

TRANSPORT FOR NSW (TfNSW)

TfNSW SPECIFICATION D&C TS932

TUNNEL AND UNDERPASS ELECTRICAL SERVICES WORKS

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TUNNEL AND UNDERPASS ELECTRICAL SERVICES WORKS

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VERSION FOR: DATE:

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FOREWORD

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When this document forms part of a deed

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REVISIONS TO PREVIOUS VERSION

This document has been revised from Specification TfNSW D&C TS932 Edition 1 Revision 0.

TfNSW SPECIFICATION D&C TS932

TUNNEL AND UNDERPASS ELECTRICAL SERVICES WORKS

1 GENERAL

1.1 SCOPE

This Specification sets out the requirements for the design and installation of electrical services works comprising the main switchboard, distribution boards and control panels (collectively termed “electrical boards”) and associated cabling within tunnels, including tunnels in motorways, and long underpasses.

Supply of the electrical boards is covered under Specification TfNSW D&C TS931.

Design and installation of the overall electrical power supply and distribution system along motorways is covered under Specification TfNSW D&C TS914. Where there is a conflict between the requirements in TfNSW D&C TS914 and TfNSW D&C TS932, the requirements in TfNSW D&C TS932 will prevail.

1.2 RELATED SPECIFICATIONS

This Specification is a Level 3 document which forms part of the suite of TfNSW specification documents for Motorway Systems (see figure below). Other documents within the suite are:

Level 1

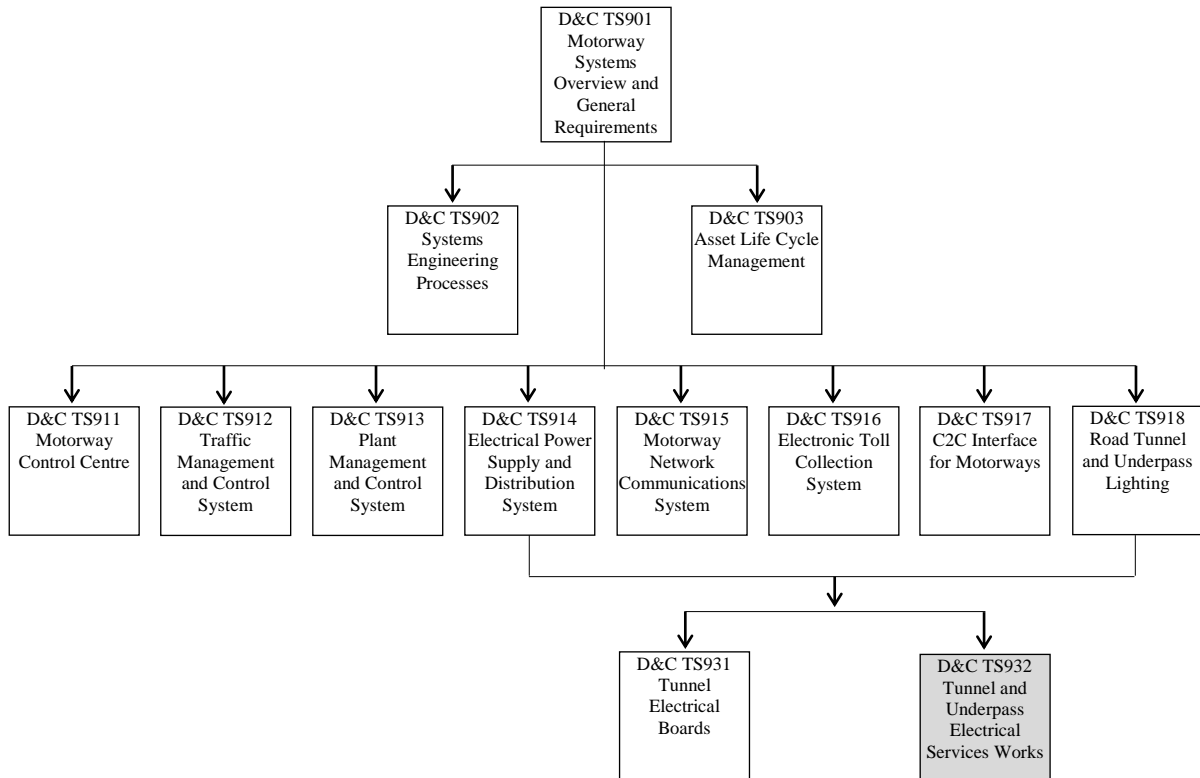
- D&C TS901 “Motorway Systems Overview and General Requirements”.

Level 2

- D&C TS911 “Motorway Systems - Motorway Control Centre”;
- D&C TS912 “Motorway Systems - Traffic Management and Control System”;
- D&C TS913 “Motorway Systems - Plant Management and Control System”;
- D&C TS914 “Motorway Systems - Electrical Power Supply and Distribution System”;
- D&C TS915 “Motorway Systems - Motorway Network Communications System”;
- D&C TS916 “Motorway Systems - Electronic Toll Collection System”;
- D&C TS917 “Motorway Systems - C2C Interface for Motorways”;
- D&C TS918 “Motorway Systems - Road Tunnel and Underpass Lighting”.

Level 3

- D&C TS931 “Tunnel Electrical Boards”.



1.3 STRUCTURE OF THE SPECIFICATION

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

1.3.1 (Not Used)

1.3.2 (Not Used)

1.3.3 Schedule of Identified Records

The records listed in Annexure TS932/C are **Identified Records** for the purposes of Specification TfNSW D&C Q6 Annexure Q/E.

1.3.4 Referenced Documents

Standards, specifications and test methods are referred to in abbreviated form (e.g. AS 1023). For convenience, the full titles are given in Annexure TS932/M.

1.4 DEFINITIONS AND ACRONYMS

1.4.1 Definitions

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

The terms “**main switchboard**”, “**distribution board**”, and “**control panel**” are collectively termed “electrical boards”.

The following definitions apply to this Specification.

“**Supplier**” can mean either the manufacturer or distributor of the equipment or components.

“**Space factor**” is the ratio of the sum of the cross sectional areas of the installed cables to the internal cross sectional area of the conduit.

1.4.2 Acronyms

The following acronyms apply to this Specification:

AC	Alternating current
BP	Blue point
DC	Direct current
PVC	Polyvinyl chloride
TfNSW	Transport for NSW
SWTC	Project Deed Scope of Works and Technical Criteria
UPVC	Unplasticised polyvinyl chloride
WAE	Work-As-Executed (Drawings)

1.5 SCOPE OF ELECTRICAL SERVICES WORKS

- (a) The electrical services works includes (but not limited to) the design, supply of materials and equipment, installation and commissioning, and further elaborated as follows:
- (i) Installation, connection, testing and commissioning of the main switchboard, distribution boards and control panels (refer also Clauses 1.1 and 3.1).
 - (ii) Connection of the electricity mains supply (i.e. consumer mains) to the main switchboard.
 - (iii) Connection of all sub-mains from the main switchboard to the distribution boards or control panels.
 - (iv) Connection from the electrical boards to electrical equipment and luminaires.
 - (v) All necessary cabling for the electrical services works.
 - (vi) Provision of a suitable earthing system.
 - (vii) All control and safety devices.
 - (viii) All cable ladders and mounting hardware.
 - (ix) All labels and signage required for identification and safety purposes as required by this Specification, relevant standards, regulations or guidelines.
 - (x) Testing and commissioning of the completed electrical services works, and obtaining the necessary local Electricity Distributor approval.

2 DESIGN

2.1 GENERAL

2.1.1 Standards

- (a) Design of electrical services works must comply with the relevant Australian Standards, TfNSW specifications and the Project Deed Scope of Works and Technical Criteria (SWTC).

2.1.2 Earthing System

- (a) The design must include a suitable earthing system.

2.1.3 Electrical Board Locations

- (a) The electrical boards must be located in a dry and well ventilated environment, and positioned such that they are readily accessible.

2.1.4 Cable Routing

- (a) Cable runs must be as straight as possible.
- (b) Cable layout must not obstruct doorways, passages or any other accessways.
- (c) Cables and other electrical installation must not be located within the clearance envelope of the tunnel.

2.1.5 Cable Sizing

- (a) Sub-mains cabling must be suitably sized to meet the voltage drop and current carrying requirements of the installation.

2.2 DESIGN DOCUMENTATION AND DRAWINGS

2.2.1 General

- (a) Design Documentation must include (but not limited to) the following:
 - (i) current and voltage drop calculations;
 - (ii) schematic or wiring diagrams;
 - (iii) equipment location and cabling drawings;
 - (iv) cable schedules.
- (b) The following details must be shown on the Design Documentation drawings:
 - (i) cable routes and electrical board locations;
 - (ii) junction boxes, including the types, sizes and their locations;
 - (iii) details of cable mountings and conduit supports.

2.2.2 Format

- (a) Design Documentation drawings must be submitted electronically in both native and PDF formats.
- (b) Other Design Documentation may be submitted electronically in PDF format.

3 MATERIALS AND EQUIPMENT

3.1 ELECTRICAL BOARDS

- (a) Electrical boards must comply with TfNSW D&C TS931.

3.2 OTHER EQUIPMENT

- (a) All other electrical equipment located outside equipment rooms inside tunnels must also be:
 - (i) suitable for operating within the tunnel environment;
 - (ii) fire resistant, non-flammable, and its components must be of low smoke and halogen free composition;
 - (iii) rated for 0 to 40°C ambient temperature.
- (b) These electrical equipment must also comply with the material and ingress protection requirements specified for the electrical boards in TfNSW D&C TS931.

3.3 CONDUITS

- (a) Conduits must comply with AS/NZS 2053.
- (b) Conduits which are exposed to the tunnel environment must be of galvanized steel complying with AS/NZS 2053.7.
- (c) Galvanized steel conduits must also be used where there is a risk of mechanical damage to the wiring system.
- (d) Halogen free tube (HFT) plastic rigid conduits may be used in equipment rooms and cross passages, where the resulting installation of conduits complies with TfNSW D&C TS914.
- (e) Buried conduits must be heavy duty UPVC complying with AS/NZS 2053.2.
- (f) All above-ground galvanized elbows and tees must be of the inspection type.

3.4 CABLE SUPPORTS

- (a) Cable support system components must be of hot-dip galvanized steel.
- (b) Slots or ladder rails must be suitable for fixing cable ties or strapping.

3.5 MATERIALS AND EQUIPMENT REVIEWS

- (a) Prior to their supply and/or installation, complete information on all materials and equipment proposed for use in the Works must be submitted to the Principal for review.
- (b) The submission must list the manufacturers, model numbers and all other information necessary for the Principal to identify the items and determine their compliance or otherwise.
- (c) The submission must include materials which are specified in the Design Documentation with the manufacturers' names, models or trade names, as well as materials proposed for use.

4 INSTALLATION

4.1 GENERAL

4.1.1 Existing Services

- (a) Before commencing any excavation at the Site, make all necessary enquiries and carry out all necessary inspections to confirm the types and locations of existing surface and underground utility services.
- (b) Implement all necessary measures to avoid damage to existing services.

4.1.2 Personnel

- (a) All personnel undertaking electrical wiring work must be licensed electricians and experienced in this field of work.

4.1.3 Notices and Fees

- (a) The Contractor must provide all necessary notices to, pay all fees and charges, and arrange for all inspections and tests by the local Electricity Distributor.

4.1.4 Test Certificates

- (a) If not already submitted, test certificates of all electrical boards to verify that the equipment has passed all necessary type or verification tests must be obtained from the Supplier for submission to the Principal.

4.2 INCOMING POWER SUPPLY

- (a) Incoming power supply cables must be enclosed within heavy duty rigid UPVC conduits, and buried underground. If an alternative method is proposed, this must be approved by the local Electricity Distributor.
- (b) Trenches excavated for laying the conduits must be backfilled and compacted to the original ground level, with allowance for settlement.
- (c) Marking tape complying with AS 2648.1 must be placed at approximately 200 mm above the conduits for the entire run.

4.3 CONDUIT INSTALLATION

- (a) Sufficient draw in boxes must be provided to allow cables to be drawn in without recourse to dismantling any sections of the runs.
- (b) Above ground conduits must be fixed at intervals not exceeding 900 mm and located on tunnel or building walls.
- (c) Polypropylene draw cord must be provided in all cabling conduits, including those that are not in use.

4.4 CABLING

4.4.1 General

- (a) Conduits and fittings must be completely installed before the cables are drawn in.
- (b) Cables must be accessible after installation.
- (c) Cable entry must be located such that ingress of water and dirt is prevented. Drainage openings must be provided at the closest practical locations.

4.4.2 Earthing

- (a) Installation of the earthing system must be as shown on the Design Documentation drawings, and include supply of all necessary materials.

4.4.3 Cable Joints

- (a) All cables must be run continuously between equipment terminals.
- (b) Intermediate joints must not be employed unless it can be demonstrated to the Principal that they are unavoidable.
- (c) Where such circumstances arise, full details including joint types, joint locations and future accessibility, must first be submitted to the Principal for approval.
- (d) Where a device is supplied with a pre-terminated or factory fly lead, a suitable IP rated (in accordance with AS 60529) junction box may be used in the final termination.
- (e) Looping of control wiring must be carried out only at equipment terminals. “Blue point” (BP) connectors or other connecting devices must not be used at equipment terminals.

4.4.4 Cable Supports

- (a) Cable support systems must be provided for groups of cable considered too large for individual conduits.
- (b) The support system must consist of cable trays, ladders, connectors, bends and other support hardware necessary to provide adequate support and must be in accordance with the manufacturer’s recommendations.
- (c) Cable trays or ladders provided must have at least 10% spare capacity.

- (d) Cabling supported by suspending from overhead catenary wire is not acceptable, except for cables used in carriageway heat and fire detection systems.

4.4.5 Cable Tails

- (a) Within equipment cabling spaces, cables and cable tails must be neatly arranged and laced or cleated where necessary until they are finished off at their respective terminals.
- (b) At all supports, mechanical strain must not be imposed upon the conductor termination under either normal or fault conditions.

4.4.6 Sub-circuits

- (a) Sub-circuit cabling must be so arranged that the phases are evenly balanced.

4.4.7 Disused Cables

- (a) All disused cables (including the associated conduits and fittings) must be removed and disposed of after completion of the Works.

4.5 EQUIPMENT INSTALLATION

4.5.1 Mounting Heights

- (a) All equipment requiring regular inspection or adjustment must be mounted in accordance with the mounting heights specified in AS/NZS 3000.

4.5.2 Protection Against Damage

- (a) Equipment installation must be protected against damage from the operation of fire protection systems, or from cleaning and spillage.

4.6 COLOUR IDENTIFICATION AND LABELLING

4.6.1 Conduits

- (a) All conduits must be identified in accordance with the requirements of AS 1345 and AS/NZS 3000.

4.6.2 Cables

- (a) All cables to be installed under this Contract must be labelled near the cable origin and destination terminations.
- (b) Labels must be permanent straight cut type (minimum 5 mm black legend on yellow background). Hand written labels must not be used and legends must be either preprinted or generated on a hand-held label printer.
- (c) Marker holders must be securely attached to the cable and must not be an adhesive-type attachment.
- (d) Marker holders or the method of attachment to the cable must be permanent and must provide protection to the label.

- (e) Details of the cable identification system must be submitted to the Principal for approval prior to use.

4.6.3 Wiring

- (a) All electrical wiring and cable cores must be colour identified according to their intended functions, as detailed below

(i) A Phase	Red
(ii) B Phase	White
(iii) C Phase	Blue
(iv) Neutral	Black
(v) Earth	Green/Yellow
(vi) 230V AC Control Active	Red
(vii) 230V AC Control Neutral	Black
(viii) DC Control Positive	Orange
(ix) DC Control Common	Brown
(x) 4-20 mA Positive	White
(xi) 4-20 mA Negative	Black

- (b) Additional colours may be used as necessary to provide logical circuit identification. Use of additional or alternative colours requires the approval of the Principal.
- (c) Alternative colour coding may be used for the flexible connection to individual tunnel luminaires, but only with the approval of the Principal. Any alternative colour coding must be logical and consistent throughout the installation.

4.6.4 Equipment

- (a) Safety signage in accordance with AS 1319 must be provided on equipment with safety risks generated from a risk assessment.

5 SITE TESTING AND COMMISSIONING

5.1 INSPECTION AND TESTING

5.1.1 Equipment

- (a) Testing of electrical boards must include checking the insulation resistance between phases, and between phases to earth. The tests must be performed only after disconnecting the cable tails to avoid damage to the equipment.
- (b) Earthing continuity of all equipment must be checked as part of the testing.

5.1.2 Cables

- (a) Cabling must be tested for continuity, and insulation resistance between individual cores and between all cores and earth. Care must be taken during these tests to ensure that no equipment likely to be damaged by the test voltages is connected to the cables.
- (c) Cabling must be checked for correctness of the core numbering.

5.2 FUNCTIONAL TESTS

- (a) Full functional tests to check the operation of the equipment must be carried out as part of the site testing.
- (b) Testing of the following functions must be carried out, as a minimum:
 - (i) sequence testing on control circuits;
 - (ii) testing of the operation of the interlocks and logics;
 - (iii) operation of protective devices within the equipment.

5.3 COMMISSIONING

- (a) At completion of installation, all necessary tests must be carried out to verify that the equipment and systems operate in accordance with the SWTC and the Specifications and in a manner in which they were intended to operate.
- (b) Engineers and sub-professionals who are experienced in the commissioning of each part of the Works must be used to carry out this work.
- (c) Testing must be carried out progressively to verify that each section of the system operates satisfactorily prior to integration of the section with other sections of the system.
- (d) After satisfactory completion of testing and pre-commissioning of all sections of the system, the equipment and systems must be commissioned to verify:
 - (i) complete integration of all elements;
 - (ii) the equipment and systems operating in accordance with the requirements of the Contract.
- (e) If the equipment or systems fail a particular test, the fault or deficiency must be rectified and all tests on the equipment or systems repeated.
- (f) Commissioning must include repeating all initial and pre-commissioning tests and making necessary adjustments to the equipment and systems.
- (g) A commissioning report must be submitted to the Principal.

6 ACCEPTANCE

6.1 WORK-AS-EXECUTED DRAWINGS

- (a) Work-As-Executed (WAE) drawings must show all information necessary to facilitate future operations and maintenance, including accurate cable routes and cable lengths, cable ladder runs

etc, underground cable details, including depth of laying, enclosures etc, and any modifications carried out to facilitate satisfactory installation or operations.

- (b) Within 10 working days of completion of commissioning, WAE electrical schematic wiring details must be submitted to the Principal.
- (c) Prior to acceptance, WAE drawings of the electrical services works in both native and PDF format must be submitted to the Principal.

6.2 OPERATIONS AND MAINTENANCE MANUALS

- (a) Prior to acceptance of the electrical services works, electronic copies of the Installation, Operating and Maintenance Instructions in PDF format, covering all aspects of the electrical services works, must be submitted to the Principal.

6.3 TESTING EQUIPMENT

- (a) If the equipment requires regular testing after installation, the necessary testing equipment must be provided to the Principal.

6.4 COMPLETION

- (a) Prior to Completion, all required documentation, including WAE drawings, test reports and certificates, commissioning report and Operations and Maintenance Manuals, in accordance with the SWTC and the Specifications must be submitted to the Principal.
- (b) You will not be granted Completion until these documentation have been submitted.

ANNEXURES TS932/A TO TS932/B – (NOT USED)

ANNEXURE TS932/C – SCHEDULE OF IDENTIFIED RECORDS

Refer to Clause 1.3.3.

C1 (NOT USED)

C2 SCHEDULE OF IDENTIFIED RECORDS

The records listed below are Identified Records for the purposes of TfNSW D&C Q6 Annexure Q/E.

Clause	Description of Identified Record
3.5	Equipment and materials information.
5.3	Commissioning report.
6.1	WAE drawings
6.2	Operations and Maintenance Manuals

ANNEXURES TS932/D TO TS932/L – (NOT USED)

ANNEXURE TS932/M – REFERENCED DOCUMENTS

Refer to Clause 1.3.4.

TfNSW Specifications

TfNSW D&C Q6	Quality Management System (Type 6)
TfNSW D&C TS901	Motorway Systems Overview and General Requirements
TfNSW D&C TS911	Motorway Systems - Motorway Control Centre
TfNSW D&C TS912	Motorway Systems - Traffic Management and Control System
TfNSW D&C TS913	Motorway Systems - Plant Management and Control System
TfNSW D&C TS914	Motorway Systems - Electrical Power Supply and Distribution System
TfNSW D&C TS915	Motorway Systems - Motorway Network Communications System
TfNSW D&C TS916	Motorway Systems - Electronic Toll Collection System
TfNSW D&C TS917	Motorway Systems - C2C Interface for Motorways
TfNSW D&C TS918	Motorway Systems - Road Tunnel and Underpass Lighting
TfNSW D&C TS931	Tunnel Electrical Boards

Australian Standards

AS 1319	Safety signs for the occupational environment
AS 1345	Identification of the contents of pipes, conduits and ducts
AS/NZS 2053	Conduits and fittings for electrical installations
AS 2648.1	Underground working tape – Non-detectable tape
AS/NZS 3000	Electrical installations (known as the Australian/New Zealand Wiring Rules)
AS 60529	Degrees of protection provided by enclosures (IP Code)