Backfilling and Spoil Disposal	12
5.3 Conduit Installation.....	12
5.4 (Not Used)	14
5.5 Footway Pits	14
5.6 Roadway Pits	15
5.7 Traffic Signals on Multi-function Poles	15
5.8 Concrete Work - General.....	16
5.9 Post and Mast Arm Footings.....	16
5.10 Controller Housing Footings.....	17
5.11 Telecommunications Line Conduit	18
6 ABOVE GROUND WORKS.....	18
6.1 Signal Posts and Mast Arms	18
6.2 Traffic Signal Lanterns.....	20
6.3 Pedestrian Push-button Assemblies and Audio-tactile Facilities	22

6.4	Traffic Signal Controller	23
6.5	Special Facilities	23
6.6	Surface Treatment	23
6.7	Traffic Signs on Signal Posts.....	24
7	CABLING WORKS	24
7.1	General	24
7.2	Cable Layout (Cabling Rules)	25
7.3	Cable Installation	25
7.4	Cable Joints.....	26
7.5	Cable Termination.....	27
7.6	Detector Loops.....	28
7.7	Electricity Supply.....	29
8	ADDITIONAL REQUIREMENTS FOR TRAFFIC SIGNAL RECONSTRUCTION SITES	30
8.1	Drawings of Existing Facilities.....	30
8.2	Notification to Transport Management Centre	30
8.3	Traffic Signal Blackout	31
8.4	Required Work at Reconstruction Sites	31
8.5	Damage in Existing Installation.....	32
8.6	Other Requirements	32
9	TESTING AND COMMISSIONING	33
9.1	Contractor’s Preliminary Inspections and Testing.....	33
9.2	Final Inspection and Commissioning Tests.....	33
10	COMPLETION AND HANDOVER	34
10.1	Final Restoration.....	34
10.2	Use of Traffic Signal Works by TfNSW.....	34
10.3	Drawings	34
10.4	Handover	35
	ANNEXURE TS101/A – PROJECT SPECIFIC REQUIREMENTS.....	36
	ANNEXURE TS101/B – (NOT USED)	37
	ANNEXURE TS101/C – SCHEDULES OF HOLD POINTS AND IDENTIFIED RECORDS	37
	C1 Schedule of Hold Points and Witness Points.....	37
	C2 Schedule of Identified Records.....	37
	ANNEXURE TS101/D – PLANNING DOCUMENTS	38
	ANNEXURE TS101/E – LOOP TESTING.....	39
	E1 Sequence.....	39
	E2 Testing Point and Preliminary Checks	39
	E3 Test Parameters and Acceptable Results	39
	E4 Test Instruments.....	39
	E5 Test Procedure	40
	E6 Recording of Test Results.....	41
	ANNEXURES TS101/F TO TS101/L – (NOT USED).....	42
	ANNEXURE TS101/M – REFERENCED DOCUMENTS	43
	M1 Referenced Documents.....	43
	M2 Traffic Signal Installation Standard Drawings.....	44

M3 Applicable Materials Drawings.....46

LAST PAGE OF THIS DOCUMENT IS48

FOREWORD

TfNSW COPYRIGHT AND USE OF THIS DOCUMENT

Copyright in this document belongs to Transport for NSW.

When this document forms part of a deed

This document should be read with all the documents forming the Project Deed.

When this document does not form part of a contract

This copy is not a controlled document. Observe the Notice that appears on the first page of the copy controlled by TfNSW. A full copy of the latest version of the document is available on the TfNSW Internet website: <http://www.rms.nsw.gov.au/business-industry/partners-suppliers/specifications/index.html>

BASE SPECIFICATION

This document is based on Specification TfNSW TS101 Edition 2 Revision 3.

TfNSW SPECIFICATION D&C TS101

TRAFFIC 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 signals, 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 traffic signal 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 by 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 (Not Used)

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 TfNSW D&C Q6 for definition of **HOLD POINTS**.

The records listed in Annexure TS101/C are **Identified Records** for the purposes of TfNSW D&C Q6 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

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.

The following definitions apply to this Specification:

Acceptable Product	ITS equipment or device that has been evaluated by TfNSW and considered acceptable for typical use, and registered in Specification TfNSW TS200.
Type Approved Product	ITS equipment or device that has been evaluated as compliant to TfNSW specifications, and provided with a TfNSW Type Approval Certification Number in accordance with Specification TfNSW TS201, and registered in TfNSW 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).
Traffic Signals 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:

AC	Alternating current
DC	Direct current
ELV	Extra Low Voltage
FAT	Factory Acceptance Test
ITP	Inspection and Test Plan
ITS	Intelligent Transport Systems

LV	Low Voltage
MFP	Multi-function pole
NB	Nominal bore (i.e. internal diameter)
PJB	Pavement junction box (pit)
TMC	Transport Management Centre (TfNSW)
WAE	Work-As-Executed (drawings)

2 GENERAL REQUIREMENTS

2.1 CONTRACTOR PREQUALIFICATION AND RESPONSIBILITIES

2.1.1 Contractor Prequalification

The contractor carrying out traffic signals construction and/or reconstruction work must be prequalified under the TfNSW Prequalification Scheme for Traffic Signal Contractors. Details of the Prequalification Scheme is available at the TfNSW 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, traffic signals in accordance with this Specification and traffic signal 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 traffic signal design plans (refer Clause 3.1);
- (c) incidental works, such as relocation of minor traffic signs;
- (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 TfNSW D&C G22 for work health and safety.

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

TRAFFIC SIGNAL
WORKS BY
(Contractor's name)
*(Contractor's 24 hour contact telephone
number)*

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 TfNSW D&C 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 TfNSW D&C G36, including working outside of normal working hours.

2.2.4 Materials and Equipment Storage

Comply with TfNSW D&C 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

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.

2.3.3 (Not Used)

2.4 PROGRAM

As part of the Contract Program, submit to the Principal an installation program for the traffic signal works. The installation program must show the commencement date of excavations at each traffic signal location, and the completion date of all electrical works.

If the traffic signal 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 traffic signals reconstruction work, to ensure that the new traffic signals are ready for use when existing traffic signals 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 Project Verifier with at least 36 hour notice for sites in Sydney, Newcastle and Wollongong, and 48 hour notice for all other sites, 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 (NOT USED)

3 DESIGN DRAWINGS

3.1 TRAFFIC SIGNAL DESIGN PLANS

3.1.1 General

Submit, as part of your Design Documentation drawings, the project traffic signal design plans to the Principal for acceptance.

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 traffic signal 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).

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 TfNSW 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).

3.1.2 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 or kerb alignments.

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

3.1.3 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.

3.2 (NOT USED)

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 (Not Used)

3.3.4 Location of Pits

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

Do not locate pits in kerb ramps or driveways unless approved or directed otherwise by the Principal.

3.4 (NOT USED)

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 traffic signals work at any site until your submitted traffic signal design plans 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 traffic signal 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 Design Documentation drawings, concrete must be grade N25 with maximum aggregate size of 20 mm, complying with Specification TfNSW D&C 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 TfNSW D&C 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 multicore power cables, detector feeder cables and detector loop cables must comply with Specification TfNSW TSI-SP-046.

4.3.2 Sealant for Cable Joints

Sealant for sealing cable joints must be “Type Approved” under Specification TfNSW 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 TfNSW. Where so stated in Annexure TS101/A, TfNSW will also supply the controller.

All equipment supplied must comply with this Specification and other applicable TfNSW equipment specifications and drawings. Where TfNSW 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 TfNSW, you are responsible for their care until the traffic signal works has passed all relevant tests and handed over to TfNSW.

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

4.5 EQUIPMENT SELECTION

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

4.5.1 Equipment Listed in TfNSW TS200

The ITS equipment listed in TfNSW 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 TfNSW Drawings

Mechanical parts/components that are fully described in the TfNSW 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 TfNSW 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 TfNSW TSI-SP-043 and TfNSW TSI-SP-054 respectively and be an “Acceptable” item listed in TfNSW TS200.

4.6.2 Traffic Signal Lanterns

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

Mounting brackets for mounting traffic signs must be in accordance with Drawing Nos. VT006-51, VT006-52, VT006-53, VT006-54, VT006-55, VT006-56, VT006-57, VT006-58 or VT006-61.

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 TfNSW 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 and black lantern covers for use for covering non-operational lanterns must be in accordance with Drawing No. VM418-1 and Drawing No. VM418-3 respectively.

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.

HOLD POINT

Process Held: Road opening (i.e. excavation of roadway pavement).

Submission Details: Details of open trenching work, including if appropriate, methods of shoring and provision for traffic.

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

5.1.2 Saw Cutting of Existing Concrete Pavement

This Clause 5.1.2 is applicable only to existing concrete pavements.

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 concrete pavement slab, comply with the Standard Drawings for rigid pavement maintenance. These Standard Drawings are available on the TfNSW website at:

PCP: http://home.rms.nsw.gov.au/dts/cserv/os/original/standarddrawings/ds2013_001838.pdf

JRCP: http://home.rms.nsw.gov.au/dts/cserv/os/original/standarddrawings/ds2013_001890.pdf

CRCP: http://home.rms.nsw.gov.au/dts/cserv/os/original/standarddrawings/ds2014_005043.pdf

Where excavation for post footing is to be carried out on an existing concrete 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.

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 TfNSW D&C 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

Permitted Use ⁽¹⁾	Nominal Bore (mm)
In footways and roadways	80 ^(2, 3)
In roadways for mid-block pedestrian signal installations	50 ⁽³⁾
Underground power supply, or underground section of overhead power supply	25

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 minimum 80 mm NB (unless approved otherwise by the Principal as per note ⁽²⁾ above), 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.

Where conduits are to be installed across a new roadway (with the overlying pavement still to be constructed), or across an existing roadway 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;
- (ii) 0.75 m when installed by trenchless methods, for a maximum bore diameter of 150 mm. For bore diameters larger than 150 mm, comply with TfNSW Technical Direction GTD 2018 002, unless approved otherwise by the Principal. GTD 2018 002 is available from the TfNSW website at <http://www.rms.nsw.gov.au/business-industry/partners-suppliers/documents/technical-directions/gtd2018-002.pdf>.

(b) in footways:

- (i) 0.5 m.

For conduits running along the length of a concrete median which is at least 75 mm thick, provide a minimum cover of 375 mm as measured from the median surface.

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 carriageways at junction pits.

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

5.3.6 Backfilling

WITNESS POINT

Process to be Witnessed: Backfilling over installed conduits.

Submission Details: Notice of location and proposed time for backfilling over installed conduits, with the notice period in accordance with Clause 2.5.

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).

5.4 (NOT USED)

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 TS101.2 – Required PJB Pit Sizes⁽¹⁾

Condition	Size of PJB Pit
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

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 TfNSW, and such pits must be provided with a heavy-duty cover and frame complying with Specification TfNSW 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 TfNSW 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 TfNSW D&C R53 unless specified otherwise in this Specification.

The Hold Point under Clause 3.3.1 of TfNSW R53 for placing of concrete applies, except that the notice period will be in accordance with Clause 2.5 (of TfNSW D&C TS101).

5.8.2 Sampling and Testing

Sampling and testing must be in accordance with TfNSW D&C R53.

Provide a copy of the test reports to the Project Verifier.

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

Type	Reference Drawing No.	
	Footing	Holding Down Bolt
Post		
Type 2 post	VC002-71	VC002-50
Type 6 post	VC002-72	VC002-38
Type 7 and 8 posts	VC002-59	VC002-60
Type 13 post	VC002-66	VC002-67
Mast Arm		
Type 4 mast arm	VC002-75	VC002-50
Type 5 and 9 mast arms	VC002-72	VC002-38
Type 10 and 11 mast arms	VC002-65	ME10728 Sheet 4

5.9.2 Setback Distances

Comply with Drawing No. VD001-5 for minimum setback distances, but unless shown otherwise on the relevant traffic signals design plan, do not install post or mast arm on a footway closer than 0.6 m in from the face of the kerb.

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.

HOLD POINT

Process Held: Commencement of construction of post footing to a modified design, necessitated by site conditions.

Submission Details: Details of modified footing design.

Release of Hold Point: The Principal will consider the submitted details and may require additional details or amendments to the design, prior to authorising the release of the Hold Point.

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 traffic signals 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 telecommunications jointing 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 Telecommunications Jointing Pit

Unless otherwise shown on the traffic signals 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

TfNSW 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 Project Verifier 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

Mast Arm Type	Reference Drawing No.
Type 5 ⁽¹⁾ mast arm	VM211-26
Type 9 mast arm	VM215-1
Other types ⁽²⁾	Relevant design drawings and assembly instructions

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.

6.1.3 Erection of Special STOP Signs

Where shown on the traffic signals 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 it is necessary for a post/mast arm to pass through an existing awning, the Principal will seek permission from the owner(s) of the affected premises and, if applicable, the relevant local Council to undertake modifications to the awning.

Do not commence this work until you have received notification from the Principal that permission has been obtained from the relevant parties to do so.

WITNESS POINT

Process to be Witnessed: Modification work to an existing awning.

Submission Details: Notification of location, date and time of the work, at least 48 hours prior.

Make good any hole created in the awning, to the satisfaction of the property owner and the Principal. Provide a 25 mm clearance between the post/mast arm and the awning, and install a gutter to prevent rainwater from the awning flowing into the opening. Comply with any other requirements (such as provision of flashing) specified by the local Council.

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

Post and Mast Arm Type	Reference Drawing No.
Type 2 post	VM202-8
Type 6 post	VM212-2 and VM211-17
Type 5S (short) mast arm	VM211-6 Sheet 1
Type 5L (long) mast arm	VM211-21
Type 5XL (extra-long) mast arm	VM211-17
Type 9 mast arm	VM215-1

Mount vehicle lanterns on Type 2 posts at the top of such posts, unless otherwise shown on the relevant traffic signals 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.

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

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 traffic signal 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

Process Held:	Mounting lantern(s) in the stipulated position(s) due to local obstruction.
Submission Details:	Proposal to overcome local obstruction.
Release of Hold Point:	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.

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

For new sites under construction, and for existing out-of-service sites, cover the street-level primary and dual primary lanterns facing each approach with yellow lantern covers (refer Clause 4.7.7). For new sites, cover the lanterns immediately after erection of signal lanterns and until the traffic signals are commissioned and operational.

For non-operational lanterns at in-service sites (i.e. other lanterns are still operational at the site), cover the lanterns with black lantern covers (refer Clause 4.7.7) if the non-operational lanterns are to be left blacked-out for more than two hours or such other period as determined by the Principal.

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

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 traffic signals design plan.

Install audio-tactile push-button assemblies (and associated electronic driver units) where specified on the traffic signals 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 traffic signals 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 TfNSW 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, unless directed or approved otherwise by the Principal.

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 traffic signals 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 traffic signals 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 traffic signals 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.

Install such traffic signs at a minimum distance of 300 mm away from the kerb.

7 CABLING WORKS

7.1 GENERAL

7.1.1 Quality Documentation

Before installing any multicore power cables, detector feeder cables or detector loop cables, submit documentation verifying that the cable has been tested and complies with the requirements of TfNSW TSI-SP-046.

7.1.2 Cable Types

Cabling between the controller and signal posts/mast arms must be 29-core cable complying with TfNSW 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 TfNSW TSI-SP-046.

Cabling to posts used solely for provision of pedestrian push-button assemblies 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.

Cabling to push-button assemblies within the same post must be standard 7/0.40 gauge (1.5 mm²) insulated cable, complying with AS/NZS 3808, with two 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.

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 traffic signal reconstruction sites (refer Clause 8) where capacity of the existing conduit (crossing the road) precludes installation of any extra cables.

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, where approved by the Principal.

At each traffic signals 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.

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

7.3 CABLE INSTALLATION

7.3.1 General

Install all traffic signal 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 at least an additional one metre for all cables 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 Design Documentation drawings, do not make joints in cables without the prior approval of the Principal. Do not make more than one joint in any cable run.

For reconstruction sites where cables are directly buried in the ground without conduits, do not make joints within the buried section of the cables.

Do not locate 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 or under the supervision of 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. Do not lace together the cores of different cables in the same loom. Once the spare cores of each cable are laced together, neatly tie the cable looms together and locate them towards the rear of the housing.

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.

All wiring to push-button assemblies on short posts, installed in the footway with audio-tactile facilities, must be of 5-core cables. The standard colours for the insulated cores must be allocated as follows:

Red	Push-button active
Black	Common (ELV) Return
Green Yellow	Earth
White	Audio-tactile transducer
Blue	Audio-tactile transducer

All wiring to push-button assemblies on short posts, installed on medians and at mid-block crossings without audio-tactile facilities, must be of 3-core cables with standard colours Red, Black and Green Yellow as shown above.

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 traffic signals design plan.

Table TS101.6 – Detector Loop Installation

Detector Loop Type	Reference Drawing No. for	
	Installation Method	Wiring
Stop-line (presence) detector	VC005-17	VC005-19
Advance (passage) detector	VC005-18	VC005-19
Bicycle stop-line detector	VC005-36	VC005-37

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

All pre-formed vehicle detector loops used must be listed in TfNSW TS200 under the “Acceptable” category.

Install the pre-formed loops on the top of the pavement base before the final asphalt wearing course is applied.

The recommended default installation depth is 40 mm to 50 mm (measured from the finished pavement surface) for 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 traffic signals 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 traffic signals 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 TRAFFIC SIGNAL RECONSTRUCTION SITES

8.1 DRAWINGS OF EXISTING FACILITIES

The Principal will provide you with the traffic signal design plans, cable installation drawings and cable connection chart that were implemented for the existing traffic signals site, in pdf format. The Principal may provide these documents in CADD file format, but only if the existing CADD file is considered as suitable.

8.2 NOTIFICATION TO TRANSPORT MANAGEMENT CENTRE

Upon arrival each day at any existing live traffic signals site, immediately notify the TMC and the Traffic Signal Service Provider’s contact room (or TfNSW) 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 traffic signals 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 or alternative traffic control measures 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.

HOLD POINT

Process Held:	Traffic signal blackout at a traffic signal reconstruction site.
Submission Details:	Details of the date, time and duration when the signal installation will be taken out of service, and evidence that all necessary preparatory work has been carried out.
Release of Hold Point:	The Principal will consider the submitted details, prior to authorising the release of the Hold Point.

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 Unit

Replace all existing post mounted loop detector units, 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 Type 1 Post

Replace any existing Type 1 post (which are no longer used) with a current Type post (which may be Type 2, Type 7, Type 8 or Type 13) and their associated footing, where new cabling and/or conduits are to be installed. The Principal will advise the particular Type of post to be used.

8.4.3 Existing Porcelain Type Terminal Blocks

Replace all existing post top assemblies containing porcelain type terminal blocks, with new post top assemblies.

Replace all old Types 3 and 4 mast arms and electric light pole (ELP) terminal boxes, which contain porcelain type terminal blocks, as follows:

- (a) old Type 3 mast arm - replace with new Type 3 mast arm in accordance with Drawing Nos. VM204-25 and VM204-26.
- (b) old Type 4 mast arm - replace with new Type 4 mast arm in accordance with Drawing No. VM203-26.
- (c) old ELP terminal box with two pipe entries - replace with terminal box with single pipe entry in accordance with Drawing No. VM015-16.

8.4.4 Existing Signal Controller

Replace the existing controller with a brand new controller unless the existing controller is compliant with TSC/4 or a later version, and suits the operational requirements of the site without hardware/software changes.

8.4.5 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 TfNSW or Service Providers' workshop for use as spare parts during future maintenance work.

8.4.6 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, replace these cables with new cables within new conduits as part of the reconstruction.

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 or cables, but install the new cables inside new underground conduits and new pits.

Where existing conduits have been abandoned, due to stage construction works, the existing conduits may be left in place. Once the cables have been removed (refer Clause 8.6.2), seal off the conduit at its entry into the pit.

8.6.2 Cabling

Where the number of spare cores in an existing multicore 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/or cables, provide at least the minimum number of spare cores (refer Clause 7.1.2) for all cables (new and existing) on the same cable run, except for those existing cables on the end of the same 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.

Remove all existing abandoned cables from abandoned conduits.

Where it is not possible to remove the cables entirely, cut off and remove the length of cable located within the pit, and end cap the remaining length of cable left behind inside the conduit with heat shrink before sealing off the conduit at its entry into the pit (refer Clause 8.6.1). Do not leave abandoned cables inside a pit.

9 TESTING AND COMMISSIONING

9.1 CONTRACTOR'S PRELIMINARY INSPECTIONS AND TESTING

Before handing over the traffic signal works to TfNSW, 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 3 working days' notice for sites in Sydney, Newcastle and Wollongong, and 5 working days' notice for all other sites, that the traffic signal works at a site are ready for the tests.

Provide the Principal with details of WAE details marked on the traffic signals 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 HANDOVER

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 Design Documentation drawings.

Restore any excavated concrete pavement areas in accordance with the Design Documentation drawings, or if not shown on the Design Documentation drawings, in accordance with the Standard Drawings for concrete pavement maintenance specified in Clause 5.1.2.

10.1.2 (Not Used)

10.2 USE OF TRAFFIC SIGNAL WORKS BY TfNSW

When the majority of the traffic signal works is complete and tested, and the commissioning results have been accepted by the Principal, TfNSW may make use of the traffic signal 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.

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 Marked Up Work-As-Executed Drawings

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

- (a) traffic signals 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 Principal will review the marked up WAE details for accuracy, and only accept them if they are correct. If the marked up WAE information are incorrect, you will be advised accordingly and you will not be given Completion.

If the marked up WAE details are correct, the Principal will forward the WAE drawings, signed as accepted as correct, to the TfNSW Electrical Design Office.

10.3.3 Final Work-As-Executed Drawings

Submit the final WAE drawings to the Principal within 30 days from the date of completion of the final inspection and commissioning tests.

The final WAE drawings must be in CADD file format, complying with the requirements set out in the TfNSW CADD Manual and must be compatible with the CADD program Micro-station.

Where the Works are carried out in stages (“stage construction”) and each intermediate stage does not last longer than six months, you do not need to submit WAE drawings in CADD file format for each intermediate stage.

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 in electronic format by email, all Identified Records (refer Clause 1.2.3) together with the marked up copies of the WAE drawings (refer Clause 10.3.2).

The Principal will issue you with a notice of nonconformity if the Identified Records and marked up copies of the WAE drawings are 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, TfNSW is responsible for the site’s traffic signals 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.

Clause	Description	Requirement
4.4.1	Controller supplied by TfNSW	Yes / No

ANNEXURE TS101/B – (NOT USED)**ANNEXURE TS101/C – SCHEDULES OF HOLD POINTS AND IDENTIFIED RECORDS****C1 SCHEDULE OF HOLD POINTS AND WITNESS POINTS**

Clause	Type	Description
3.4	Hold	(Not Used)
3.5.1	Hold	Submission of details of excavation near, or installing attachments to, an existing bridge structure
5.1.1	Hold	Submission of details of open trenching work
5.3.6	Witness	Backfilling over placed conduits
5.8.1	Hold	Notification of concrete placing
5.9.4	Hold	Submission of details of modified footing design
6.1.1	Hold	Submission of evidence that all requirements have been satisfied prior to erection of signal post or mast arm
6.1.4	Hold	Submission of evidence that all necessary approvals have been obtained prior to making any opening or hole through awning
6.2.7	Hold	Submission of proposal to overcome local obstruction to mounting of lanterns or target boards
8.2	Hold	Submission of required details prior to traffic signal blackout at traffic signal reconstruction site

C2 SCHEDULE OF IDENTIFIED RECORDS

Clause	Description of Identified Records
8.2	Logbook containing notified information to TMC
8.4.4	Disposal records of obsolete equipment (including recycle settlement summary)
9.1	Results of inspections and tests based on Contractor's ITP
9.2	Results of final inspection and commissioning tests
10.3	WAE drawings

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.

Clause	Description of Document
3.1	Traffic signal design plans
3.1.2	Cable installation drawings
3.1.3	Cable connection chart

ANNEXURE TS101/E – LOOP TESTING

E1 SEQUENCE

During the initial installation, test each loop individually at the PJB pit before joining their connecting cables inside the pit. Once the loops have been joined in the pit, carry out the rest of the test at the controller, for each lane.

E2 TESTING POINT AND PRELIMINARY CHECKS

The testing point is at the end of the detector loop's feeder cable, located inside the traffic signals 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 TS101.E1- Test Parameters and Acceptable Ranges

Test Parameter	Acceptable Range
DC resistance (Ω)	1 – 3 ⁽¹⁾
Inductance (μH)	50 – 700
Insulation resistance ($\text{M}\Omega$)	> 200 ⁽²⁾

Notes:

⁽¹⁾ Suggested range.

⁽²⁾ 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" 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 TfNSW.

(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 and Inductance

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

General Test Setup for Loop Testing

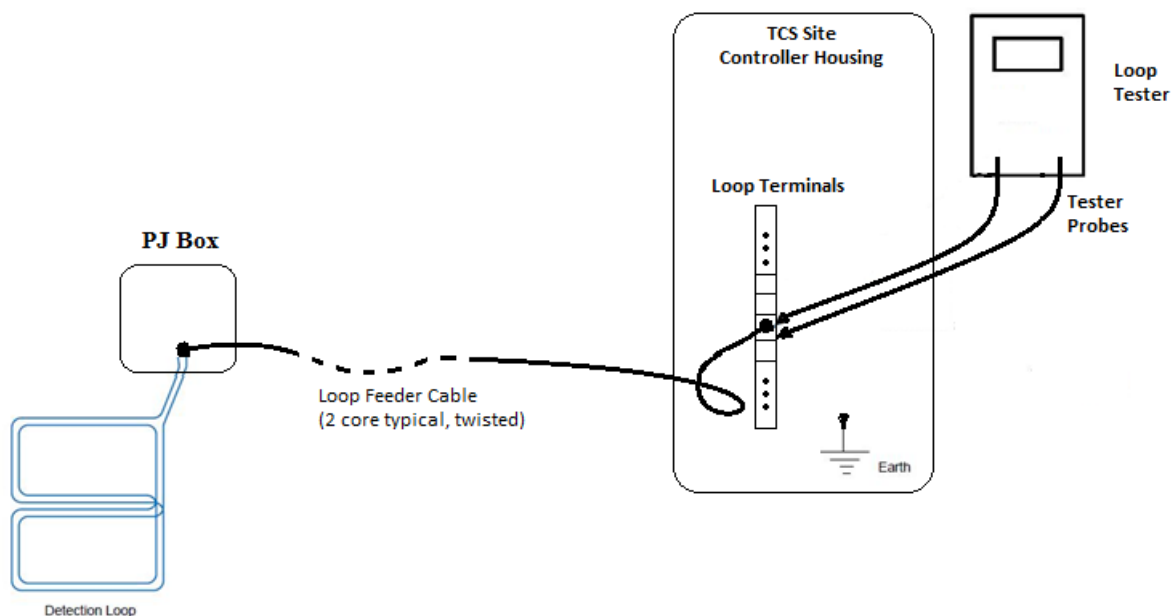


Figure TS101/E.1 – Measurement for DC Resistance and Inductance of Loops

(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 traffic signals 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 traffic signals 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.

General Test Setup for Loop Insulation Resistance Testing

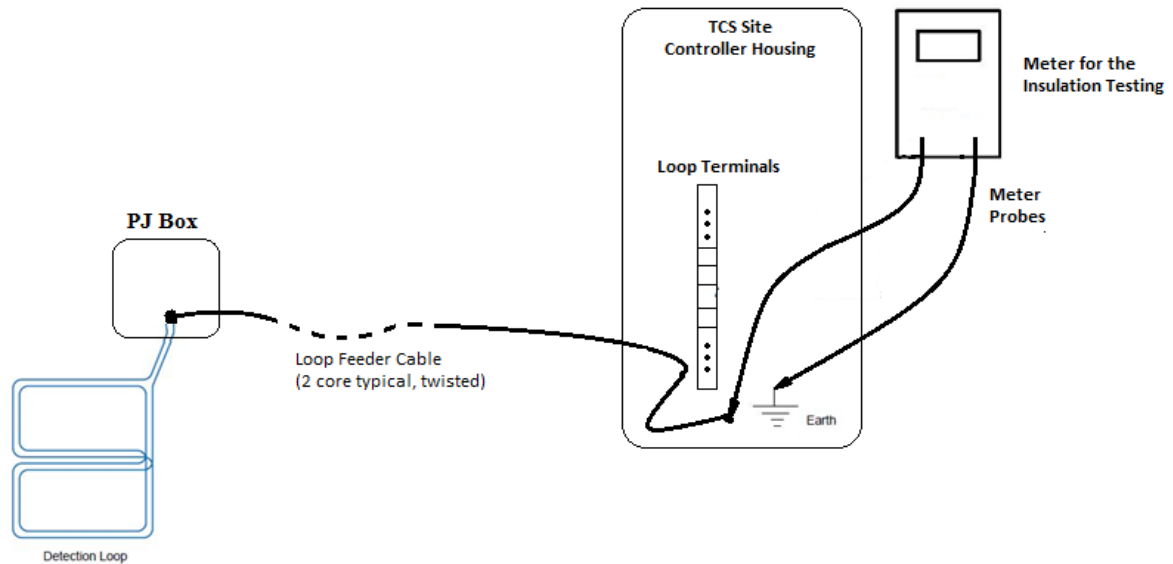


Figure TS101/E.2 – Testing for Loop Insulation Resistance

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.

D&C TS101

Traffic Control Signals – New Installation and Reconstruction

Record Sheet for Loop Testing Results

Contractor		Testing Date			
Testing Organisation		Signature			
Site No.		Site Location		Weather Condition	

Test Instruments:

Loop Tester					
Make		Model		Serial No.	
Megohm-meter					
Make		Model		Serial No.	

Lane	Loop	Resistance (Ω)	Inductance (μ H)	Insulation Resistance (M Ω)
Lane 1	1			
	2			
Lane 2	1			
	2			
Lane 3	1			
	2			
Lane 4	1			
	2			
Lane 5	1			
	2			
Lane 6	1			
	2			
Lane 7	1			
	2			
Lane 8	1			
	2			

ANNEXURES TS101/F TO TS101/L – (NOT USED)

ANNEXURE TS101/M – REFERENCED DOCUMENTS

M1 REFERENCED DOCUMENTS

TfNSW Specifications

TfNSW D&C G10	Traffic Management
TfNSW D&C G22	Work Health and Safety (Construction Work)
TfNSW D&C G36	Environmental Protection
TfNSW D&C Q6	Quality Management System (Type 6)
TfNSW D&C R53	Concrete for General Works
TfNSW TS200	Register of ITS Field Equipment
TfNSW TS201	Approval of ITS Field Equipment
TfNSW TS202	Approval of ITS Solution for Projects
TfNSW TSI-SP-043	Traffic Signal Posts
TfNSW TSI-SP-045	Traffic Signal Lanterns
TfNSW TSI-SP-046	Cables for Traffic Signal Installations
TfNSW TSI-SP-048	Pedestrian Push-Button Assembly and Audio Tactile Facility
TfNSW TSI-SP-054	Traffic Signal Mast Arms
TfNSW TSI-SP-055	Pit Covers and Frames
TfNSW TSI-SP-056	Slot Sealant for Vehicle Detector Loops
TfNSW TSI-SP-061	Underground Mains Fuse
TfNSW TSI-SP-069	Control Equipment for Road Traffic Signals

TfNSW 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)
AS/NZS 3100	Approval and test specification - General requirements for electrical equipment
AS/NZS 3750.9	Paints for steel structures - Organic zinc-rich primer
AS/NZS 3808	Insulating and sheathing materials for electric cables
AS 4702	Polymeric cable protection covers
AS 5100	Bridge Design

M2 TRAFFIC SIGNAL INSTALLATION STANDARD DRAWINGS

VC001-4	Precaution against obstruction of water mains
VC001-8	Typical excavations and installation of components for mid-block locations
VC001-9	Typical intersection excavations and installation of component parts
VC002-43	Footing for type 2 post and post-mounted controller
VC002-45	Installation and mechanical details of special type 2 post with shallow cover
VC002-59	Footing for type 7 & 8 posts
VC002-65	Footing for type 10 and type 11 mast arms
VC002-66	Footing for type 13 Short push button post
VC002-71	Footing for type 2 post
VC002-72	Footing for type 5 & 9 mast arms & type 6 post
VC002-73	Footing for ground-mounted controller housing
VC002-75	Footing for type 4 mast arm
VC002-76	Footing for ground-mounted small Controller and CCTV housings
VC002-78	Alternative footing for type 13 post with exposed base plate on final surface
VC002-82	Method of Installation of Adaptor Stool to Suit Type 7, 8 & 13 Posts on an Existing Type 2
VC005-17	Method of installation of stop line detectors
VC005-18	Method of installation of advance detectors
VC005-19	Symmetripole loop detector wiring guide
VC005-36	Method of installation of bicycle stop line detectors
VC005-37	Quadruple type bicycle loop detector wiring guide for a possible entry positions
VC005-38	Sample of bicycle stop line loop detector to suit bicycle lanes from 1.2m to 2.0m wide
VC007-4	General arrangement of a pavement junction box pit (small, large and extra-large types)
VC007-5	Large footway cable junction pit
VD001-5	Standard positioning of traffic signal components at intersections
VD001-6	Standard positioning of traffic signal components at mid-block locations
VD001-7	Orientation of pedestrian push-button arrow disc
VD002-20	Typical traffic signal design plan for mid-block location
VD002-21	Typical cable installation plan for mid-block location

VD002-22	Typical traffic signal design plan for intersection location
VD002-23	Typical cable installation plan for intersection location
VD002-25	Traffic signal post top assembly-suggested terminal allocations
VD002-37	Typical cable connection chart for intersection location
VD003-6	Symbols and abbreviations
VD006-20	Standard cable chart for mid-block pedestrian-actuated signals
VE500-1	General arrangement of consumer mains for overhead supply
VE500-11	Installation of underground fuse box
VE530-7	Standard connection chart for post-mounted audio-tactile equipment
VE530-8	Method of installation of audio-tactile signal facilities
VE535-1	Connection diagram for Fire/Ambulance station signals
VM015-16	Assembly details of terminal box, lanterns and pedestrian push buttons on wooden poles
VM015-18	General arrangement of traffic signals on wooden poles
VM200-27	Assembly details for dual lanterns using lock washers
VM200-28	Assembly details of lock washers
VM202-8	Traffic signal lantern and accessories assembly on standard type 2 post
VM202-12	Installation of traffic signal priority sign (R1-202)
VM203-13	General arrangement of Type 4 mast arm
VM211-6	General arrangement of Type 5 mast arms
VM211-17	Lower assembly details of terminal box and lanterns for mast arms and type 6 post
VM211-20	Safety clearances from overhead power lines and communications cables for traffic signals and signs
VM211-21	Assembly details of upper lanterns to type 5 mast arms
VM211-26	Assembly details of type 5L and 5S mast arms
VM212-2	General arrangement of type 6 post
VM215-1	General arrangement of type 9 mast arms
VM417-3	Method of jointing multi-core traffic signal cables
VM417-4	Method of protection for two-core screened detector feeder cable
VM417-5	Method of inserting lip blade crimp lugs into terminals
VM625-17	Outline and arrangement of post-mounted controller
VR007-6	Maximum allowable cable combination in ducts for traffic signal installation
VR007-7	Table showing conduit and excess lead lengths for lanterns and audio-tactile housing
VR017-11	Method of clamping conduits on post top assemblies
VT006-60	Assembly details for traffic signs using lock washers

M3 APPLICABLE MATERIALS DRAWINGS

VC002-27	L bolt used for Type 2 post footing
VC002-38	Holding-down bolt assembly for type 5 and type 9 mast arms and type 6 post
VC002-50	Holding-down bolt assembly for type 2 post (alternative method)
VC002-56	Holding-down bolt assembly for ground mounted controller
VC002-60	Holding-down bolt assembly for type 7 & 8 post
VC002-67	Holding-down bolt assembly for type 13 short push
VE500-10	Underground fuse box
VM007-2	Pole mounting fuse box
VM012-7	Lantern mounting straps
VM012-8	Adjustable "Z" bracket for 200 mm lanterns
VM012-12	Fixed "Z" bracket for 200 mm lanterns
VM012-13	Fixed "Z" bracket for 300 mm lanterns
VM012-14	Tee-bar strap for dual 200 mm lanterns
VM012-15	Tee-bar strap for dual 300 mm lanterns
VM012-20	Special fixed Z bracket for Illuminated Authorised Vehicles Excepted sign
VM015-21	Terminal box for mounting on wooden poles
VM015-22	Terminal box for mast arms and type 6 posts
VM015-41	Mechanical details of terminal box for type 8 post
VM015-42	Assembly details of terminal box for type 8 post
VM016-10	Small pavement junction box casting
VM016-11	Large pavement junction box casting
VM016-12	Extra-large pavement junction box casting
VM041-32	Direction arrow/transducer disc for pedestrian push-button assemblies
VM052-5	Support cradle and securing bracket for underground fuse box
VM200-10	Lantern mounting bracket for wooden poles
VM200-14	Lower mounting bracket
VM200-15	Post top assembly
VM200-24	Standard lock washer
VM200-29	Special lock washer for T-bar assemblies for dual lanterns
VM202-1	Type 2 post (mechanical details)
VM202-10	Type 2 adaptor plate for type 5 or 6 footing
VM202-15	Type 7 post mechanical details
VM202-16	Bracket for 0.35m offset of a type 2 post
VM202-17	Bracket for 0.7m offset of a type 2 post
VM202-20	Type 13 Short Push Button Post (mechanical details)
VM202-21	Adaptor Plate for 7, 8 and 13 posts on a Type 2 Footing

VM202-25	Type 8 post mechanical details
VM202-26	Adapter stool for type 7 & 8 post on a type 2 footing
VM202-31	Adaptor plate for a Type 2 Post on a shallow-cover (skid) plate installation
VM203-26	Mechanical details of Type 4 Mast Arm
VM204-25	Alternative Replacement Type 3 Mast Arm Column Mechanical Details
VM204-26	Alternative Replacement Type 3 Mast Arm Outreach Mechanical Details
VM206-13	Target board mounting details
VM206-14	Target boards for 200 mm 1-aspect, 3-aspect, "3 + 3"- aspect, and 4-aspect signal lanterns
VM206-21	Target boards for 300 mm 3-aspect and "3 + 3"-aspect signal lanterns
VM208-29	Type B 200 mm closed visors
VM208-31	Type A 200 mm open visor
VM208-39	Blanking-out disc for signal lanterns
VM208-43	Type B 300 mm closed visors
VM208-44	Type A 300 mm open visor
VM208-45	Louvre for 200 mm signal lanterns
VM211-22	Type 5 mast arm: mast column
VM211-23	Type 5 mast arm: outreach 5L
VM211-24	Type 5 mast arm: outreach 5S
VM211-28	Type 5 mast arm: outreach 5XL
VM212-1	Type 6 post (mechanical details)
VM213-1	Finial cap for post top assemblies
VM213-2	Finial cap (split type) for post top assemblies
VM215-2	Type 9 mast arm: mast column
VM215-3	Type 9 mast arm: outreach arm (various lengths)
VM215-4	Mechanical details of upper lantern support to suit 300mm lantern on mast arms
VM215-5	Mast arm: identification plate
VM215-6	Mechanical details of upper lantern support to suit 200mm lantern on mast arms
VM416-2	Danger Label for Traffic Signal Supply Cable
VM417-3	Cable jointing kits
VM418-1	Traffic signal out-of-service lantern cover (yellow)
VM418-3	Traffic signal out-of-service lantern cover (black)
VM620-19	Engraved plate for emergency signal control switch
VM623-2	Supporting post for post-mounted controller housing
VT006-51	Single mounting bracket (small) for 450mm high special stop sign
VT006-52	Single mounting bracket for large signs
VT006-53	Double mounting bracket for small signs
VT006-54	Double mounting bracket for medium signs

VT006-55	Double mounting bracket for large signs
VT006-56	Vertical saddle (bracket) for 450mm high special stop sign
VT006-57	Vertical saddle (bracket) for large signs
VT006-58	Horizontal saddle (bracket) for various sized signs
VT006-61	Single end mounted bracket for special stop signs