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REVISION REGISTER

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<td>A/GM, CS (J Staugas)</td>
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<td>Global</td>
<td>Specification reorganised and reworded to improve clarity. Requirements expanded or clarified. Headings added to break long clauses to shorter sub-clauses. Terminology made consistent throughout document.</td>
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FOREWORD

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BASE SPECIFICATION

This document is based on non-D&C Specification RMS TS915 Edition 1 Revision 1.
RMS SPECIFICATION D&C TS915

OMCS REQUIREMENTS -
MOTORWAY NETWORK COMMUNICATIONS SYSTEM

1 GENERAL

1.1 SCOPE

This Specification sets out the requirements for the design and construction of the Motorway Network Communications System (MNCS) which carries the data, voice and video image communications from devices and equipment at locations along the Motorway to the Motorway Control Centre, and vice versa.

It also includes the requirements for the design and construction of communications infrastructure for the exclusive use of RMS as part of the RMS Traffic Data Network.

The MNCS must be suitable for the full range of Motorway operational requirements including emergency situations.

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 TS914 “OMCS Requirements - Electrical Power Supply and Distribution 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 TS915/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 TS915/C are Identified Records for the purposes of RMS D&C Q6 Annexure Q/E.

1.3.4 Planning Documents

The PROJECT QUALITY PLAN must include each of the documents and requirements listed in Annexure TS915/D and must be implemented.

In all cases where this Specification refers to the manufacturer’s recommendations, these must be included in the PROJECT QUALITY PLAN.

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 TS915/M.
1.4 DEFINITIONS AND ACRONYMS

1.4.1 Definitions

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

For the purpose of this specification, a “cableway segment” is any nest of conduits connecting the same cableway pits, buildings, cable ladder or tray, cabinet plinths, any electrical equipment or cable containment. Conduit nests housing electrical power cables are treated as separate conduit segments to adjacent conduit nests housing communication cables (which forms its own segment).

1.4.2 Acronyms

The following acronyms apply to this Specification:

- **ADSL**: Asymmetric digital subscriber line
- **C2C**: Centre-to-centre
- **CCTV**: Closed circuit television
- **COTS**: Commercial off the shelf
- **DRS**: Disaster Recovery Site
- **DMZ**: De-militarised Zone
- **ETC**: Electronic toll collection
- **FOBOT**: Fibre optic break out tray
- **FT**: Fault tolerant
- **GUI**: Graphical User Interface
- **HA**: High availability
- **IP**: Internet Protocol
- **ISLUS**: Integrated Speed Limit and Lane Use Sign (incorporating Variable Speed Limit signs)
- **ITS**: Intelligent Transport Systems
- **LSZH**: Low smoke, zero halogen
- **MAN**: Metropolitan Area Network
- **METS**: Motorist Emergency Telephone System
- **MCC**: Motorway Control Centre
- **MNCS**: Motorway Network Communication System
- **MTBF**: Mean Time Between Failure
- **MTU**: Maximum Transmission Unit
- **NMS**: Network Management System
- **NTP**: Network Time Protocol
- **OMCS**: Operations Management and Control System
- **OTDR**: Optical time domain reflectometer
- **PD**: Physical Devices
- **PLC**: Programmable logic controllers
2 MOTORWAY NETWORK COMMUNICATIONS SYSTEM

The Contractor is responsible for the design and construction of the Motorway Network Communications System (MNCS), to the requirements stated in Clauses 2 and 3.

2.1 GENERAL REQUIREMENTS

2.1.1 Services To Be Provided

The MNCS must provide the following communication infrastructure services:

(a) data communications between the OMCS computers at the Motorway Control Centre (MCC) and the roadside and tunnel devices;
(b) data communications with the MCC and the Disaster Recovery Site (DRS);
(c) data communications between the DRS and the roadside and tunnel devices;
(d) voice communications from Motorist Emergency Telephone System (METS) telephones to the MCC and DRS;
(e) Motorway CCTV camera image and control data communications between the Motorway CCTV sites, the MCC, and DRS;
(f) data communications between the MCC, DRS and RMS/TMC WAN;
(g) data communications for the Motorway Electronic Toll Collection (ETC) System.
2.1.2 Adequate Capacity

The MNCS must provide adequate communications capacity to support the OMCS operation under all conditions of communication load.

2.1.3 Compatibility

The MNCS must be compatible with the existing computer systems, equipment and ITS devices and signs used in the RMS OMCS for adjoining tunnels, roadways and motorways.

2.1.4 Weather Conditions

The MNCS must be capable of withstanding the adverse effects of all weather conditions likely to be encountered on the Motorway or Tunnel.

2.2 NETWORK ARCHITECTURE

2.2.1 General

(a) The MNCS must be a resilient and reliable system, designed to be fault tolerant and fail-safe with layers of redundancy, so that any singular failure of the MNCS components will not adversely impact the operation of the OMCS.

(b) The MNCS design must be scalable and flexible. It must provide high availability (HA), fault tolerant (FT) network access by using redundant devices within each layer to provide device level redundancy and dual forwarding paths.

(c) The MNCS architecture must prevent cascading failures as the result of a fault. The failure of any component or module of the MNCS must not cause the failure of any other component or module of the MNCS or OMCS.

(d) The operation of the MNCS must not be degraded as a result of a single communications cable failure or breakage event.

2.2.2 Network Topology

(a) The MNCS network topology must be dual (fibre) ring as shown conceptually in Figure TS915.1.

(b) The MNCS network topology must be resilient to any single cable break at any point within the physical infrastructure.
(c) The MNCS design must prevent data flooding due to malfunction of the network elements particularly where protocols such as spanning tree is used.

(d) Subnets and/or virtual LANs (VLAN) must be used to functionally group devices e.g. traffic control devices, traffic data, METS and CCTV. TMCS and PMCS subnets/VLANs must be set up separately on the MNCS.

(e) CCTV and traffic monitoring video services from the Motorway or tunnel must be separated from other MNCS services over dedicated optical fibres to prevent bandwidth degradation.
(f) TMCS and PMCS sub-nets must be set up separately on the MNCS. The sub-nets and/or VLANs must correspond to the functional groupings of devices e.g. traffic control devices, traffic data, METS, and CCTV.

2.2.3 Network Functional Layers

The MNCS design must be based on a modular and hierarchical design which groups the network into different functional layers with Layer 3 routed topology.

![Network Functional Layers Diagram]

The Network functional layers in the MNCS design comprise the following:

2.2.3.1 Core Layer

(a) This is the backbone layer, with high speed switching and the ability to move larger quantities of data. It handles the requests from lower network layers and provides services to other layers.

(b) The core layer must be reliable and fault tolerant, with redundant hardware. All hardware must be fitted with dual redundant power supplies, as a minimum.

(c) The core layer must implement multiple forwarding paths to ensure redundancy.

(d) The combination of static and dynamic routing protocols may be used to provide routing. The MNCS design must describe the details of the routing protocols.

2.2.3.2 Distribution or Aggregation Layer

(a) This is the isolation point between the network’s access layer and the core layer. It is used for policy base services and controls the access of data to the core layer and provides the redundancy to access devices. This is achieved by VLAN, including VLAN definitions, VLAN routing, media transitions where there are changes to the MTU or frame format, and security access control lists.

(b) The MNCS architecture must adopt logical separation of the network into VLANs for roadside devices and CCTV. This reduces network congestion overheads by ensuring communication to specific devices (rather than an overall broadcast to the entire network) when needed.
2.2.3.3 Access Layer

(a) The access layer provides Ethernet connectivity to end points such as servers, workstations, roadside devices and other network assets. Such end points must connect directly to the access layer.

(b) The MNCS must support switched IP communication between servers, work stations, and all roadside devices. The IP network interface for roadside ITS devices must have a primary and secondary connection to a port on two geographically separated MNCS Ethernet switches.

2.2.4 Network Latency

The typical MNCS latency or round-trip delay must be within 20 milliseconds for any optical fibre connected network link or path part of the MNCS. Sites where connection to remote roadside devices such as VMS and CCTV by means other than optical fibre must have a latency of within 50 milliseconds.

2.2.5 Submission of MNCS Architecture Design

HOLD POINT

Process Held: Commencement of Motorway Network Communication System detailed design.

Submission Details: MNCS architecture drawings, architecture design reports, engineering data and Systems Engineering Management Plan (SEMP).

Release of Hold Point: The Nominated Authority will consider the submitted documents prior to authorising the release of the Hold Point.

The SEMP must cover the planning and quality management aspects of the MNCS.

2.3 NETWORK MANAGEMENT SYSTEM

2.3.1 Network Devices

(a) All IP networked devices, excluding PLCs, must be SNMP capable and managed within the MNCS Network Management System (NMS).

(b) A comprehensive Motorway operator workstation GUI based interface must be supplied with the NMS.

2.3.2 Network Monitoring

(a) The NMS must provide a network monitoring system to support management of the MNCS, to monitor loading and overall performance of the MNCS in real time, and to alert faults and alarms on the MNCS to Motorway operator’s workstation.
2.3.3 Key Functionality

The NMS must provide the following key functionality for managing the MNCS:
(a) a server based system platform with connectivity at all points on the MNCS network;
(b) a network topology display, including all extremities of the MNCS up to the point of connection to device modems;
(c) real time display of the level of data communications traffic at all points on the network;
(d) network analysis tools to enable monitoring of demand and future loading trends;
(e) real time display of network segments which are in fault condition or in maintenance mode;
(f) transfer of alarms and faults to the OMCS fault management system for operator intervention;
(g) continuous monitoring of all redundant links, with any faults reported to the OMCS;
(h) data analysis and reporting on any point of the MNCS;
(i) network device discovery;
(j) configuration management.

2.4 NETWORK SECURITY

MNCS exchanges data with the various external systems such as ETC back office systems, RMS/TMC WAN, corporate IT and authorised third party systems (e.g. adjoining motorways) over the network boundaries.

2.4.1 MNCS Security Controls

MNCS must ensure robust and reliable security management by utilising the following minimum security controls:
(a) Access control
    Protect MNCS against unauthorized use of network resources. This includes physical access restrictions such as key-locks and door alarms for equipment sites, cabinets and buildings.
(b) Authentication and non-repudiation
    Confirm and manage the identities of communicating entities accessing the MNCS.
(c) Data confidentiality
    Protect MNCS data from unauthorized disclosure.
(d) Communication security
    Information flows must be only between the authorised end points.
(e) Data integrity
    Ensuring the correctness or accuracy of data.
2.4.2 Demilitarized Zone and Network Boundary

(a) The MNCS Demilitarized Zone (DMZ) is required to provide the control for the following services:
   (i) network management functions;
   (ii) remote access for users, including third parties;
   (iii) secure file transfer (using SFTP or other protocols).

(b) DMZ and MNCS boundary must enforce security controls at the network level through firewalls and zones to provide secure access to trusted external networks.

2.4.3 Security Independence of Other External Networks

The MNCS security must be configured separately and be independent of the other external networks including the ETC and the Motorway’s corporate networks.

2.4.4 Penetration Testing

Yearly penetration testing of the MNCS network must be conducted that includes:

(a) attempted penetrations of the various IP segments;
(b) potential discovery of vulnerabilities;
(c) a report detailing the results of the tests.

Any identified high or medium level vulnerabilities must be mitigated.

Penetration testing services may be provided, in whole or in part, by third party contractor(s).

2.5 NETWORK PROTOCOLS

2.5.1 Use Standard Protocol

MNCS network protocols must be industry standard protocols, and must be available as commercial off the shelf (COTS) items.

2.5.2 Network Time Protocol

Time synchronisation services must be provided as part of MNCS to maintain an accurate time source for systems and devices using the MNCS. MNCS core network equipment must be synchronised with the TMC Network Time servers using NTP. NTP must be distributed to all infrastructure and end points in MNCS from the core layer.

2.6 NETWORK DEVICES

2.6.1 Switches and Other Equipment

The MNCS must include:

(a) dual redundant core switches that connect to the MNCS distribution switches, to provide redundant network connectivity for the primary and secondary servers;
(b) dual redundant switches that connect to the operator interface workstations and video wall;
In addition to the communications equipment provided at the MCC and DRS, including the MNCS switches and power supplies, the MNCS must include switches at points on the Motorway to regenerate communication signals on the network.

2.6.2 Redundant Hot Swappable Items

(a) All MNCS core platforms and critical network devices must include the following redundant hot swappable items:
   (i) supervisor modules;
   (ii) line cards;
   (iii) fan modules;
   (iv) power supplies.

(b) Access layer hardware must be duplicated, where possible, and equipped with redundant and hot swappable power supplies.

2.7 MNCS Availability

The MNCS must have an availability of 99.995%.

(a) Mission critical and safety critical MNCS faults

Mission critical and safety critical MNCS faults which lead to unplanned motorway or tunnel closure or heightened operational mode must be able to be rectified in less than 1 hour.

(b) All other MNCS faults

The system must be designed to ensure that all other MNCS faults causing network degradation and loss of redundancy can be rectified in less than 24 hours.

3 MNCS Infrastructure Requirements

The requirements of this Clause apply also to the communications infrastructure dedicated for RMS use specified under Clause 4.

3.1 Power Supply

(a) Electrical power distribution requirements for the MNCS (and for the entire OMCS) are specified in Specification RMS D&C TS914.

(b) Secure and reliable dual redundant power supplies must be installed to provide power to the core, distribution and access devices at all locations along the Motorway. These power supplies must be continuously monitored and any faults reported to the OMCS.
3.2 POWER OVER ETHERNET (POE)

A typical PoE system consists of a power source equipment (PSE) and a powered device (PD). The PSE may either be an End-span (comprising a L2 Ethernet switch supporting PoE+) or a Mid-span (comprising a PoE injector).

PoE system must comply with the following:

(a) PoE devices and equipment must be certified to IEEE 802.3at-2009.

(b) PoE devices and equipment used must be durable industrial electronic equipment, with local availability of spares off the shelf.

(c) The maximum cable distance from the MNCS switch to the PoE field device must not exceed 95 m, even if a mid-span device is used.

(d) Power supply capacity must be calculated with a zero diversity factor (i.e. worst case) for all multi-PoE configured equipment.

(e) The capacity of the PoE equipment supply to the field devices must be compatible with:
   (i) the nominal operating voltage and maximum and minimum ranges of the device to be powered;
   (ii) the current carrying capacity of the PoE cable, which must be Cat 5e or higher;
   (iii) a minimum of 30% of the nominal value in the power supply capacity per device must be included in the design, in addition to the transient current in-rush loads in all the operating modes of the device.

(f) All PoE equipment must be certified with a minimum Mean Time Between Failure (MTBF) of 140,000 hours.

(g) PoE equipment must be clearly labelled and securely mounted using standard mounting hardware (e.g. DIN rail or 19-inch rack mount) and arranged for orderly and neat cable marshalling.

(h) PoE equipment must be installed and operated in an environment that does not exceed the operating conditions specified by the manufacturer.

(i) All externally mounted PoE devices must be fitted with appropriate lightning protection.

3.3 SEPARATION OF ETC SYSTEM

(a) The ETC communications infrastructure must be physically separated from MNCS services through provision of dedicated equipment rooms or housings, fibre distributions frames and FOBOT.

(b) Where, due to site constraints, the ETC and OMCS services is proposed to share common cableways, approval must be sought from the RMS Representative and a separate cable and FOBOT must be provided for each at access level.
3.4 CABLEWAY

3.4.1 General

(a) Supply and installation of all communications and power supply cableways, including the number and types of conduits, including those on the Motorway and Local Roads, must comply with the requirements of Specification RMS D&C R155.

(b) The design of the cableways must be such that accumulation of water, dirt and debris within the conduits is avoided, and once cabling has been installed, the cableway network must be vermin proof. Junction pits must be drained.

(c) The completed MNCS network must connect the MCC with at least one other DRS location remote to the MCC.

(d) Conduits dedicated for RMS use may utilise the pits within the MNCS cableways.

3.4.2 Motorway Cableway

(a) The cableway must be installed wholly within the Motorway boundary to prevent disturbance by other agencies or contractors on land not controlled by the Motorway. Spur cableways on Local Roads (refer Clause 3.4.3) are permitted to extend outside the Motorway boundary.

(b) Two separate cableways must be installed, to provide a primary and secondary path along the length of the Motorway. These primary and secondary cableways must be separated from each other by installing one cableway beside one carriageway of the Motorway, and the other cableway beside the other carriageway. (Refer figure in Annexure TS915/E.)

(c) Where it is not possible to install the primary and secondary cableways on different sides of the Motorway, a minimum separation of 2 m must be maintained between the primary and secondary cableways.

(d) Where it is not possible to provide the 2 m separation, the ducts must be concrete encased, and approval of the design must be sought from the RMS Representative prior to carrying this out.

(e) In tunnels, the primary and secondary cableways must be separated from each other by installing one cableway beside each carriageway in the tunnel, or within a dedicated service channel underneath each carriageway where one exists.

3.4.3 Local Roads Cableway

(a) A Local Road cableway must be supplied and installed to connect the primary or secondary Motorway cableways at each Motorway interchange, to provide connection to ITS equipment in accordance with the SWTC requirements.

(b) The Local Road cableway must include RMS dedicated conduits, where required in accordance with Clause 4.3.1, to connect existing RMS ITS equipment adjacent to Local Road cableways. (Refer figure in Annexure 915/E.)

3.4.4 Spare Conduits

(a) The design and installation of cableways must include spare conduits for all segments of the cableway, as follows.
Where the total number of electrical power and communication conduits in the cableway segment is five or less, one additional conduit must be included as a spare conduit. Where the total number of power and communication conduits in a cableway segment exceeds five, an additional 20% of the original total number of conduits to be installed for that cableway segment (rounded up to the nearest integer) must be installed as spare conduits.

Where the cableway comprises conduits of different sizes, the spare conduits must be of the same size of that of the largest utilised conduit in the cableway segment.

Spare conduits are not required where conduits enter footings for ISLUS and VMS, provided that the length of the conduits does not exceed 10 m.

RMS may use the spare capacity in any Motorway and Local Road cableways for any purpose.

### 3.4.5 Submission of Cableway Design

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

### 3.5 Optical Fibre Cabling

The requirements of this Clause apply also to the optical fibre cabling dedicated for RMS use specified under Clause 4.4.

#### 3.5.1 Optical Fibre Cable

(a) Optical fibre cabling for use in the MNCS must comply with current ACMA Regulations and relevant Australian Standards.

(b) Supply and installation of all optical fibre cabling must comply with the requirements of IEC 60794-3-11 and the applicable parts of IEC 60793 for optical fibre.

(c) The cable construction must be suitable for outdoor underground use.

(d) All optical fibre cables installed for the MNCS and RMS Traffic Data Network must be loose tube, gel filled, OS1 or OS2, single mode optical fibre (SMOF).

(e) All optical fibre in tunnels must be of low smoke, zero halogen (LSZH) composition.

(f) Each fibre within a cable must be uniquely identifiable in accordance with AS/CA S008.

(g) Optical fibre cables must have laser safety labelling in accordance with AS/NZS IEC 60825.2. Optical fibre cable joint enclosures and termination enclosures must also be provided with appropriate warning tags/tapes and warning labels for the optical connectors.
(h) The Contractor must record details of the optical fibre cables installed, in accordance with the schedule shown in Annexure TS915/F.

3.5.2 Spare Capacity

The design and installation of optical fibre cabling must include a minimum 33% of unutilised (dark) optical fibre cores as spare capacity along the entire route.

3.5.3 Sealing and Protection

(a) Unterminated end of cables must be sealed at all times with end caps to prevent the ingress of moisture before and after cables are laid.

(b) Cables must be protected against termites, ants, and rodents with suitable protective measures and with the sealing of any gaps between the conduits and pit or housing walls.

3.6 Cable Installation

The requirements of this Clause apply also to the optical fibre cabling dedicated for RMS use specified under Clause 4.4.

3.6.1 General

(a) The RMS Representative must be notified at least 10 working days prior to the commencement of installation of cables.

(b) The Contractor must implement measures to ensure that cables are not damaged during installation. Cables must be handled and hauled by hand wherever possible.

3.6.2 Cable Drums

The communications cables must be delivered on purpose-built cable drums. All cable drums must be robust and in sound condition, and must remain in such condition before the complete cable on the drum has been removed for use.

3.6.3 Cable Hauling

(a) Optical fibre cables must be fitted with hauling eyes. During hauling, a minimum twist draw rope must be fitted to the hauling eye via an approved swivel.

(b) During hauling, a cable tension limiting device must be used to limit the hauling tension to 75% of the maximum permissible tension specified by the cable manufacturer.

(c) Cables must be hauled only through one duct/conduit section at a time. (One duct/conduit section is the duct/conduit between two successive access points along a given cable route.)

(d) Cables must not be coiled or bent to a radius smaller than 20 times the cable diameter, or the value recommended by the cable manufacturer.

(e) Cable must not be twisted or kinked as it is being fed into the duct or other cable enclosure. When pulling cables through pits, rollers or guides must be used to prevent the cable from rubbing on the ends of ducts, conduits or on concrete surfaces. All changes of direction greater than 30° must be supported by rollers.
3.6.4 Cable Labelling

Engraved stainless steel labels must be attached to each fibre in each pit, enclosure and termination point to uniquely identify the fibre including its source and destination. Plastic labels must be used at termination points where the label may be in close proximity to electrical power.

3.7 CABLE TERMINATION

3.7.1 General

(a) Joints in optical fibre cables must be kept to a minimum. Cable terminations must not be located inside pits or underground enclosures.

(b) All cable joint enclosures must be of water-tight design, appropriate for the sizes and types of cables with which they are to be used, and purpose-built for such uses.

3.7.2 Length

Each cable must have sufficient length to allow connection to the cabinet, with a minimum 5 m length of the cable coiled within the equipment cabinet pit to allow drawing into the equipment cabinet for fibre terminations.

3.7.3 Snap-in Connectors

All optical fibre terminations and breakouts must be made within the housing with approved termination SC-APC connections and FOBOT.

3.7.4 Service Loops

(a) Service loops must be installed in a minimum of one in every three pits, for the entire length of the fibre run.

(b) Service loops must comply with the minimum bend radius recommended by the cable manufacturer.

3.8 OUTDOOR EQUIPMENT

(a) Outdoor equipment used for the MNCS must comply with Specification RMS TSI-SP-016.

(b) Housings used as enclosure for outdoor equipment must comply with Specification RMS TSI-SP-012.

3.9 THIRD PARTY NETWORK FOR CONNECTION OF REMOTE ROADSIDE DEVICES

Where connection to remote roadside devices such as VMS and CCTV is not possible using the MNCS cableway/fibre network, the Contractor must obtain approval from the RMS Representative to use ADSL, VDSL or other reliable telecommunication carrier services in place of optical fibre connection.
3.10 TESTING AND AS-BUILT DETAILS

3.10.1 Testing

(a) Tests must be carried out to demonstrate the performance of each installed optical fibre link, including the insertion loss of any splices and terminations.

<table>
<thead>
<tr>
<th>WITNESS POINT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process to be Witnessed: Performance testing of each optical fibre link.</td>
</tr>
<tr>
<td>Submission Details: Notification in writing of testing, at least 10 working days prior to the date of testing.</td>
</tr>
</tbody>
</table>

(b) The splice and termination attenuation must be typically 0.2 dB and 0.3 dB respectively, but in all cases no higher than 0.5 dB.

(c) OTDR test reports must be provided to confirm that the installed cable meets the specified performance requirements for the cable.

3.10.2 As-built Details

As-built details of the cableways constructed and optical fibre installed must be submitted to the RMS Representative.

4 RMS TRAFFIC DATA NETWORK INFRASTRUCTURE

4.1 GENERAL

In addition to work to be carried out under Clauses 2 and 3, the Contractor must supply and install communications infrastructure on Motorway for the exclusive use of RMS.

This communications infrastructure will be utilised for data and video communications with the motorways forming part of the Sydney Orbital Motorway Network and RMS traffic management systems used to optimise traffic flows and minimise the impact of incidents on the Sydney road network.

4.2 DEDICATED RMS EQUIPMENT CABINET

The cabinets dedicated for RMS use will house RMS communications equipment, including optical fibre terminations and Ethernet communications equipment.

4.2.1 Indoor Equipment Cabinet – Number Required

The number of equipment cabinets provided must be as follows:

(a) in MCC server room: two required;
(b) at DRS: one required.
4.2.2 Indoor Equipment Cabinet – Requirements

(a) The equipment cabinets must comply with the following requirements:

(i) accommodate 19 inch rack mounted equipment;
(ii) minimum height 45 rack units high;
(iii) minimum width 800 mm;
(iv) minimum depth 1000 mm;
(v) fitted with perforated doors;
(vi) mounted on 100 mm plinth;
(vii) fitted with twelve way IEC power distribution.

(b) The equipment cabinets must be clearly labelled to RMS requirements and supplied by uninterruptible power supply (refer Specification RMS D&C TS914) rated at 4 kVA for a minimum of 4 hours.

4.2.3 Roadside Equipment Cabinet – Number Required

(a) Roadside equipment cabinets dedicated for RMS use must be supplied and installed at each of the End Points of the Motorway stated in the SWTC, to provide access to the RMS optical fibre network of the adjacent motorway. This requirement does not apply if existing RMS communications network nodes are present at the End Points of the Motorway.

(b) In addition, roadside intermediate equipment cabinets dedicated for RMS use must be supplied and installed at Motorway interchanges and at those locations along the Motorway specified in the SWTC, for connection to RMS traffic control signals, CCTV cameras and other ITS devices located along Local Roads.

4.2.4 Roadside Equipment Cabinet – Requirements

(a) The roadside equipment cabinets supplied and installed must comply with the requirements of TSI-SP-012 and the following:

(i) be of a design accepted by the RMS Representative.
(ii) accommodate 19 inch rack mounted equipment;
(iii) minimum height 1375 mm;
(iv) minimum width 750 mm;
(v) minimum depth 600 mm;
(vi) mounted on minimum 100 mm thick plinth.

4.2.5 Roadside Equipment Cabinet – Siting

(a) The roadside equipment cabinets must be located as near as practicable to existing power distribution points or OMCS MNCS cabinets, and must include a dedicated communication pit installed adjacent to the cabinet.
4.3 DEDICATED RMS CONDUITS

4.3.1 Motorway Cableway

(a) Within the Motorway cableways described in Clauses 3.4.2, an additional 100 mm diameter communications conduit dedicated for RMS use must be supplied and installed in the primary and secondary cableways (making a total of two additional conduits) for the full length of the Motorway between the End Points locations stated in the SWTC.

(b) These two additional 100 mm conduits do not constitute part of the spare conduits to be provided under Clause 3.4.4.

(c) The two 100 mm conduits dedicated for RMS use must be linked to the MCC and DRS to permit cable terminations in the RMS equipment cabinets.

(d) The two 100 mm conduits must be run from each Motorway cableway to the RMS intermediate equipment cabinets to permit cable terminations in the cabinets.

4.3.2 Local Road Cableway

(a) Where the Local Road cableways described in Clause 3.4.3 pass within 50 m of existing RMS traffic control signals, CCTV and other ITS devices, a 100 mm conduit dedicated for RMS use must be provided as part of the Local Road cableway. (Refer figure in Annexure TS914/E.)

(b) The dedicated RMS conduit RMS use must be terminated at the dedicated RMS intermediate equipment cabinet provided in accordance with Clause 4.2.3(b). Refer also figure in Annexure TS915/E.

(c) If there is no existing RMS conduit that allows connection to the existing RMS ITS device, then a new pit must be installed on the Local Road cableway for connection to that device. (Refer figure in Annexure TS914/E.) The new pit must provide a dedicated entry point for connection to the existing RMS device.

(d) Existing RMS conduit networks (e.g. at intersections) for existing RMS traffic control signals, CCTV and other ITS devices may be utilised for Local Roads, subject to approval by the RMS Representative.

4.3.3 Sub-ducts

(a) Every dedicated RMS conduit must contain three 32 mm diameter sub-ducts with draw rope within each sub-duct.

4.4 DEDICATED RMS OPTICAL FIBRE CABLELING

4.4.1 General

(a) The cables installed for RMS use must be installed inside any one of the three 32 mm sub-ducts in the dedicated RMS conduits.

(b) Fibre termination cable schedules (showing FOBOT port allocations and cable splicing) must be provided inside the RMS End Point cabinets and roadside intermediate equipment cabinets.
4.4.2 Motorway Cableway

(a) Within the Motorway primary and secondary cableways, one 48 core SMOF cable must be installed for RMS use in each of the dedicated RMS conduits in the cableways (making a total of two 48 core cables) between the End Points stated in the SWTC.

(b) The two 48 core cables installed for RMS use must be terminated as follows:

(i) at End Points in RMS communications nodes:

using the 19 inch rack mounted FOBOT with SC/APC connectors.

(ii) at MCC and DRS:

inside the RMS equipment cabinets using the 19 inch rack mounted FOBOT with SC/APC connectors.

(c) All FOBOTs must be labelled to clearly identify the optical fibre and its origin or destination using an appropriate labelling standard agreed with TMC.

4.4.3 Local Road Cableway

(a) For each existing traffic control signals, CCTV cameras or other ITS devices passed by the Local Road cableway (refer Clause 3.4.3), one separate 12 core SMOF cable must be installed for RMS use between the roadside intermediate equipment cabinets to be installed in accordance with Clause 4.2.3 and the RMS cabinets/pits of the existing ITS device. (The total number of cables will be equal to the number of existing RMS ITS devices passed by the Local Road cableway.)

(b) The 12 core SMOF cable installed for RMS use must be terminated at the RMS roadside intermediate equipment cabinets and existing RMS ITS equipment cabinets on SC/APC DIN mount enclosures.

(c) The cable must have a minimum 5 m length coiled within the intermediate equipment cabinet pit to allow drawing of the cable into the equipment cabinet.

(d) In the case of the pit to be provided under Clause 4.3.2(c), termination of the cable is not required at the pit, but at least 100 m of optical fibre must be left coiled inside the pit for RMS to connect to the ITS device.

4.5 MNCS - RMS TRAFFIC DATA NETWORK INTERFACE

(a) The MNCS accesses and connects into the RMS Traffic Data Network WAN at the dedicated RMS equipment cabinets.

(b) The Contractor must provide a minimum of two secured Ethernet interfaces at both the MCC and DRS sites for connection to the RMS/TMC Network.

(c) The two Ethernet interfaces at the MCC and DRS must be configured as follows:

(i) Interface 1: CCTV communications;

(ii) Interface 2: all other communications (including C2C interface).
Figure TS915.3 – MNCS - RMS Traffic Data Network Interface
ANNEXURES TS915/A AND TS915/B – (NOT USED)

ANNEXURE TS915/C – SCHEDULES OF HOLD POINTS, WITNESS POINTS AND IDENTIFIED RECORDS

Refer to Clause 1.3.3.

C1 SCHEDULE OF HOLD POINTS AND WITNESS POINTS

<table>
<thead>
<tr>
<th>Clause</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.2.5</td>
<td>Hold</td>
<td>Submission of Motorway Network Communication System architecture design.</td>
</tr>
<tr>
<td>3.4.7</td>
<td>Hold</td>
<td>Submission of Cableway design for Motorway and Local Roads.</td>
</tr>
<tr>
<td>3.9.1</td>
<td>Witness</td>
<td>Performance testing of each optical fibre link.</td>
</tr>
</tbody>
</table>

C2 SCHEDULE OF IDENTIFIED RECORDS

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

<table>
<thead>
<tr>
<th>Clause</th>
<th>Description of Identified Record</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.2.5</td>
<td>Motorway Network Communication System architecture design, including design drawings, design reports and engineering data.</td>
</tr>
<tr>
<td>3.9.1</td>
<td>OTDR test reports confirming that installed cable meets the specified performance requirements for the cable.</td>
</tr>
<tr>
<td>3.9.2</td>
<td>Drawings and reports showing as-built details of the cableway and installed optical fibre cables.</td>
</tr>
</tbody>
</table>
ANNEXURE TS915/D – PLANNING DOCUMENTS

Refer to Clause 1.3.4.

The following documents are a summary of documents that must be included in the PROJECT QUALITY PLAN. The requirements of this Specification and others included in the deed must be reviewed to determine additional documentation requirements.

<table>
<thead>
<tr>
<th>Clause</th>
<th>Description of Document</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.2.5</td>
<td>Systems Engineering Management Plan (SEMP).</td>
</tr>
</tbody>
</table>
ANNEXURE TS915/E - ILLUSTRATION OF REQUIREMENTS FOR DEDICATED RMS CONDUIT IN LOCAL ROAD CABLEWAY

Notes:

1. Where the Local Road cableway pass within 50 m of existing RMS traffic control signals (TCS), CCTV and other ITS devices, a conduit dedicated for RMS use must be provided as part of the Local Road cableway. Refer Clause 4.3.2 (a).

2. Where an existing RMS device passed by the Local Road cableway does not have an existing RMS conduit for connecting to, a new pit must be installed for later connection by RMS to that device. Refer Clause 4.3.2 (c).

3. For the purpose of illustrating the requirement in Note (2) above, the existing CCTV pit is shown without a conduit connecting to it.

4. In the example shown above, three 12 core optical fibre cables are to be installed within the Local Road cableway, one for each of the existing RMS ITS devices to connect with the IEC. Refer Clause 4.4.3 (a). The actual number of 12 core cable required will depend on the actual number of existing RMS ITS devices passed by the Local Road cableway.

5. The required connection between the IEC and the cableway along the other carriageway (secondary cableway in this example) is not shown.
ANNEXURE TS915/F – RMS SMOF CABLE CHARACTERISTICS

Refer to Clause 3.5.

The Tenderer is required to complete a copy of Technical Schedule above for each type of SMOF cable, or variation within the type, offered in the Tender.

<table>
<thead>
<tr>
<th>Cable Characteristics</th>
<th>Units</th>
<th>48 Core</th>
<th>12 Core</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type and Composition</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OS1 or OS2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall diameter</td>
<td>mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of tubes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of cores per tube</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Physical Construction</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protection against termites &amp; ants</td>
<td>Yes / No</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>Rodent resistant</td>
<td>Yes / No</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>Nylon jacket</td>
<td>Yes / No</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>Polyethylene sheath</td>
<td>Yes / No</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>Strength member type</td>
<td>GRP / Metallic</td>
<td>GRP / Metallic</td>
<td></td>
</tr>
<tr>
<td>Gel filled (waterproofing)</td>
<td>Yes / No</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>Steel wire armour</td>
<td>Yes / No</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>LSZH (in tunnels only)</td>
<td>Yes / No</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>Sacrificial sheath</td>
<td>Yes / No</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>Loose tube</td>
<td>Yes / No</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td>Fibre marking scheme</td>
<td>Yes / No</td>
<td>Yes / No</td>
<td></td>
</tr>
<tr>
<td><strong>Mechanical Properties</strong></td>
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<td></td>
</tr>
<tr>
<td>Mass</td>
<td>kg/km</td>
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</tr>
<tr>
<td>Minimum bending radius</td>
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<tr>
<td>- no load</td>
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<tr>
<td>- full load</td>
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</tr>
<tr>
<td>Maximum tensile load during installation</td>
<td>kN</td>
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<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crush resistance</td>
<td>kN/1000 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- short term</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- long term</td>
<td></td>
<td></td>
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<tr>
<td><strong>Splices and Terminations</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Splice attenuation</td>
<td>dB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- typical</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- worst case</td>
<td></td>
<td></td>
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<tr>
<td>Termination attenuation</td>
<td>dB</td>
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<td>- typical</td>
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<td></td>
</tr>
<tr>
<td>- worst case</td>
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</tbody>
</table>

ANNEXURES TS915/G TO TS915/L – (NOT USED)
ANNEXURE TS915/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 TS914  OMCS Requirements - Electrical Power Supply and Distribution 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
TSI-SP-012  General Requirements for Roadside Equipment Housings
TSI-SP-016  General Requirements for Outdoor Electronic Equipment

**Australian Standards**

AS/NZS IEC 60825.2  Safety of laser products - Part 2: Safety of optical fibre communication systems (OFCS)
AS/CA S008  Requirements for customer cabling products

**International Standards**

IEEE 802.3z  Gigabit Ethernet Standard
IEC 60793  Optical fibres - Measurement methods and test procedures
IEC 60794-3-11  Optical fibre cables - Part 3-11: Outdoor cables - Product specification for duct, directly buried, and lashed aerial single-mode optic fibre telecommunication cables