ROADS AND MARITIME SERVICES (RMS)

RMS SPECIFICATION D&C TS914

OMCS REQUIREMENTS - ELECTRICAL POWER SUPPLY AND DISTRIBUTION SYSTEM

REVISION REGISTER

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	2	Design requirements previously scattered throughout specification consolidated under new Clause 2. Duplicated clauses on design deleted. Subsequent clauses renumbered.		
	6	Lighting requirements previously under Clauses 2.3, 3.3 and 4.4 consolidated under Clause 6. Duplicated clauses deleted and specific requirements cross referred to other documents (not within scope). Tunnel signposting requirements previously under Clause 2.4 deleted (not within scope).		

Transport Roads & Maritime Services

SPECIFICATION D&C TS914

OMCS REQUIREMENTS - ELECTRICAL POWER SUPPLY AND DISTRIBUTION SYSTEM

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VERSION FOR:
DATE:

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FOREWORD

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BASE SPECIFICATION

This document is based on non-D&C Specification RMS TS914 Edition 1 Revision 1.

RMS SPECIFICATION D&C TS914

OMCS REQUIREMENTS - ELECTRICAL POWER SUPPLY AND DISTRIBUTION SYSTEM

1 GENERAL

1.1 SCOPE

This Specification sets out the requirements for electrical power supply and distribution system for tunnel equipment and electrical infrastructure along motorways, to provide safe operating conditions for the full range of operational requirements, including emergencies.

This Specification is applicable to the tunnels, long underpasses and roadways on Motorways.

Power over Ethernet requirements are stated in Specification D&C TS915.

1.2 RELATED SPECIFICATIONS

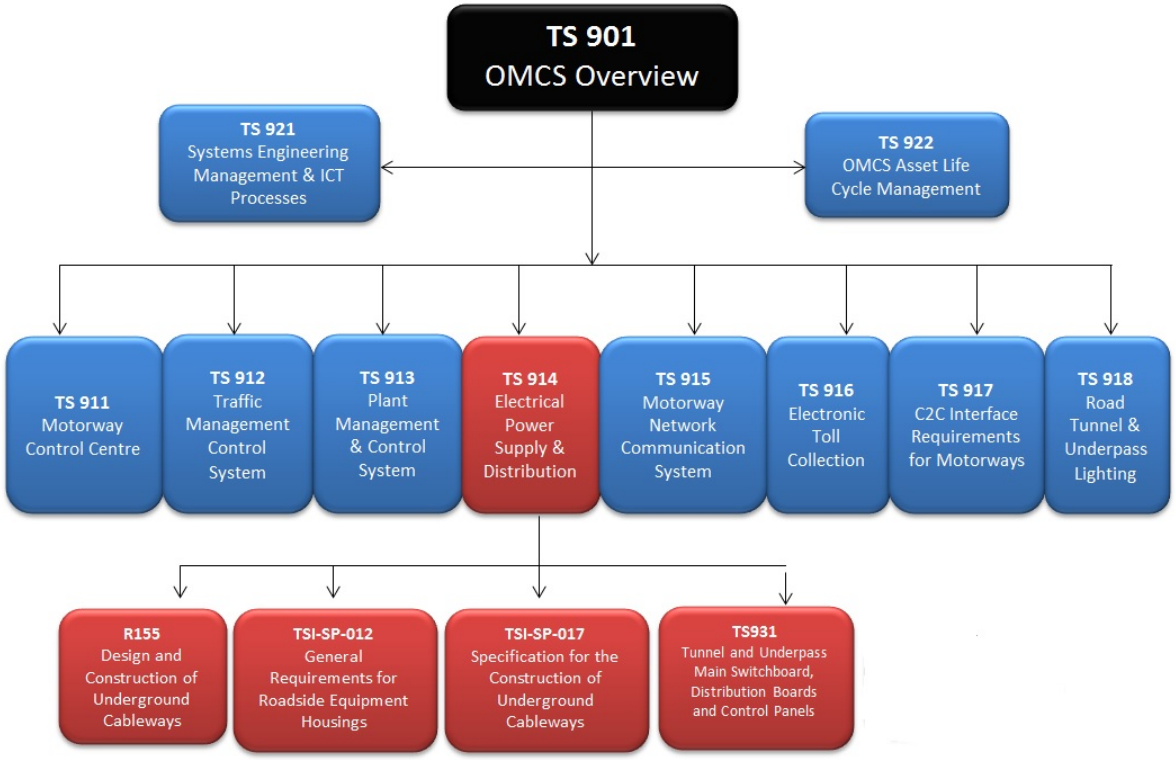
This Specification is a Level 2 document which forms part of the suite of RMS specification documents for the Operations Management and Control System (OMCS) for Motorways (see figure below). Other documents within the suite are:

Level 1

- D&C TS901 “OMCS Overview and General Requirements”;

Level 2

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



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 Schedules of HOLD POINTS and Identified Records

The schedules in Annexure TS914/C list the **HOLD POINTS** that must be observed. Refer to Specification RMS D&C Q6 for the definition of **HOLD POINTS**.

The records listed in Annexure TS914/C are **Identified Records** for the purposes of RMS D&C Q6 Annexure Q/E.

1.3.4 (Not Used)

1.3.5 (Not Used)

1.3.6 Referenced Documents

Standards, specifications and test methods are referred to in abbreviated form (e.g. AS 2350). For convenience, the full titles are given in Annexure TS914/M.

1.4 DEFINITIONS AND ACRONYMS

1.4.1 Definitions

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

The following definitions apply to this Specification:

Electricity Supply Authority The Electricity Distributor within whose distribution area the electrical installation is situated or where the installation work is carried out.

Firm power supply The grade of power supply which is derived from a connection within the Electricity Supply Authority zone substation. This is where there are N components of each type forming the power supply connection and that connection will maintain the rated capacity of power supply with (N-1) components in service.

1.4.2 Acronyms

The following acronyms apply to this Specification:

AC Alternating current

CCTV Closed circuit television

CMS Changeable message signs

C2C Centre to centre

DC Direct current

EPSD Electrical power supply and distribution

IEC International Electrotechnical Commission

ITS Intelligent transport systems

LED Light emitting diode

MCC Motorway Control Centre

MNCS Motorway Network Communication System

OMCS Operations Management and Control System

PMCS Plant Monitoring and Control System

PVC Polyvinyl chloride

TMCS Traffic Management and Control System

SPD Surge protection device

SWTC Project Deed Scope of Works and Technical Criteria

UPS Uninterruptible power supply

VMS Variable message signs

VSLS Variable speed limit signs

2 EPSD DESIGN – GENERAL

2.1 DESIGN CRITERIA

The design of the EPSD system for tunnels, long underpasses and roadways must be in accordance with the specific requirements of the SWTC and the requirements of relevant Authorities, and must take into consideration the power requirements of all equipment connected along the Motorway.

Except where otherwise required by this Specification, the following design codes must be used where applicable:

(a) RMS Specifications;

(b) Australian Standards;

(c) PIARC publications (produced by the Permanent International Association of Road Congresses).

For the roadside traffic management infrastructure (refer Clause 5.7), the design and installation of the EPSD system must also comply with RMS D&C TS915.

2.2 COMPATIBILITY

The EPSD system must be compatible with the existing computer systems, equipment and communication networks used in the RMS OMCS.

2.3 CAPACITY AND REDUNDANCY

The EPSD system must be designed with adequate redundancy to ensure that failure of any part of the EPSD does not adversely impact the operation of the OMCS, and to allow maintenance to be performed on any part of the EPSD system, without affecting the operational and traffic capacity of tunnels.

For the roadside traffic management infrastructure (refer Clause 5.7), the EPSD system including the cableways along the Motorway, must have the capacity to meet the requirements of the roadside traffic management infrastructure.

3 TUNNEL POWER SYSTEM

3.1 ELECTRICITY SUPPLY

The Contractor must make arrangements with the relevant Electricity Supply Authorities for the provision of two firm and secure permanent high voltage (HV) power supplies to the tunnel substation(s).

Supply to the tunnel substation(s) must be in accordance with the following:

(a) Supply must be by connection to the Electricity Supply Authority’s power distribution system for the area.

(b) Supply must be by provision of multiple feeders from separate zone supply substations or from separate HV sections of a transmission or sub-transmission substation. Each feeder must be capable of supplying the total load requirements of the particular tunnel substation.

(c) Automatic changeover facilities must be provided within the low voltage (LV) network and arranged in such a manner that the transfer of load from one feeder to another does not adversely impact on the electricity supply HV network or the electrical integrity of the system. Automatic changeover equipment must have independent backup battery supply to enable changeover during mains failure.

(d) Feeders must be installed in separate ductlines, physically isolated from one another such that failure of one feeder will not affect the others. Ductlines must generally be encased in concrete.

(e) Separation of pilot and inter-trip wiring must be maintained in accordance with the Electricity Supply Authority requirements. Such cables must be physically isolated from the feeders so that any major disruption or failure of a feeder cable will not impact on the pilot and inter-trip control wiring.

(f) All equipment of the EPSD system must be designed such that they can be safely isolated during maintenance, to minimise tunnel closures or other impacts on the tunnel operation.

3.2 HIGH VOLTAGE DISTRIBUTION

High voltage (HV) distribution must be in accordance with the following:

(a) Each substation must be supplied from the two separate incoming supplies. Each supply must be connected to its respective HV switchgear.

(b) In all instances, HV substations must be separated from each tunnel carriageway by a barrier of at least FRL ---/240/240 fire rating. The HV supply along one carriageway must be separated from the HV supply along the other by a barrier of the same FRL.

(c) HV switchgear must be provided for the complete protection and control of incoming HV supplies, HV supply reticulation within the tunnels, transformers and ring feeder connections.

(d) HV circuit breakers must comply with the standards of the relevant Electricity Supply Authorities, AS 62271.200 (all parts) and AS 62271.100. Circuit breakers selected must be of make and model that is commonly used, and stocked in Australia.

(e) Multiple transformers must be provided in each tunnel substation to allow for redundancy, to carry the full load during failure or maintenance. The transformers must be separated from each other by a barrier of at least FRL ---/240/240 fire rating.

The substation(s) supplying power to ventilation plant, essential services and lighting must have sufficient rated transformer capacity to continuously supply 120% of the full design load with any one transformer being out of operation.

The changeover mechanism to transfer the transformer source must be located on the downstream main low voltage switchboard that automatically transfers supply, upon failure of the one source, to the other transformer.

Transformers must comply with the Electricity Supply Authority requirements, AS 2374 and AS 60076. Where dry type transformers are supplied, the requirement of AS 3953 must be followed. Transformers located underground must be of the encapsulated dry type.

(f) The locations of the substations must ensure that correct voltage levels are maintained throughout the tunnels for all services. Automatic tap-changing facilities must be provided to maintain voltage levels within specified tolerances, if the Contractor's power supply design analysis indicates that tap-changing facilities are necessary.

HOLD POINT	
Process Held:	Connection for provision of two firm and secure permanent high voltage power supplies to each tunnel substation.
Submission Details:	Drawings, design reports, engineering data, and Electricity Supply Authority approval to connect HV power supplies.
Release of Hold Point:	The Nominated Authority will consider the submitted documents prior to authorising the release of the Hold Point.

3.3 LOW VOLTAGE DISTRIBUTION

Low voltage (LV) distribution must be in accordance with the following:

(a) Modular design metal clad switchgear for the protection and control of LV supplies must be provided to all tunnel lighting systems, control and management systems, ventilation, fire protection, surveillance systems, communication systems, the Motorway Control Centre (MCC), administration and plant buildings, general lighting, power and air conditioning equipment.

(b) All equipment, including lighting and emergency systems must be protected against voltage fluctuations induced from any source.

(c) The Mains Transient Voltage must be determined from the Overvoltage Category and the AC mains supply voltage in accordance with Table 2J of AS 60950.1. For equipment supplied from an AC mains supply, the Mains Transient Voltage for Overvoltage Category II must be greater than 2.5 kV.

(d) Equipment that is likely, when installed, to be subjected to transient overvoltages that exceed those for its design Overvoltage Category must have the installation designed to provide additional protection external to the equipment.

(e) Adjacent distribution boards must be fed from separate supplies with a minimum of two supplies required for each portion of tunnel. A minimum of two switchboards or distribution board pairs must service each portion of tunnel. Each switchboard must typically supply 50% of the load for that portion. The supply to the second switchboard, or distribution board pair, must be from the alternate electrical power supply.

Switchboards and distribution boards and their construction must be of the topology that allows for any single switchboard to be taken out of service without compromise to tunnel operations or resilience required.

Distribution boards may have a single source of supply where the services fed from that distribution board are interleaved with that from the adjacent distribution board such that loss of a single distribution board does not affect the ability of the tunnel to operate normally.

(f) Automatic transfer of load between transformers in each substation must be provided to eliminate shutdown in case of transformer failure or supply failure. Interlocked withdrawable main circuit breakers must be provided in each main switchboard for automatic transfer of load.

(g) LV main switchboard must comply with AS/NZS 61439.1 requirements for Form 3b type tested with minimum IP41 degree of protection.

(h) All LV switchboards must be fitted with a multifunction power analyser to monitor measurements such as Power Factor, voltage, and power readings.

(i) Circuit breakers must be provided for the protection and control of all outgoing submains to lighting and mechanical services distribution boards.

(j) Any distribution boards, cabling systems and enclosures located in tunnel walls must have an IP65 rated enclosure to withstand the conditions experienced during tunnel cleaning operations.

(k) Control panels and switchgear cubicles in the equipment rooms must be of dust-proof and vermin-proof construction, to a minimum IP41 degree of protection.

3.4 SYSTEM PROTECTION

System protection must be in accordance with the following:

(a) Modular integrated protection relays must be sourced from suppliers with recognised and established technical support facilities and must be acceptable to the Electricity Supply Authority.

(b) All protection relays must be multi-function industrial processor based with choices of inverse time current characteristics, definite time ranges and other relevant parameters. These relays must be fitted with alarm contacts and provide visual and audible alarm at the MCC, as specified in RMS D&C TS915, identifying the source and location of the fault.

(c) Relay settings must be coordinated by the Contractor with the Electricity Supply Authority to achieve correct time current grading in the power system.

3.5 SUBSTATIONS AND EQUIPMENT ROOMS

Substations and equipment rooms must be in accordance with the following:

(a) Electrical substations and equipment rooms must be finished to a condition which prevents generation of dust and particles within the room. Concrete floors must be coated with a durable polyurethane finish or approved equivalent finish to seal the floor surface. Doors in the closed position must provide effective air flow sealing.

(b) Electrical substations and equipment rooms must be sealed against water ingress through walls, ceilings, floors and cable access ducting.

(c) A drainage scheme must be provided for any substation, which will provide protection from any potential water ingress. The drainage scheme must connect to the tunnel drainage network. Any drainage scheme must include protection to prevent potential backflow due to downstream flooding of the drainage systems.

(d) Electrical equipment rooms must comply with the requirements of AS/NZS 3000 and AS 2067 and have environmental controls to ensure that durability of the equipment is not affected by the atmosphere or tunnel environment, including ingress prevention of contaminated and vitiated tunnel carriageway air.

(e) In all instances, LV main switchboards and their incoming power supply must be separated from each tunnel carriageway by a barrier of at least FRL ---/240/240 fire rating.

(f) Equipment rooms must be designed to:

(i) provide adequate temperature control management by means of efficient, redundant air-conditioning systems;

(ii) prevent the effects of hydrocarbon soot build up on conductors;

(iii) limit the amount of dust build-up in the equipment room by ensuring a positive pressurisation level relative to the carriageway;

(iv) support maintenance routines specific to underground installations.

(g) Where heat generated by the equipment in substations and electrical equipment rooms is greater than the heat dissipated naturally to the surrounding, appropriate mechanical cooling must be provided to maintain the actual temperature within the manufacturer's recommended working temperature limits. Mechanical cooling must not induce dust particles in the air. Air intake from tunnel must not be used for cooling purpose.

3.6 TUNNEL ELECTRICAL INSTALLATION

Tunnel electrical installation must be in accordance with the following:

(a) The design and installation of electrical components must comply with the standards of the relevant Electricity Supply Authority and AS/NZS 3000.

(b) All voltage drop calculations must be based on a maximum voltage drop under the maximum expected load from any operational condition, including Incident conditions of 4% calculated from either the Electricity Supply Authority LV point of connection or the LV terminals of the relevant Motorway substation transformer, whichever is applicable, to any point in the installation. Cable sizes must be selected to suit.

(c) Conduits, cable fastening and support devices, cubicles, trunking, cable tray boxes, metal work and cabling must be designed to withstand the tunnel environment, and must be corrosion and fire resistant, non-flammable, low smoke and halogen free.

(d) Cabling, junction boxes and elements supporting the cabling junction boxes must have a fire rating of two hours.

(e) PVC conduits are acceptable where such conduits are encased in concrete with sufficient cover to attain the required fire rating.

(f) Electrical installation must be protected to a fire protection classification level of WS52W, in accordance with AS/NZS 3013.

(g) Protection must be provided against damage by the operation of the fire protection systems, by spillage, by cleaning operations or by any other form of water ingress or mechanical damage.

(h) The provisions of paragraphs (a) to (g) above apply to all electrical installations in tunnels, including but not limited to power, electrical control, instrumentation, communications and fibre optic systems.

(i) All electrical installations and wiring must comply with AS/NZS 3000.

(j) The design, supply, installation, connection and testing and commissioning of the electrical power supply and equipment must be in accordance with Specification RMS D&C TS931.

3.7 STANDBY GENERATORS

Where dual tunnel mains supply feeders are unavailable due to the existing electricity supply arrangement in the area, diesel prime generators must be provided in lieu of one of the mains feeders.

The standby generator supplied must:

(a) be designed and located for ease of access and maintenance;

(b) be fully housed, with the housing structure design consistent with the urban design and surrounding features, and must comply with the specified noise abatement requirements. The housing must be secured and monitored for unauthorised entry;

(c) be suitably rated to take the full load of the essential tunnel electrical systems UPS controlled systems, tunnel base lighting, fire protection systems, tunnel warning and emergency equipment;

(d) be designed for full power immediately upon start-up;

(e) be provided with a “load bank” for maintenance and “exercise”;

(f) be designed for automatic start-up in the event of a mains power failure;

(g) be provided with fuel storage for at least 4 hours operation under full load;

(h) if located within or adjacent to any part of the tunnel, be housed in a fire rated structure and comply with the fire safety requirements for tunnel plant and equipment;

(i) be provided with fuel spillage containment measures;

(j) provide comprehensive monitoring and alarm information to the tunnel PMCS, including fuel level, running, fail to start, amp load, and all generator fault conditions.

3.8 UNINTERRUPTIBLE POWER SUPPLY (UPS) SYSTEM

Uninterruptible power supply systems must be in accordance with the following:

(a) A network of uninterruptible power supply systems, including batteries, must be provided to supply essential loads for a period of 30 minutes.

Essential loads include communications and monitoring equipment, control systems, computer and safety facilities, signage (excluding emergency egress signage – refer paragraph (d) below), emergency lighting, emergency power outlets and 10% of tunnel lighting evenly distributed along the tunnel.

UPS must be provided to fire protection systems if a loss of power supply could render the fire protection system inoperable, and, in the event of a fire, would result in damage to components of equipment in tunnel, or adversely impact the safe operations of the tunnel.

(b) The UPS system must include automatic static bypass transfer of essential loads in case of a UPS system fault, including overload, and automatic recovery on fault clearance. The UPS system must also be provided with maintenance bypass switching facilities.

(c) The UPS system must provide facilities for automatic detection of faulty and failing batteries within banks of batteries in the UPS. Detection of faulty individual batteries must raise an alarm in the OMCS fault management systems.

(d) If the UPS system is used for emergency lighting, it must use UPS units that are electrically separate from the essential load UPS units (refer paragraph (a) above) and must allow for 90 minutes operation of illuminated exit signage, emergency lighting and illuminated directional exit signage.

3.9 POWER FACTOR CORRECTION

Power Factor Correction must be supplied in accordance with the requirements of the Electricity Supply Authority for maintenance of Power Factor in the electrical power supply at a minimum of 0.9 under all conditions. Attention must be given to voltage levels as capacitor banks are switched in and out.

3.10 HARMONICS

Facilities must be provided to meet the requirements of the Electricity Supply Authority for limiting the effect of harmonics impressed on the power supply system by the tunnel electrical loads.

4 LONG UNDERPASS POWER SYSTEM

4.1 ELECTRICITY SUPPLY

The Contractor must make arrangements with the relevant Electricity Supply Authority for the provision of a firm and secure permanent LV power supply to the long underpass substation(s).

Supply to each long underpass substation must be provided in accordance with the following:

(a) Connection to the Electricity Supply Authority’s power distribution system in the area.

(b) Provision of multiple power supply feeders from two separate and physically isolated power supplies, which have a firm rating. Each feeder must be capable of supplying the total load requirements of the long underpass electrical services.

(c) An automatic changeover facility must be provided within the main switchboard network and arranged in such a manner that the transfer of load from one feeder to another does not adversely impact on the electricity supply network or the electrical integrity of the system.

The design of the electrical services power supply and reticulation for long underpasses must ensure that correct voltage levels are maintained to all equipment connected throughout the long underpasses.

4.2 LOW VOLTAGE DISTRIBUTION

LV distribution must be in accordance with the following:

(a) Modular design metal clad switchgear for the protection and control of LV supplies must be provided to all long underpass lighting operations systems, control and management systems, ventilation, pumping, surveillance systems, communication systems, general lighting, and power.

(b) All equipment must be protected against voltage fluctuations induced from any source, including lighting and emergency systems.

(c) The Mains Transient Voltage must be determined from the Overvoltage Category and the AC mains supply voltage in accordance with Table 2J of AS 60950.1. For equipment supplied from an AC mains supply, the mains transient voltage for Overvoltage Category II must be greater than 2.5 kV.

(d) Equipment that is likely, when installed, to be subjected to transient overvoltages that exceed those for its design Overvoltage Category must have the installation designed to provide additional protection external to the equipment.

(e) Adjacent distribution boards must be fed from separate supplies with a minimum of two supplies required for each portion of the long underpass.

(f) LV main switchboard must comply with AS/NZS 61439.1 requirements for Form 3b type tested with IP41 degree of protection.

(g) Circuit breakers must be provided for the protection and control of all outgoing submains to lighting and mechanical distribution boards.

(h) Any distribution boards located in the long underpass walls must have an IP65 rated enclosure to withstand the conditions in the long underpass during cleaning operations.

(i) Control panels and switchgear cubicles must be of dust proof and vermin proof construction to a minimum IP41 degree of protection.

(j) Standby emergency power must be provided for the security of essential loads in the event of incoming mains power failure. This must include uninterruptible power supplies (UPS) with battery backup to maintain essential loads without a break to operational and safety systems for a limited time, or diesel powered standby generators which will automatically start up upon detection of mains failure and run until mains power is restored.

(k) Automatic start standby generating equipment must be provided where there are loads beyond the capacity of the UPS such as drainage pumps, fire safety systems and ventilation plant which need to be operated under mains failure conditions to maintain the security of the long underpass infrastructure and systems.

4.3 LONG UNDERPASS ELECTRICAL INSTALLATION

Long underpass electrical installation must be in accordance with the following:

(a) The design and installation of electrical components must comply with the standards of the relevant Electricity Supply Authority and AS/NZS 3000.

(b) All voltage drop calculations must be based on a maximum voltage drop under the maximum expected load from any operational condition, including Incident conditions of 4% calculated from either the Electricity Supply Authority LV point of connection or the LV terminals of the

relevant Motorway substation transformer, whichever is applicable, to any point in the installation. Cable sizes must be selected to suit.

(c) Conduit, cable fastening and support devices, cubicles, trunking, cable tray boxes, metal work and cabling must be designed to withstand the long underpass environment, and must be corrosion and fire resistant, non-flammable, low smoke and halogen free.

(d) Cabling, junction boxes and elements supporting the cabling junction boxes must have a fire rating of two hours.

(e) PVC conduits are acceptable where such conduits are encased in concrete with sufficient cover to attain the required fire rating.

(f) Electrical installation must be protected to the level of WS52W in accordance with AS/NZS 3013 against damage by the operation of fire protection systems, by spillage, by cleaning operations or by any other form of water ingress or mechanical damage.

(g) The provisions of paragraphs (a) to (f) above apply to all electrical installations in the long underpasses, including but not limited to power, electrical control, instrumentation, communications and fibre optic systems.

(h) All electrical installations and wiring must comply with AS/NZS 3000.

(i) The design, supply, installation, connection and testing and commissioning of the electrical power supply and equipment must be in accordance with RMS D&C TS931.

4.4 POWER FACTOR CORRECTION

Power Factor Correction must be supplied in accordance with the requirements of the Electricity Supply Authority for maintenance of Power Factor in the electrical power supply at a minimum of 0.9 under all conditions. Attention must be given to voltage levels as capacitor banks are switched in and out.

5 ROADWAYS POWER SYSTEM

5.1 ELECTRICITY SUPPLY

The electrical design for the OMCS includes provision of power for the following:

(a) electrical distribution, Motorway Network Communication System and roadside equipment cabinets;

(b) roadside equipment on Motorway;

(c) roadside equipment on local roads;

(d) roadway lighting.

The Contractor must make arrangements with the relevant Electricity Supply Authority for the provision of a secure permanent LV power supply along the roadway to provide power to the electrical distribution cabinets at the one or more Main Distribution Points.

Supply to the roadway Main Distribution Points must be provided by any one of the following:

(i) connection to the Electricity Supply Authority's power distribution system in the area;

(ii) attachment to the nominated Points of Supply; or

(iii) alternative power sources, in the event that electrical power supply is not available for remote sites (refer Clause 5.3).

The design of the electrical services power supply and reticulation for roadways must ensure that correct voltage levels are maintained to all equipment connected along the roadway.

5.2 LOW VOLTAGE DISTRIBUTION

LV distribution must be in accordance with the following:

(a) Modular design metal clad switchgear for the protection and control of LV supplies must be provided to all roadway lighting operations systems, management systems, control systems, ventilation, pumping, surveillance systems, communication systems, general lighting, and power.

(b) All equipment must be protected against voltage fluctuations induced from any source, including lighting and electrical equipment.

(c) The Mains Transient Voltage for design clearances must be determined from the Overvoltage Category and the AC mains supply voltage in accordance with Table 2J of AS 60950.1. For equipment supplied from an AC mains supply, the mains transient voltage for Overvoltage Category II must be greater than 2.5 kV.

(d) Equipment that is likely, when installed, to be subjected to transient overvoltages that exceed those for its design Overvoltage Category must have the installation designed to provide additional protection of the installation external to the equipment.

(e) Lightning protection must be provided for all roadside equipment and structures in accordance with AS 1768. The risk for losses due to lightning, the tolerable risk R_a, must be less than 10^{-3} for loss of service to the public, which represents the tolerable probability of that loss occurring over the period of a year.

(f) The use of Surge Protection Devices (SPDs) must be provided with coordinated Primary and Secondary protection of supply where long distance distribution of electrical power is involved, in order to take advantage of the distance between the main switchboard, sub-distribution boards, and final load circuits by providing coordinated Primary and Secondary protection.

(g) Lightning protection for local installations must be provided at the main switchboard with Primary and Secondary protection stages incorporating SPDs with series impedance and low pass filters.

(h) LV main switchboard must comply with AS/NZS 61439.1 requirements for Form 3b type tested with IP41 degree of protection.

(i) Circuit breakers must be provided for the protection and control of all outgoing submains to all roadway lighting operations systems, management systems, control systems, ventilation, mechanical, pumping, surveillance systems, communication systems, general lighting, and power distribution boards.

(j) Control panels and switchgear cubicles must be of dust proof and vermin proof construction to a IP41 rating and comply with Specification RMS TSI-SP-012.

(k) Roadside equipment housings with a switchboard will be regarded as a separate electrical installation for earthing and isolation purposes under AS/NZS 3000, incorporating a main switch and MEN connection and earth electrode.

5.3 ALTERNATIVE POWER SOURCES

(a) Alternative power sources must be provided where there is no electrical mains power supply available for remote sites in accordance with the RMS Guidelines for Alternative Power and Communications for ITS Installations ("the Guidelines").

(b) A power selection matrix must be prepared in accordance with the Guidelines to assess the suitability of an alternative supply to each remote roadway installation substation taking into account the time of day and duration of the maximum and minimum power requirements. The environmental factors at each remote location must be incorporated into the design to determine the most effective energy source for the system.

(c) Alternative power options include:

(i) Solar power supply where ITS equipment is located with an unobstructed view of the sky primarily in northerly direction. Panels may be mounted on VMS or VSLS gantries to ensure maximum illumination or insolation of the solar panel during daylight hours.

(ii) Stand-alone alternator sets driven by diesel, petrol or LPG powered motors in critical situations where clusters of ITS equipment are located in remote locations. Such generators must be provided with a secured weather-proof housing/cabin for maintenance purposes. Make provision for remote monitoring of the generator sets, using the local ITS systems' communications equipment.

(iii) Wind driven alternators to provide supplemental power for small clusters of ITS equipment, and in situations where such equipment must be located in the open and may be installed on a VMS or VSLS structure.

(iv) Primary storage batteries or hybrid charging systems incorporating UPS or DC system battery banks.

5.4 ROADWAYS ELECTRICAL INSTALLATION

Roadways electrical installation must be in accordance with the following:

(a) The power distribution cableway design and installation must comply with Specification RMS D&C R155.

(b) The design and installation of electrical components must be to the standards documented in AS/NZS 3000 and required by the relevant Electricity Supply Authority.

(c) Conduit, cable fastening and support devices, cubicles, trunking, cable tray boxes, metal work and cabling must be designed to withstand the outdoor environment.

(d) All voltage drop calculations must be based on a maximum voltage drop under the maximum expected load from any operational condition including Incident conditions of 4% calculated from either the Electricity Supply Authority LV point of connection or the LV terminals of the relevant Motorway substation transformer, whichever is applicable, to any point in the installation. Cable sizes must be selected to suit.

(e) All cables must be colour coded for the appropriate phase as per AS/NZS 3000 and must be fitted with permanent labels at the point of connection in the switchboard identifying the destination and circuit number.

(f) Circuit protection devices must be fully coordinated to achieve complete discrimination so that, in the event of a fault, there is no interruption to upstream supplies to earth circuits.

(g) Traffic control systems must be connected to a different main switch to lighting. The traffic control systems power circuit must be provided with a warning "not to be turned off" attached next to the switch.

(h) All electrical switchboard doors must be fitted with a three point locking system.

(i) The provisions of paragraphs (a) to (h) above apply to all electrical installations along the roadway, including but not limited to power, electrical control, instrumentation, communications and fibre optic systems.

5.5 POWER FACTOR CORRECTION

Power Factor Correction must be supplied in accordance with the requirements of the Electricity Supply Authority for maintenance of Power Factor in the electrical power supply at a minimum of 0.9 under all conditions. Attention must be given to voltage levels as capacitor banks are switched in and out.

5.6 BATTERY BACKUP AND UNINTERRUPTIBLE POWER SUPPLY (UPS) SYSTEMS

Battery backup and uninterruptible power supply systems must be in accordance with the following:

(a) A network of monitored battery backup or UPS systems, including batteries, must be provided to supply essential loads for the backup times shown in Annexure TS914/E. Essential loads include communications and monitoring equipment, control systems, computer and safety facilities, signage, emergency lighting and emergency power outlets.

The battery backup system calculations must be carried out for each electrical distribution cabinets depending on the type and power consumption of the equipment supplied. Dedicated battery backup systems may be considered to cater for the variance in the backup time.

(b) The UPS system, if used, must include automatic static bypass transfer of essential loads in case of a UPS system fault, including overload, and automatic recovery on fault clearance. The UPS system must also be provided with maintenance bypass switching facilities.

(c) The UPS system must provide facilities for automatic detection of faulty and failing batteries within banks of batteries in the UPS. When faulty batteries are detected, an alarm must be raised in the fault management systems in the OMCS.

5.7 ROADSIDE TRAFFIC MANAGEMENT INFRASTRUCTURE

5.7.1 Traffic Management and Control Systems

The power distribution requirements for traffic management infrastructure and motorway network communication systems to power the distributed communication systems at all the locations on the Motorway must meet the following Traffic Management and Control System (TMCS) requirements:

(a) MNCS hubs;

(b) roadside controller systems;

(c) Motorway closed circuit television (CCTV) management systems;

(d) vehicle detectors (traffic monitoring units) producing flow, speed and occupancy data for various types of vehicles.

5.7.2 Driver Advisory and Traffic Lane Control Devices

The power distribution requirements for traffic management infrastructure must meet the following Driver Advisory and Traffic Lane Control Devices requirements:

(a) variable message signs (VMS);

(b) variable speed limit signs (VSLS);

(c) lane use signals (LUS);

(d) movable physical barriers (MPB);

(e) movable medians (MM);

(f) changeable message signs (CMS).

6 LIGHTING

Lighting is not within the scope of this Specification.

In addition to relevant roadside traffic management infrastructure requirements elsewhere in the SWTC and the electrical installation requirements in this Specification, the lighting design and installation for tunnels and long underpasses must comply with AS/NZS 1158 and RMS D&C TS918.

For roadways, the lighting design and installation must comply with the requirements stated in the preceding paragraph except that for AS/NZS 1158, it must comply with category V3.

ANNEXURES TS914/A AND TS914/B – (NOT USED)

ANNEXURE TS914/C – SCHEDULES OF HOLD POINTS AND IDENTIFIED RECORDS

Refer to Clause 1.3.3.

C1 SCHEDULE OF HOLD POINTS

Clause	Description
3.2	Connection for provision of two firm and secure permanent high voltage power supplies to each tunnel substation.

C2 SCHEDULE OF IDENTIFIED RECORDS

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

Clause	Description of Identified Record
3.2	Drawings, design reports, engineering data, and Electricity Supply Authority approval to connect power supplies for tunnels, long underpasses, and roadways.

ANNEXURE TS914/D – (NOT USED)

ANNEXURE TS914/E – BACKUP TIMES FOR UPS SYSTEMS

Refer to Clause 5.6.

The Contractor must complete the table below and submit it to the Principal for concurrence.

Parameter	MNCS Switch	CCTV	TMU	VMS/ISLUS (Controller Only)	2 Way Radio (UHF)
Backup Time (hr)	12	4	24	12	4
Working Load (W) (1)	*60*	*60*	*24*	*60*	*400*
Current (A) @ 24V (2)					

Notes:

(1) The working load values shown in *italics* in the table are examples only. The Contractor must determine the appropriate working loads and insert them in the table.

(2) The Contractor must nominate the amount of current required.

ANNEXURES TS914/F TO TS914/L – (NOT USED)

ANNEXURE TS914/M – REFERENCED DOCUMENTS

Refer to Clause 1.3.6.

RMS Specifications

RMS D&C Q6	Quality Management System (Type 6)
RMS D&C R155	Design and Construction of Underground Cableways
RMS D&C TS901	OMCS Overview and General Requirements
RMS D&C TS911	OMCS Requirements - Motorway Control Centre
RMS D&C TS912	OMCS Requirements - Traffic Management and Control System
RMS D&C TS913	OMCS Requirements - Plant Management and Control System
RMS D&C TS915	OMCS Requirements - Motorway Network Communications System
RMS D&C TS916	OMCS Requirements - Electronic Toll Collection System
RMS D&C TS917	OMCS Requirements - C2C Interface for Motorways
RMS D&C TS918	OMCS Requirements - Road Tunnel and Underpass Lighting
RMS D&C TS931	Tunnel and Underpass Main Switchboard, Distribution Boards and Control Panels
RMS TSI-SP-012	General Requirements for Roadside Equipment Housings

RMS Guidelines

RMS Guidelines for Alternative Power & Communications for ITS Installations

Australian Standards

AS/NZS 1158	Lighting for roads and public spaces
AS 1768	Lightning protection
AS 2067	Substations and high voltage installations exceeding 1 kV a.c.
AS 2374	Power transformers - Minimum Energy Performance Standard (MEPS) requirements for distribution transformers
AS/NZS 3000	Electrical installations (known as the Australian/New Zealand wiring rules)
AS 3013	Electrical installations - Classification of the fire and mechanical performance of wiring system elements
AS 3953	Loading guide for dry-type power transformers
AS 60076	Power transformers
AS 60950.1	Information technology equipment - Safety - General requirements
AS/NZS 61439.1	Low-voltage switchgear and control gear assemblies - General rules (IEC 61439-1, Ed. 2.0 (2011), MOD)
AS 62271	High-voltage switchgear and controlgear
AS 62271.100	High-voltage alternating-current circuit-breakers (IEC 62271-100, Ed. 1.2 (2006) MOD)

AS 62271.200	A.C. metal-enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 52 kV (IEC 62271-200, Ed. 1 (2003) MOD)