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REVISIONS TO PREVIOUS VERSION

This document has been revised from Specification RMS TS020 Edition 1 Revision 1.

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

PROJECT SPECIFIC CHANGES

Any project specific changes are indicated in the following manner:

(a) Text which is additional to the base document and which is included in the Specification is shown in bold italics e.g. Additional Text.

(b) Text which has been deleted from the base document and which is not included in the Specification is shown struck out e.g. Deleted Text.
RMS QA SPECIFICATION TS020
ITS COMMUNICATIONS SYSTEM

1 GENERAL

This Specification sets out the requirements for the design, supply, installation and commissioning of a reliable, managed communications system servicing Intelligent Transport Systems (ITS) for projects within New South Wales.

The ITS Communication System provides secure network connectivity from the Central Management Centre (CMC) to the ITS field devices, enabling the operation of ITS within the corridor.

1.1 SCOPE

The scope of this Specification covers the systems design, procurement of all hardware and performance of all site works required to commission the ITS Communications System.

The scope includes performance of works for:

- solution architecture and detailed design of the system;
- physical equipment and site layout;
- procurement;
- installation, test and commissioning;
- integration of the system with the host network; and
- integration testing of field sites.

The Principal may request assistance from the Principal Manager, ITS to coordinate integration aspects of system commissioning.

The scope includes but is not be limited to supply of:

- redundant network Access Node equipment;
- Distribution Nodes equipment providing multi-port Ethernet connectivity;
- communications cabling, cable tails or cable break-out modules;
- ITS equipment housings for communications equipment and cable management; and
- site earthworks for equipment footings, underground cableways and cable pits where not provided by the Principal.

Exclusions from scope include:

- Definition of the geographical scope for the transport corridor, and general placement of field devices and cable pit locations defined by the Principal;
- Installation of the ITS devices at sites within the corridor are defined by the Principal and specified for delivery under separate contracts;
• Provision of RMS Wide Area Network (WAN) between the ITS CMC and the Access Gateway node; and
• Performance of the traffic management and control functionality enabled by the Communications System.

1.2 STRUCTURE OF THE SPECIFICATION

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

1.2.1 Project Specific Requirements

Project specific details of work are shown in Annexure TS020/A.

1.2.2 Measurement and Payment

The method of measurement and payment is detailed in Annexure TS020/B.

1.2.3 Schedules of HOLD POINTS, WITNESS POINTS and Identified Records

The schedules in Annexure TS020/C list the HOLD POINTS and WITNESS POINTS that must be observed. Refer to Specification RMS Q for definitions of HOLD POINTS and WITNESS POINTS.

The records listed in Annexure TS020/C are Identified Records for the purposes of RMS Q Annexure Q/E.

1.2.4 Planning Documents

The PROJECT QUALITY PLAN must include each of the documents and requirements listed in Annexure TS020/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.

1.2.5 (Not Used)

1.2.6 Referenced Documents

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

Standards, specifications and test methods are referred to in abbreviated form (e.g. AS 2350). For convenience, the full titles are given in Annexure TS020/M.

In the event of a discrepancy between this document and a referenced document, this document takes precedence.
1.3 DEFINITIONS AND ABBREVIATIONS

1.3.1 Definitions

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

The following definitions are applicable to this Specification:

**Access Gateway**
The connection between RMS existing network and this ITS Communications System.

**Access Node**
A point on a network to connect an Access Service.

**Access Service**
Communications connectivity.

A communications link between the roadside communications network and the Control and Management Centre.

**Backbone**
A number of connectivity devices connected in a hierarchy to a series of central connectivity devices, such as hubs, switches, or routers.

**Backhaul**
Mid-to-long-distance transport of data from a series of disparate locations back to a more centralised location.

**Break out Module**
A fibre cable splice/termination enclosure.

**Core**
The central part of a communications network.

**Core Access Service**
Connectivity to the core communications network.

**Distribution Node**
Provides network connection for one or more ITS Field Sites to the Backbone.

**ITS Field Site**
Roadside location for ITS equipment.

**Node**
A point on a network.

**Referencing Specification**
The document or specification that stipulates or requires compliance with this Specification in full or in part.

**RMS Representative**
The person appointed by Roads and Maritime Services to carry responsibilities on behalf of Roads and Maritime Services for the execution of the contract under which the communications network is supplied.

A reference to the RMS Representative in this Specification shall be taken to include a reference to the representative(s) of the RMS Representative.

**Site Access Node**
The local site connection point for an ITS Field Site to provide access to the communications network.

**Site Access Service**
Local communications connectivity.
1.3.2 Abbreviations

The following abbreviations apply to this Specification:

**BOM**  Break Out Module

**CCTV**  Closed Circuit Television

**DRC**  Disaster Recovery Centre

**IP**  Internet Protocol

**ISO**  International Standards Organisation

**ITS**  Intelligent Transport Systems

**CMC**  Control and Management Centre

**CMS**  Control and Management System

**ETS**  Emergency Telephone System

**MTBF**  Mean Time Between Failures

**NMS**  Network Management System

**RMS**  Road and Maritime Services

**SMOF**  Single Mode Optic Fibre

**UPS**  Uninterruptible Power Supply (DC/AC - Direct or Alternating Current)

**VoIP**  Voice over Internet Protocol

**WAN**  Wide Area Network

2 THE ITS COMMUNICATIONS SYSTEM

2.1 OVERVIEW

The ITS Communications System is a collection of communications networks that link ITS devices operating at field sites with their associated Control and Management Systems to enable traffic management and control functionality for strategic parts of the State Road Network.

The criticality of the ITS Communications System is driven by the requirements of the most critical system supported by the communications solution.

For example, satisfactory operation of real-time traffic management systems will typically require the ITS Communications System be engineered for high availability, high fault tolerance and prevention of single points of failure.

To meet the maintenance and repair time objectives for ITS field devices, all active communications network equipment provided must be interfaced to and configured within the Network Management System at the Control and Management Centre for network administration, performance monitoring and fault management capability.

The simplest example of ITS Communications System is one that supports a single ITS Field Site at a single physical location (Figure 1).
2.2 ACCESS GATEWAY

The ITS Communication System accesses the Principal’s existing communications network at the RMS WAN node switch equipment (provided by RMS).

The ITS Communications System must provide a managed gateway to the RMS WAN to aggregate & distribute network traffic from ITS Field Sites to the CMC and to allow autonomous (degraded) functionality when the RMS WAN is not available.

The Principal provides the backhaul path from the RMS WAN Node to the CMC.

Access to the RMS WAN will be provided to the Contractor at an equipment cabinet or building. Network access back to the CMC will be pre-validated by the Principal.

Duplicate RMS WAN connections will be supplied by the Principal, connecting the ITS Communications System to the CMC and its Disaster Recovery Centre (DRC).

2.3 ROAD CORRIDOR COMMUNICATIONS NETWORKS

The ITS Communications System must extend the RMS communications backbone from the RMS WAN into the road corridor, including the extension of physical, spatial, logical and electrical network redundancy and the management of the this ITS Communications System back to the CMS.

From the gateway equipment, the ITS Communications Network must continue along the road corridor, strategically locating switch equipment at Distribution Nodes that create, along with redundant cabling, a redundant backbone.

2.3.1 Corridor Communications Network topologies

The communications topologies overlay the road corridor connecting ITS devices, increasing in complexity from single sites to multi-sites, corridors, redundant corridors and to fully autonomous networks with a local CMS and NMS.

A simple Corridor Communications Network provides Site Access Services to many ITS Field Sites that are located along a road corridor (Figure 2).
Figure 2 – A Simple Corridor Communications Network can support multiple ITS sites

For more complex ITS corridors, Distribution Nodes are added to manage connectivity along the backbone and connections to large numbers of non-critical ITS Field Sites e.g. traffic monitoring and video surveillance sites (Figure 3).

Figure 3 – ITS Corridor Communications Network, with Distribution Nodes along the backbone
For critical ITS corridors, redundant access and backbone paths to Distribution Nodes deliver high availability and redundancy where this is required by the Principal e.g. corridors supporting tolling systems or real-time traffic control (Figure 4).

Figure 4 – Critical (redundant backbone) ITS Corridor Communications Network

An autonomous ITS Communications System is a network that incorporates a local CMS (provided by others) and a dedicated NMS provided by the Contractor. It does not require ITS Field Sites to access the RMS CMS for traffic management functionality.

Autonomous networks must be linked to the RMS WAN at network gateways to support inter-systems operation only, as local corridor systems operate directly with their ITS field sites (Figure 5).
2.4 **DISTRIBUTION NODE**

The Distribution Nodes along the corridor provide network access to multiple ITS Field Sites. The placement of Distribution Node sites by the Contractor must be optimised against the location of the ITS devices and existing infrastructure.

The Distribution Node communications equipment must be fully redundant and configured for auto-failover for fault tolerance along the communications backbone.

Physical diversity of backbone media must be maintained entering the Distribution Node equipment housing or building.

2.5 **SITE ACCESS NODES**

The ITS Communication System must extend from the Distribution Nodes to the nominated Field Sites, providing access to communications services for site equipment.

The Contractors design must identify all the communications services required by site equipment and the fibre optic cable size required, including spare fibres cores.

Site Access Services and associated cableways will not be redundant unless specified by the Principal.

The Contractor must supply and install fibre optic cable to an in-ground communications pit for the communications services to be accessed by the ITS Site Equipment (**Figure 6**).
The physical layout of fibre cables and location of the communications pits must be identified in the design of cableways and ducts (Specification RMS R155) and situated as close as practical to the location of ITS field devices.

Where there is more than one field device at the site connecting to more than one cable fibre core, the Contractor must terminate the fibre optic cable at a labelled fibre optic cable Break out Module (BOM) within the pit. The point of connection from the BOM to each site field device will be made by the site field device installer in accordance with the site design.

Where the site design consists of only one site field device, the fibre optic cable from the Distribution Node must be left coiled in the pit with provision of sufficient additional unterminated cable to be pulled through access conduits to the location of the ITS Field Site’s equipment cabinet (by others).

After site equipment installation and connection to the fibre cable tail or BOM (by others), the Contractor must configure the site communications terminal equipment within the NMS and verify the communications service and monitoring to each site device.

**Figure 6 – Communications Network delivery and ITS Field Site Integration**

### 2.6 STAND-ALONE NETWORK CAPABILITY

The ITS Communications System must be designed to operate as a stand-alone managed IP communications network whenever the WAN access connection to the RMS CMC is unavailable (degraded mode operations).
2.7 **NETWORK MANAGEMENT SYSTEM**

The ITS Communications System must integrate with the existing RMS NMS system to provide visibility of the performance of the overall ITS Communications Network including network link availability, operational status, and network switch equipment faults to the RMS NMS. The ITS Field Sites must also provide the RMS NMS with visibility of network terminal devices where provided.

2.8 **BACKBONE FIBRE**

Te Backbone fibre provides the connectivity between Distribution Nodes and the Gateway devices.

The Contractor must incorporate the delivery of a fibre optic backbone of fibre optic cables into the communications backbone design. Each fibre optic cable must be identified in the solution architecture.

The SMOF cable must meet the requirements of Annexure TS020/L.

2.9 **SOLUTION ARCHITECTURE**

The Contractor must submit high level concept design documentation for the overall ITS Communications System including a Systems Engineering Management Plan (SEMP) outlining the framework within which the system will be designed and developed.

**HOLD POINT**

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3 **DESIGN REQUIREMENTS**

3.1 **GENERAL**

The Contractor must provide an initial solution architecture and a subsequent detailed design for an IP communications system to service the ITS devices in the network.

The Contractor must ensure the network design provides each device at each ITS Field Site with suitable network capacity and availability for operation under all load and environmental conditions.

In general, the communications network must be:

(a) scalable for future services;
(b) easy to upgrade and maintain;
(c) highly available;
(d) resilient;
(e) tolerant of single points of failure along the backbone; and
(f) secure against unauthorised access; and
(g) managed for network load and faults

The network must support communications between the RMS WAN and the ITS Field Devices at field sites as per the Principal’s design drawings, including (as required):

(i) data communications with Electronic Message Signs (EMS);
(ii) data communications with Vehicle Detection Systems (VDS);
(iii) data communications with Ramp Metering Sites;
(iv) video image data with Video Surveillance Camera (VSC) Sites;
(v) data communications with Electronic Toll Collection systems; and
(vi) voice communications with Emergency Telephones.

3.2 EXISTING INFRASTRUCTURE

The Contractor must apply to the Principal for connection to existing power supply and communications infrastructure nodes (where available) to assure the required capacity is available. Where required, the Principal will upgrade existing infrastructure or provide an alternate connection node to the Contractor that meets the new capacity demand identified.

3.3 SECURITY

Security measures must be implemented to prevent disruption of the system in the event of:

(a) unauthorised connection or intrusion into the network;
(b) unauthorised connection to and/or configuration of switching and routing equipment;
(c) attempted connection into the network by unknown devices;
(d) unauthorised access to an equipment housing containing an ITS or a communications device; and
(e) broadcast storms and denial of service attacks.

All detected intrusion events must create an alert and be logged within the NMS.

Physical security measures such as key-locks and door alarms must be implemented at equipment sites, including all cabinets and buildings.

Where Tolling Systems are included in the corridor by the Principal, Tolling System security must be configured for authorisation and permissions separately from other ITS equipment.

3.4 COMPLIANCE WITH REGULATORY REQUIREMENTS

All equipment used must comply with relevant regulatory requirements for communications equipment. The Contractor must declare all equipment regulatory approvals in the System detailed design.

All installation practices used must comply with Specification AS/AC S009 and relevant, regulatory requirements.
3.4.1 Open Standards

All network elements and protocols must comply with industry standards and be commercially available ‘off-the-shelf’. Proprietary protocols must not be employed within the design (unless specifically approved by the Principal).

3.5 COMMUNICATIONS BEARERS

3.5.1 Single Mode Optic Fibre Cable

The Contractor must supply and use Single Mode Optic Fibre (SMOF) cable complying with required RMS SMOF characteristics as per Annexure TS020/L.

3.5.2 Copper

Copper cabling must not be used for any communications section over 50 meters.

The Contractor must advise the Principal during detailed design where any copper cabling is to be used, including the use of any existing cabling infrastructure, and the surge suppression techniques that are included in the design.

Any copper cabling used must be protected against electrical transients and lightning strikes. Lightning and surge protection procedures must conform with the relevant provisions of AS 1768.

3.5.3 Wireless

Where fibre optic and copper cable is not practical and wireless communications is a viable solution, the Contractor may apply to the Principal for permission to employ wireless technologies. Where approved, wireless links must be designed and implemented to minimise service disruption due to radio frequency propagation effects.

For Emergency Telephones Sites, the use of cellular wireless technologies (3G/GSM) is the default. The Contractor must provide access services to Emergency Telephone Sites via ducted communications on a per site basis where cellular wireless is not viable.

3.5.4 Use of Third Party Communication Networks

The ITS Communications System is an extension of the Principal’s private network.

Third party networks and commercial carriers must not be used within the design without the express permission of the Principal.

Emergency Telephones Sites using cellular telephony or PSTN connections may be an exception to this design requirement.

3.6 PROVISION OF FIBRE

The communications backbone for a corridor communications network must employ a minimum of two SMOF cables, each with a minimum of 48 fibre cores per cable. The requirement for two physical cable paths to be supplied is mandatory, even where the corridor network does not support critical ITS communications (where mandatory path separation is not required).
The number of fibre cores supplied in each of the two cables must be increased whenever the scalability and spare fibre capacity requirements of this Specification would not otherwise be achieved.

Additional pairs of SMOF cables must be provided to support each of the following business needs where they are nominated within the project scope by the Principal and defined in the system design:

(a) Electronic Tolling Systems;
(b) Private Motorway Operators systems; and
(c) External parties.

The Contractor must provide all fibre optic cable paths within conduits specified by the Principal, and must advise the Principal of the level of physical separation achieved between fibre cable paths via the ducts and cableway and the ITS Communications System design.

Fibre cable core capacity provided between Distribution Nodes and Site Access Nodes must also be designed to ensure the scalability and spare fibre capacity requirements of this Specification are met.

3.7 PHYSICAL SEPARATION OF SERVICES

3.7.1 Electronics Tolling System

The Electronic Tolling System infrastructure must be physically separated from other services through provision of discrete equipment rooms or housings, fibre distribution frames and patch panels.

Where an ITS Field Site shares Electronic Tolling Equipment with other ITS services, a separate cable and BOM must be provided from the Distribution Node to the ITS Field Site communications pit.

Electronic Tolling infrastructure may share a common cableway and pits with other ITS infrastructure.

3.7.2 Video Surveillance Cameras

Video Surveillance Camera (VSC) traffic must be separated from other services over dedicated fibres to prevent high video bandwidth demand degrading the transport of other ITS services. If VSC traffic is aggregated to share bandwidth on a fibre media, this must be designed to ensure that no degradation of other network traffic occurs.

3.8 NETWORK MANAGEMENT SYSTEM INTEGRATION

The Contractor must integrate the ITS Communications Systems network equipment and the ITS Field Sites remote terminal equipment into the Principal’s NMS.

The Contractor must configure all equipment into the Principals NMS to:

(a) provide a network topology display of all links and communications devices including the gateway, distribution and communications terminal equipment at the at ITS Field Sites;
(b) enable each communications equipment fault to be localised to an individual item of equipment;
(c) report all communications equipment faults in real-time, raise alerts and log all faults;
TS020 ITS Communications System

(d) display all faulty equipment and link sections in real-time;
(e) log all network maintenance actions e.g. configuration changes, user IDs, system backups;
(f) provide a means for system operators and maintenance personnel to log all network maintenance activity;
(g) support analysis of communications performance down to the level of individual link sections and individual communications devices to facilitate troubleshooting and forecasting of upgrade requirements;
(h) flag and log atypical data loads e.g. broadcast storms and denial of service attacks on link sections;
(i) provide communications link section performance down to individual communications device level in real-time to facilitate early warning of communications problems;
(j) provide a means to export log files to external applications for analysis;
(k) interface to the ITS CMS fault management system; and
(l) interface to the security system logs to facilitate correlation of observed events.

The Principal will provide sufficient authentication permissions for the Contractor to access network resources to conduct systems integration.

3.9 NETWORK TIME PROTOCOL

All equipment with an internal clock must be slaved off the RMS Network Time Protocol servers at the CMC and DRC.

3.10 POWER DISTRIBUTION

The Contractor must nominate the mains power connection points from which each item of communications equipment must be powered.

Where existing power infrastructure is provided, it must be given preference over supply of new infrastructure. Any works required to enhance existing infrastructure must be included in the detailed design.

Where no existing power is present, the Contractor must engage the local power authority to provide mains power from the point of supply. In this case, the Contractor must perform all works in connecting the equipment site to the point of supply, including pits, conduits and underground cableways as required by the site layout.

The Contractor must provide underground cableways and associated earth works from the power connection point to the mains distribution switchboard in the equipment shelter in accordance with RMS R155.

All electrical installations supporting the ITS Communications System must comply with AS 3000 and AS 1768, and any batteries supplied must be suitably environmentally rated for their designed installation environment (refer to Clause 4 of this document).
3.10.1 Uninterruptable Power Supply

A minimum of 24 hours battery backup power (UPS) must be provided for all active communications equipment unless directed otherwise by the Principal. Wherever possible, the battery backup power (UPS) must be designed to deliver a DC connection to the supported communications equipment.

The backup power technologies (inverter-battery-inverter/generator set/ inverter-battery/solar-battery-inverter) must be appropriate and aesthetic to the location, and the design parameters of backup power must be included in detailed design.

3.10.2 Power to Field Communications Equipment

Where the ITS Communications Network needs to support communications to existing ITS Field Equipment with serial communications interfaces, Media Converters must be used to convert the serial communications to IP data.

In this situation the Media Converter should be supported by a battery backup power supply (UPS) as specified in the relevant ITS Field Device specification.

3.11 DETAILED DESIGN

The Contractor must submit detailed design documentation for the ITS Communications System including Project Management Plans and Verification/Validation plans detailing how the system will be delivered, configured and proven.

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

3.12 NON FUNCTIONAL REQUIREMENTS

3.12.1 Availability

Availability of the overall ITS Communications System including a Critical CCN must be greater than 99.995% per month, and availability aggregated over all connected ITS Field Sites must be greater than 99.95% per month.

Communications availability for a single ITS Field Sites must be greater than 99.9% per month.

Equipment must have a minimum mean time between failure (MTBF) of 45,000 hours in operation, in accordance with TSI-SP-016.
The Contractor must submit network availability calculations based upon the proposed equipment using a recognised availability calculation method during detailed design.

### 3.12.2 Reliability

Communications equipment must be designed to provide continuous operation for a service life of 15 years as a minimum.

Equipment enclosures and mechanical fittings must be designed to provide continuous operation for a service life of 20 years as a minimum.

The operation of the communications Backbone, Gateway and Distribution Nodes must not be adversely affected by any single point of failure.

#### 3.12.2.1 Duplication of Communications Backbone

The redundancy of the Principal’s existing RMS WAN must be continued within the ITS Communications System through duplication of the communications backbone and its configuration as a redundant, fault tolerant network without single points of failure.

#### 3.12.2.2 Physical separation for robustness

The ITS Communications System must implement logical/electrical and spatial/geographical redundancy. Spacing of conduits for redundant communications bearers must be at least 2 metres. Concessions may be sought from the Principal in physically constrained locations.

Duplicated Core Access Node sites must also be physically separated along the backbone.

### 3.12.3 Scalability

The communications backbone must be capable of supporting a 50% expansion of data load without degradation of service performance.

Each site Access Service must support a 100% expansion of the data load to each connected ITS Field Site without degradation of service performance.

#### 3.12.3.1 Spare Switch Capacity

Network switch capacity must provide for the operation of the network under all load conditions. The system must be designed with an additional 50% spare capacity for future expansion.

#### 3.12.3.2 Spare Fibre Capacity

There must be a minimum of at least 30% unutilised (dark) fibres in each backbone cable.

There must be a minimum of at least 50% unutilised (dark) fibres in each Site Access Service cable.

### 3.12.4 Network Latency

Communications latency (round-trip delay) must not exceed 100 milliseconds (ms) for any path within the ITS Communications System, including from the Access Gateway equipment to ITS Field Site.
4 EQUIPMENT ENVIRONMENTS

4.1 INSTALLATION ENVIRONMENTAL REQUIREMENTS

All ITS equipment supplied must be suitable for the environment in which it is designed to operate. No powered ITS equipment is permitted be installed directly within underground pits or ducts.

Within the ITS Communications Network, the three primary operating environments for equipment installation are “Temperature Controlled Room”, “Air-Cooled Outdoor Cabinet”, “Standard Outdoor Cabinet”, and “Self-contained Outdoor Enclosure”.

4.1.1 Temperature Controlled Room

Temperature Controlled Rooms are indoor spaces provided with active temperature control to ensure the ambient environment remains suitable for sensitive equipment. Typically air-conditioning is used to ensure that the indoor ambient temperature does not exceed 30°C.

The equipment installed within Temperature Controlled Rooms must be capable of continuous, normal operation under the following conditions as a minimum without degradation to system performance or life expectancy:

(a) ambient air temperature range between –10°C and 45°C;
(b) humidity of up to 90% within the temperature range -10°C to 45°C;
(c) exposure to infestation by vermin.

Any indoor equipment enclosures must have a degree of protection of not less than IP4x, as defined in AS 60529.

4.1.2 Air-Cooled Outdoor Cabinets (Specifically Approved)

Under specific circumstances Air-Cooled Outdoor Cabinets may be required to support specific ITS Communications requirements. Any proposed supply of Air-Cooled Cabinets must be specifically approved by the Principle, and ideally they should not require any active cooling.

In direct sunlight the internal temperatures within double-skinned Air-Cooled Cabinets can be reduced to less than 50°C, allowing the installation of more sensitive electronic equipment.

All equipment designed for installation within approved Air-Cooled Outdoor Cabinets must be capable of continuous, normal operation under the following conditions as a minimum without degradation to system performance or life expectancy:

(a) internal ambient air temperature range between –10°C and 55°C;
(b) humidity of up to 90% within the temperature range -10°C to 55°C;
(c) vibrations reasonably expected in the installed location;
(d) exposure to infestation by vermin.

Any equipment enclosures within air-cooled cabinets must have a degree of protection of not less than IP3x, as defined in AS 60529.
4.1.3 Standard Outdoor Cabinets

Standard RMS Outdoor Cabinets do not have any active cooling, and in direct sunlight the internal temperatures within cabinets fitted with electronic equipment can reach 70°C (and above) making these cabinets a particularly harsh environment for ITS equipment.

As an example, where equipment within outdoor cabinets need backup power, special high-temperature rated battery technology (such as LiFePO4) will need to be considered in the power supply design.

All equipment designed for installation within standard RMS cabinets must be capable of continuous, normal operation under the following conditions as a minimum without degradation to system performance or life expectancy:

(a) internal ambient air temperature range between –10°C and 70°C;
(b) humidity of up to 90% within the temperature range -10°C to 70°C;
(c) vibrations reasonably expected in the installed location;
(d) exposure to infestation by vermin.

Any equipment enclosures within cabinets must have a degree of protection of not less than IP3x, as defined in AS 60529.

4.1.4 Self-Contained Outdoor Enclosure

Some ITS equipment (such as CCTV cameras) are supplied with their own integrated outdoor enclosures designed for direct installation on suitable structures, and will be provided with an environmental rating for the complete device.

All equipment designed for direct installation outdoors must be capable of continuous, normal operation under the following conditions as a minimum without degradation to system performance or life expectancy:

(a) installed directly in sunlight (unless to be installed in a permanently sheltered position);
(b) ambient air temperature range between –10°C and 50°C;
(c) humidity of up to 90% within the temperature range -10°C to 50°C;
(d) maximum wind conditions likely to occur at the installation site;
(e) conditions, both permanent and temporary, that may be unique to the specified location, for example instances of thick smoke and electromagnetic interference;
(f) vibrations reasonably expected in the installed location;
(g) exposure to vandalism; and
(h) exposure to infestation by vermin.

Any outdoor equipment enclosures must have a degree of protection of not less than IP45, as defined in AS 60529.

4.2 Electromagnetic Compatibility and Emissions

The equipment must be certified to the applicable statutory requirements for electromagnetic compatibility and interference e.g. C-tick certification.
The EMS equipment must comply with AS/NZS 61000.6.1 for immunity to surges and radiation.

The equipment must comply with AS/NZS 61000.6.3 for electromagnetic emissions.

Equipment designed to emit electromagnetic radiation must be fitted with screens and safety devices to prevent operator exposure to radiation levels in excess of those nominated in AS/NZS 2772.

4.3 **ITS EQUIPMENT CONNECTIONS**

The detailed design must demonstrate the suitability of all nominated ITS equipment connections.

Ethernet connections at ITS Field Sites must be not less than 100 Mbps.

Video Surveillance Sites are required to connect to dedicated fibre core(s) at Site Access Nodes.

4.4 **STANDARD EQUIPMENT CABINETS**

Standard RMS Outdoor equipment cabinets must comply with RMS Specification TSI-SP-012.

Outdoor equipment cabinets must be lockable, designed to enable safe access and be located in a position which allows for the equipment to be controlled from the cabinet for maintenance purposes.

Enclosures that incorporate conduits for entry of telecommunications cables must comply with the requirements of the AS/CA S009.

5 **CONSTRUCTION AND INSTALLATION REQUIREMENTS**

5.1 **GENERAL**

Before commencing any work, the Contractor must make all such enquires and inspections as may be necessary to make themselves fully aware of the type and location of surface and underground utility services at each site.

5.1.1 **Work Health and Safety**

Work Health and Safety measures must be implemented, including preparation of Safe Work Method Statements, in accordance with Specification RMS G22.

5.1.2 **Traffic Management**

Traffic Management must be provided in accordance with Specification RMS G10.

Access must be maintained to private properties and commercial premises.

5.2 **MOUNTING AND INSTALLATION**

All communications equipment, including switches and routers, fibre distribution panels and patch panels must be 19” rack mounted in suitable enclosures.
5.3 POWER CABLEING

The Contractor must perform all works, including civil earthworks and underground cableways, in providing power connection points from the point of supply, unless local supply is already provided.

5.4 COMMUNICATIONS CABLEING

The Contractor must submit a cable installation plan as part of the detailed design. The Contractor must perform all works to install suitable backbone and distribution fibre cabling to Site Access Nodes as per the detailed design and in accordance with AS/CA S009. The fibre optic cables must be terminated at fibre distribution frames within equipment housings or building before being patched to the switch equipment.

Fibre optic cable splices must be contained in an approved fibre optic splice enclosure within a communications pit or enclosure. Splices must not be installed in underground conduits. Any excess cable tails within enclosures must be coiled and hung neatly within the equipment housings.

Unterminated ends of all cables shall be seated at all times with approved endcaps to prevent ingress of moisture before and after cables are laid. All cable entries to buildings and equipment housings must be constructed to preclude vermin ingress, for example, through employing sealed holes or cable glands.

All fibres in all cables entering buildings or equipment shelters must be terminated at fibre optic distribution frames or patch panels with each cable and core individually labelled as per the system detailed design.

5.5 CABLEWAY, DUCTS AND PITS

All underground cabling works must be performed in accordance with RMS R155. Duplicated cableways for physical separation must be installed on either side of the carriageway. The Contractor must advise the Principal in the system detailed design where this carriageway separation is not feasible.

Where duplication either side of the carriageway is not feasible and one cableway on one side of the carriageway is required, a 2 m minimum separation must be maintained within the one cableway between the RMS fibre optic backbones primary and secondary path.

Cableways must be designed to prevent accumulation of water, dirt and debris, and once installed with the cabling, the cableway network must be vermin proof.

Junction pits must be adequately drained so as not to accumulate standing water.

5.6 ADDITIONAL SAFETY PRECAUTIONS

5.6.1 Protection of Completed Works and Existing Utilities

Completed works and existing utilities must be protected in accordance with RMS R155.
5.6.2 Installation of Equipment in High Voltage Areas

Where equipment is to be installed near high voltage earthed locations such as substations, the Contractor must obtain written authorisation from the Principal before commencing installation.

Existing high voltage earthing arrangements must not be disturbed under any circumstances.

5.7 SETTING OUT

Setting out of communications sites and associated equipment must be as per the main project signposting and delineation drawings or equivalent and performance of works in accordance with RMS R155.

5.7.1 Tolerances

Setting out of communications sites and associated equipment sites will have a positioning tolerance of +/- 5 metres from the nominated plan position e.g. Signposting and Delineation Plans, unless an alternative tolerance is identified within the specific ITS Field Site specification.

Setting out of sites at locations outside this range must be approved by the Principal.

**HOLD POINT**

<table>
<thead>
<tr>
<th>Process Held:</th>
<th>Commencement of Civil Works.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Submission Details:</td>
<td>Detailed site layout and equipment drawings.</td>
</tr>
<tr>
<td>Release of Hold Point:</td>
<td>The Principal will inspect the detailed site layout prior to authorising the release of the Hold Point.</td>
</tr>
</tbody>
</table>

5.8 CIVIL WORKS

The Contractor will perform any required Civil Works prior to installation of any electronic or cabling equipment. Once the pre-requisite Civil Works have been completed, the contractor may proceed to completely install the first Core Access Node site in preparation for type testing validation.

**WITNESS POINT**

<table>
<thead>
<tr>
<th>Process Witnessed:</th>
<th>First off site installation for Core Access Node.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Submission Details:</td>
<td>Site installation inspection by the Principal.</td>
</tr>
</tbody>
</table>

6 TESTING AND COMMISSIONING

6.1 SITE TYPE TEST

Site equipment installation test and acceptance must be completed for at least one site of each type before continuing installation on any other sites. The sites chosen for this preliminary fit out will be mutually agreed between the Contractor and the Principal.
Deficiencies to the mechanical and electrical installation must be rectified where it is evident the installation does not meet RMS TS020 (this Specification).

### HOLD POINT

**Process Held:** ITS Communications System installation at other sites after the first site.

**Submission Details:** Documentation to verify that the first ITS Communications System installation complies with RMS TS020 (this Specification).

**Release of Hold Point:** The Principal will review the ITS Communications System inspection and test reports prior to authorising the release of the Hold Point.

### 6.2 COMMUNICATIONS SITE COMMISSIONING

The ITS communications sites for Distribution Nodes and Access Node equipment are connected with the existing host communications network at network interface points. All switch equipment are integrated and tested with the host LAN, NMS, security system and Network Time servers.

### HOLD POINT

**Process Held:** Site Access Node Acceptance

**Submission Details:** System performance test results. NMS configuration documentation for switch terminal equipment, and channel site testing from the host system.

**Release of Hold Point:** The Principal will review performance of the System operation including NMS integration prior to authorising the release of the Hold Point.

### 6.3 ITS FIELD SITE COMMISSIONING AND ACCEPTANCE

Before Site Access Services, Distribution Nodes and Site Access Nodes can be accepted, the ITS Field Site communication terminal equipment (provided by others) must be tested end-to-end from the host CMS and integrated and tested with the NMS, security system and Network Time servers.

### HOLD POINT

**Process Held:** System Acceptance

**Submission Details:** NMS configuration documentation for ITS Field Site remote terminal equipment and ITS Field Site testing from the host system.

**Release of Hold Point:** The Principal will review performance of the ITS Field Site operation including NMS integration prior to authorising the release of the Hold Point.

### 6.4 SYSTEM COMMISSIONING AND ACCEPTANCE

Commissioning tests for ITS hosts systems fully integrated to ITS Field Sites.
WITNESS POINT

Process Witnessed: All ITS Field Site operational user testing including fault insertion.

Submission Details: Notification of trial at least 3 weeks prior to commencement.

6.5 COMPLETION REPORT AND WORK-AS-EXECUTED DRAWINGS

6.5.1 Completion Report

A completion report must be provided and must include detail colour photographs of all ITS Communications installations, and colour photographs of the ITS Communications installations set against the surrounding background to allow for easy identification of the location of ITS Communications locations.

6.5.2 Work-As-Executed (WAE) Drawings and Documentation

Drawings and documentation must be provided in accordance with requirements of TSI-SP-016.

6.5.3 Warranty

Warranty for the equipment installed must be provided for 12 months after installation, or 24 months after equipment delivery to the Principal’s store, whichever comes first.

6.5.4 Spares

Spares equipment must meet requirements and conditions in TSI-SP-016.
### ANNEXURE TS020/A – PROJECT SPECIFIC REQUIREMENTS

#### A1  PROJECT LOCATION

<table>
<thead>
<tr>
<th>Number</th>
<th>Site</th>
<th>Site Type</th>
<th>Power Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>002</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>003</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>004</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>005</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
ANNEXURE TS020/B – MEASUREMENT AND PAYMENT

B1 MEASUREMENT AND PAYMENT

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

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

Pay Item TS020P1 - ITS Communications System Installation and Commissioning

This is a lump sum item for each ITS communications system.

The schedule rate must include supply and installation of ITS Communications System equipment at each site, including supply, installation and commissioning.

Pay Item TS020P2 - Documentation

This is a lump sum item for each ITS Communications System site.

The schedule rate must include submission of all ITS Communications System Work As Executed documentation in accordance.
ANNEXURE TS020/C – SCHEDULES OF HOLD POINTS, WITNESS POINTS AND IDENTIFIED RECORDS

Refer to Clause 1.2.3.

**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>2.10</td>
<td>Hold</td>
<td>Solution Architecture</td>
</tr>
<tr>
<td>3.13</td>
<td>Hold</td>
<td>System Detail Design</td>
</tr>
<tr>
<td>5.7</td>
<td>Hold</td>
<td>Commencement of Civil Works</td>
</tr>
<tr>
<td>5.8</td>
<td>Witness</td>
<td>Site Type Inspection</td>
</tr>
<tr>
<td>6.1</td>
<td>Hold</td>
<td>First off Site Equipment Installation</td>
</tr>
<tr>
<td>6.2</td>
<td>Hold</td>
<td>Communications Site Commissioning</td>
</tr>
<tr>
<td>6.3</td>
<td>Hold</td>
<td>ITS Field Site - Commissioning and Acceptance</td>
</tr>
<tr>
<td>6.4</td>
<td>Witness</td>
<td>System Commissioning and Acceptance</td>
</tr>
</tbody>
</table>

**C2 SCHEDULE OF IDENTIFIED RECORDS**

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

<table>
<thead>
<tr>
<th>Clause</th>
<th>Description of Identified Record</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>Detailed design</td>
</tr>
<tr>
<td>5.1.1</td>
<td>Safe Work Method Statements</td>
</tr>
<tr>
<td>5.1.2</td>
<td>Traffic Management Plan</td>
</tr>
<tr>
<td>6.1</td>
<td>Site type test records</td>
</tr>
<tr>
<td>6.4</td>
<td>Site test &amp; commissioning records</td>
</tr>
<tr>
<td>6.5.1</td>
<td>Completion Report</td>
</tr>
<tr>
<td>6.5.2</td>
<td>Work-as-executed drawings and documentation. General arrangement and schematic drawings, equipment schedule and spares holdings for each site</td>
</tr>
<tr>
<td>6.5.2</td>
<td>Manufacturers installation, operation and maintenance manuals for each item of equipment</td>
</tr>
<tr>
<td>6.5.2</td>
<td>Manuals provided by the equipment installer describing installation procedure, operation and maintenance of the system</td>
</tr>
</tbody>
</table>
ANNEXURE TS020/D – PLANNING DOCUMENTS

Refer to Clause 1.2.4. The following documents are a summary of documents that must be included in the PROJECT QUALITY PLAN. The requirements of this Specification and others included in the Contract must be reviewed to determine additional documentation requirements.

<table>
<thead>
<tr>
<th>Clause</th>
<th>Description of Document</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.10</td>
<td>Systems Engineering Management Plan</td>
</tr>
<tr>
<td>3.14</td>
<td>Project Management Plan</td>
</tr>
<tr>
<td>3.14</td>
<td>Verification and Validation Plan</td>
</tr>
</tbody>
</table>
ANNEXURES TS020/E TO TS020/K – (NOT USED)
### ANNEXURE TS020/L – RMS SMOF CABLE CHARACTERISTICS

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Units</th>
<th>Required Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core Diameter</td>
<td>µm</td>
<td>9</td>
</tr>
<tr>
<td>Cladding diameter</td>
<td>µm</td>
<td>125</td>
</tr>
<tr>
<td>Outside diameter - acrylate coated</td>
<td>mm</td>
<td>0.25</td>
</tr>
<tr>
<td>- tight buffered</td>
<td>mm</td>
<td>0.9</td>
</tr>
<tr>
<td>Overall diameter</td>
<td>mm</td>
<td>Tenderer to state</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Electrical</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Refractive index</td>
<td>1310 nm</td>
<td>1.487 min.</td>
</tr>
<tr>
<td>Numerical aperture</td>
<td>1310 nm</td>
<td>0.13</td>
</tr>
<tr>
<td>Bandwidth</td>
<td>1310 nm</td>
<td>Tenderer to state</td>
</tr>
<tr>
<td>- 1550 nm</td>
<td>MHz km</td>
<td>Tenderer to state</td>
</tr>
<tr>
<td>Chromatic dispersion</td>
<td>1310 nm</td>
<td>3.5 max.</td>
</tr>
<tr>
<td>- 1550 nm</td>
<td>ps/nm km</td>
<td>19 max.</td>
</tr>
<tr>
<td>Cut off wavelength</td>
<td>nm</td>
<td>1260 max.</td>
</tr>
<tr>
<td>Attenuation</td>
<td>1310 nm</td>
<td>0.4 max.</td>
</tr>
<tr>
<td>- 1550 nm</td>
<td>dB/km</td>
<td>0.3 max.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>General Construction</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Protection against termites and ants</td>
<td>Y/N</td>
<td>Yes, Tenderer to provide details and supporting evidence of effectiveness</td>
</tr>
<tr>
<td>Nylon Jacket</td>
<td>Y/N</td>
<td>Yes</td>
</tr>
<tr>
<td>Polyethylene Sheath</td>
<td>Y/N</td>
<td>Yes</td>
</tr>
<tr>
<td>GRP strength member</td>
<td>Y/N</td>
<td>Yes</td>
</tr>
<tr>
<td>Metallic strength member</td>
<td>Y/N</td>
<td>No</td>
</tr>
<tr>
<td>Gel filled (water proofing)</td>
<td>Y/N</td>
<td>Yes</td>
</tr>
<tr>
<td>Steel wire armour</td>
<td>Y/N</td>
<td>No</td>
</tr>
<tr>
<td>Corrugated tape (rodent resistant)</td>
<td>Y/N</td>
<td>Yes</td>
</tr>
<tr>
<td>Sacrificial sheath</td>
<td>Y/N</td>
<td>No</td>
</tr>
<tr>
<td>Loose tube</td>
<td>Y/N</td>
<td>Yes</td>
</tr>
<tr>
<td>Number of fibres</td>
<td></td>
<td>48 (unless otherwise specified)</td>
</tr>
<tr>
<td>Fibre marking scheme</td>
<td></td>
<td>Tenderer to provide details</td>
</tr>
<tr>
<td>Number of Copper twisted pairs</td>
<td></td>
<td>As specified in the Contract</td>
</tr>
<tr>
<td>Number of Copper quad cables</td>
<td></td>
<td>As specified in the Contract</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mechanical</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass</td>
<td>kg/km</td>
<td>Tenderer to state</td>
</tr>
<tr>
<td>Minimum bending radius - no load</td>
<td>mm</td>
<td>300 max.</td>
</tr>
<tr>
<td>- full load</td>
<td>mm</td>
<td>400 max.</td>
</tr>
<tr>
<td>Maximum tensile load – installation</td>
<td>kN</td>
<td>2 min.</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>ºC</td>
<td>-20 to 70</td>
</tr>
<tr>
<td>Crush resistance - short term</td>
<td>kN/1000mm</td>
<td>2 min.</td>
</tr>
<tr>
<td>- long term</td>
<td>kN/100mm</td>
<td>1 min.</td>
</tr>
</tbody>
</table>

RMS Required Characteristics for Single-Mode Optical Fibre Cables
ANNEXURE TS020/M – REFERENCED DOCUMENTS

Refer to Clause 1.2.6.

RMS Specifications

RMS Q  Quality Management System
RMS G10  Traffic Management
RMS G22  Work Health and Safety (Construction Work)
RMS R155  Design and Construction of Underground Cableways
RMS TSI-SP-012  General Requirements for Roadside Equipment Housing
RMS TSI-SP-016  General Requirements for Outdoor Electronic Equipment

Australian Standards

AS/NZS 1768  Lightning Protection
AS/NZS 2772  Radiofrequency fields - Principles and methods of measurement and computation - 3 kHz to 300 GHz
AS/NZS 3000  Electrical Installations (known as the Australian/New Zealand writing rules)
AS 60529  Degrees of protection provided by enclosures (IP Code)
AS/NZS 61000.6.1  Electromagnetic Compatibility (EMC) – Generic standards – Immunity for residential, commercial and light industrial environments
AS/NZS 61000.6.3  Electromagnetic Compatibility (EMC) – Generic standards – Emission standard for residential, commercial and light industrial environments
AS/CA S009  Installation Requirements for Customer Cabling (Wiring Rules)