Technical Specification

Transport and Main Roads Specification MRTS201 General Equipment Requirements

July 2025

Queensland Government

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1 Introduction

This Technical Specification defines the general design, supply, installation, testing and commissioning, performance, documentation, training and maintenance requirements for Intelligent Transport System (ITS) and associated electrical equipment and their use.

This Technical Specification shall be read in conjunction with MRTS01 *Introduction to Technical Specifications*, MRTS50 *Specific Quality System Requirements* and other Technical Specifications as appropriate.

This Technical Specification forms part of the Transport and Main Roads Specifications Manual.

2 Definition of terms

The standard definitions listed in Table 2 shall apply to all Technical Specifications.

Further relevant definitions are contained in particular Technical Specifications.

In Technical Specifications, any reference to a temperature shall read as a reference to a temperature measured by a shaded, wet-bulb thermometer in degrees Celsius.

Table 2 – Definition of terms

Term	Definition
ACIF	Australian Communications Industry Forum
ACMA	Australian Communications and Media Authority
Administrator	As defined in the Contract
CAT	Customer (field) Acceptance Test(s)
Contractor	As defined in the Contract
COTS	Products are regarded as Commercial Off The Shelf (COTS) when there are multiple manufacturers and/or Suppliers providing similar products of identical functionality
CT	Commissioning Tests
Design Life	Design Life is the expected time that a piece of Hardware, Software or a System should remain operational from the date of commission
DOD	Depth Of Discharge. A measure of how much energy has been withdrawn from a battery, usually expressed as a percentage of full capacity
ELV	Extra Low Voltage as defined in AS/NZS 3000
EMC	Electro-Magnetic Compatibility
Equipment	All materials, equipment, software and/or systems provided by the Contractor
ERSD	External Removable Storage Device, such as USB flash drives, External Hard drives (HDD), Solid-State Drives (SSD), Memory Cards (e.g. SD Cards) and so on.
Facility	As defined in the Contract
FAT	Factory Acceptance Test(s)
Field Processor	An industrial computer that complies with the requirements of MRTS232 *Provision of Field Processors*

Term	Definition
Fit for Purpose	Product or service shall perform the service or function for which was specified in the Contract. That service or function should be inclusive of those specified by the manufacturer.
HDLC	High-Level Data Link Control
I/O	Input(s) / Output(s)
IAT	Installation Acceptance Test(s)
ICT	Information and Communications Technology
IPxx	Ingress Protection (IP) rating to degree 'xx' as defined by AS 60529
ITS	Intelligent Transport System(s)
LV	Low Voltage as defined in AS/NZS 3000
MEN	Multiple Earthed Neutral
MRTS	Transport and Main Roads Technical Specification(s)
MTBF	Mean Time Between Failures
OSI	Open System Interconnection, the 7 layer OSI model for mapping and categorising protocols representing network functions
OWASP	Open Web Application Security Project
Principal	As defined in the Contract
Principal's TMC	As defined in the Contract
PSTN	Public Switched Telephone Network
RPEQ	Registered Professional Engineer of Queensland
SAT	STREAMS Acceptance Test(s)
SIL	Safety Integrated Level as defined in AS 61508.0
STREAMS	The Principal's traffic management system primary user interface to ITS field devices
Supplier	Product vendor or manufacturer
Telecommunications Field Cabinet	An enclosure that complies with MRTS226 *Telecommunications Field Cabinets*
Technical Specification	Transport and Main Roads Technical Specification(s)
TMC	Traffic Management Centre

3 Referenced documents

Additional requirements for equipment provided under this Technical Specification are described in the referenced documents listed in Table 3.

Table 3 – Referenced documents

Reference	Title
AS 1319	*Safety signs for the occupational environment*
AS 1627.0	*Metal finishing – Preparation and pre-treatment of surfaces, Part 0: Method selection guide*
AS 1657	*Fixed platforms, walkways, stairways and ladders – Design, construction*

Reference	Title
	and installation
AS 2578	*Traffic signal controllers* (Withdrawn)
AS 2700	*Colour standards for general purposes*
AS 2853	*Enclosures – Temperature-controlled – Performance testing and grading* (Withdrawn)
AS 3990	*Mechanical equipment – Steelwork*
AS 4070	*Recommended practices for protection of low-voltage electrical installations and equipment in MEN systems from transient overvoltages*
AS 4100	*Steel structures*
AS 4506	*Metal finishing – Thermoset powder coatings*
AS 60068.2.2	*Environmental testing, Part 2.2: Tests – Tests B: Dry heat*
AS 60068.2.78	*Environmental testing – Part 2.78: Tests – Test Cab: Damp heat, steady state*
AS 60529	*Degrees of protection provided by enclosures (IP Code)*
AS 61508.0	*Functional safety for electrical/electronic/programmable electronic safety–related systems - Functional safety and AS 61508*
AS/CA S008	*Requirements for customer cabling products*
AS/CA S009	*Installation requirements for customer cabling (Wiring rules)*
AS IEC 62619	*Secondary cells and batteries containing alkaline or non-acid electrolytes – Safety requirements for secondary lithium cells and batteries, for use in industrial applications*
AS/NZS 1158.3.1	*Lighting for roads and public spaces – Part 3.1: Pedestrian area (Category P) lighting - Performance and design requirements*
AS/NZS 1170.1	*Structural design actions – Permanent, imposed and other actions*
AS/NZS 1170.2	*Structural design actions – Wind actions*
AS/NZS 1664	*Aluminium Structures*
AS/NZS 1768	*Lightning protection*
AS/NZS ISO IEC 27001	*Information security, cybersecurity and privacy protection – Information security management systems - Requirements*
AS/NZS 3000	*Electrical Installation (known as the Australian / New Zealand Wiring Rules*
AS/NZS 3010	*Electrical installations – Generating sets*
AS/NZS 3012	*Electrical installations – Construction and demolition sites*
AS/NZS 3015	*Electrical installations – Extra-low voltage d.c. power supplies and service earthing within public telecommunications networks*
AS/NZS 3017	*Electrical installations – Verification guidelines*
AS/NZS 3085.1	*Telecommunications installations – Administration of communications cabling systems, Part 1: Basic requirements*
AS/NZS 3100	*Approval and test specification – General requirements for electrical equipment*
AS/NZS 3760	*In-service safety inspection and testing of electrical equipment and RCDs*
AS/NZS 3845	*Road safety barrier systems and devices*

Reference	Title
AS/NZS 4417	*Regulatory compliance mark for electrical and electronic equipment*
AS/NZS 4509.1	*Stand-alone power systems, Part 1: Safety and installation*
AS/NZS 4509.2	*Stand-alone power systems, Part 2: System design*
AS/NZS 5139	*Electrical installations – Safety of battery systems for use with power conversion equipment*
AS/NZS 60227.5	*Polyvinyl chloride insulated cables of rated voltages up to and including 450/750V, Part 5 – Flexible cables (cords)*
AS/NZS 61558.2.6	*Safety of transformers, reactors, power supply units and similar Part 2.6: Particular requirements for safety isolating transformers for general use*
Electrical Legislation	*Electrical Safety Act 2002, Electricity Act 1994*, and all associated Regulations and Codes of Practice
IEC 60068.1	*Environmental testing. Part 1: General and guidance*
IEC 60884	*Plugs and socket outlets for household and similar purposes*
IEC TR 62443	*Industrial communication networks – Network and system security*
MASVS	*Mobile Application Security Verification Standard – developed by the Open Web Application Security Project (OWASP)*
MRTS01	*Introduction to Technical Specifications*
MRTS50	*Specific Quality System Requirements*
MRTS61	*Gantries and Support Structures for Road Signs, Tolling Systems and ITS Devices*
MRTS78	*Fabrication of Structural Steelwork*
MRTS91	*Conduits and Pits*
MRTS93*	*Traffic Signals*
MRTS94*	*Road Lighting*
MRTS97	*Mounting Structures for Roadside Equipment*
MRTS201	*General Equipment Requirements*
MRTS202*	*Variable Message Signs*
MRTS203*	*Provision of Weigh-in-Motion System*
MRTS204*	*Vehicle Detectors*
MRTS206*	*Provision of Variable Speed Limit and Lane Control Signs*
MRTS210*	*Provision of Mains Power*
MRTS213*	*UPS for Roadside Devices*
MRTS218*	*Vehicle Activated Signs (VAS)*
MRTS221*	*Help Phones*
MRTS222*	*Electronic School Zone Signs*
MRTS225*	*Imaging*
MRTS226*	*Telecommunications Field Cabinets*
MRTS227*	*Changeable Message Signs*
MRTS228*	*Electrical Switchboards*
MRTS229*	*Electronic Traffic Control Signs*

Reference	Title
MRTS231*	*Road Weather Monitor (RWM) Systems*
MRTS232*	*Provision of Field Processors*
MRTS233*	*Roadway Flood Monitoring Systems*
MRTS234*	*Communications Cables*
MRTS245*	*ITS Telecommunications Network (ITS TN)*
MRTS250*	*Provision of Automatic Number Plate Recognition System*
MRTS251*	*Motor Vehicle Traffic Counter / Classifier*
MRTS255*	*Traffic Signal Controllers*
MRTS256*	*Power Cables*
MRTS257*	*Feeder Cable and Loop Cable for Vehicle Detector*
MRTS259*	*Transportable Generator*
MRTS260*	*Temporary Variable Speed Limit Signs*
MRTS262*	*Temporary Variable Message Signs*
MRTS263*	*Standalone Solar (PV) Power Systems*
Queensland MUTCD	*Manual of Uniform Traffic Control Devices* (Queensland MUTCD)
SD1423	*Traffic Signals – Traffic Signal Controller Base Installation Details*
SD1679	*ITS – Telecommunications Field Cabinet Base Installation Details*
TRUM Vol.4 Part 3	*Traffic and Road Use Management Manual (TRUM) – Volume 4, Part 3: Electrical Design for Roadside Devices*
TRUM Vol.4 Part 8	*Traffic and Road Use Management Manual (TRUM) – Volume 4, Part 8: Electrical Verification Requirements for New or Altered Roadside Installations*
-	*Professional Engineers Act 2002*
-	*Queensland Electrical Safety Regulation 2025*

(*) Are equipment Technical Specifications that reference this Technical Specification.

4 Quality system requirements

4.1 Hold Points, Witness Points and Milestones

General requirements for Hold Points, Witness Points and Milestones are specified in Clause 5.2 of MRTS01 *Introduction to Technical Specifications*.

The Hold Points, Witness Points and Milestones applicable to this Technical Specification are summarised in Table 4.1 below. There are no Milestones defined.

Table 4.1 – Hold Points, Witness Points and Milestones

Clause	Hold Point	Witness Point	Milestone
9.1.1	1. Approval for alternative connection of ITS equipment to STREAMS or other systems		
10.1	2. Approval of electrical design		

Clause	Hold Point	Witness Point	Milestone
13.9.4	3. Factory acceptance testing of the enclosure and the cooling system prototype		
15.1		1. Inspection of equipment prior to installations	
15.6	4. On Site verification of final ITS device locations		
15.7	5. Installation of vehicle barriers		
16.2	6. Provision of FAT plan; prior to commencement of testing 7. Provisions of SAT plan; prior to commencement of testing 8. Provision of IAT plan; prior to commencement of testing 9. Provision of CT plan; prior to commencement of testing 10. Provision of CAT plan; prior to commencement of testing		
16.3	11. Approval to deliver to Site	2. Administrator's attendance during FAT	
16.4	12. Approval to deliver to Site	3. Administrator's attendance during SAT	
16.5	13. Approval to commence CT		
16.6	14. Approval to commence CAT		
16.7	15. Handover of operations manuals		
18	16. Planning and Commencement of training		
18.2	17. Acceptance to proceed with final handover	4. Delivery of training	

4.2 Sample equipment

4.2.1 Samples for acceptance

A sample of each distinct make and model of equipment shall be submitted with the initial design documentation to the Administrator, unless:

i. the equipment complies with a current approval certificate issued by Transport and Main Roads' ITS and Electrical Technology unit, or

ii. otherwise specified.

Where components of the equipment may change (such as motherboards, processors, interfaces and/or adaptors, firmware, software), additional complete sample units shall be provided for each combination to be provided under the Contract.

Samples may be held by the Principal as the reference benchmark for the supply of similar equipment until Practical Completion.

The equipment shall be:

- Submitted in original packaging.
- Complete with all documentation available from the manufacturer, including:
  - user manuals
  - commissioning and configuration software, manuals and hardware
  - any ITS Equipment or Component which is not on the Principals Approved Equipment List shall be submitted with all test results and certificates of compliance with the relevant Australian or International Standard and/or Specifications as stipulated by the Principal, and
  - maintenance manuals.
- Complete with all software and hardware necessary for commissioning and configuration.

The documentation listed above shall be included in the operations and maintenance manuals as a minimum.

4.2.2 Samples for STREAMS Acceptance Testing (SAT)

Where a device and/or system is required to connect to STREAMS, the Contractor shall undertake STREAMS acceptance testing in accordance with the respective requirements and Clause 16.4.

In addition to the requirements above, the sample provided for STREAMS acceptance testing shall include all necessary software and firmware, with their versions clearly documented, to enable testing to proceed.

Where an item of equipment has already passed the SAT and has not since changed, the previous SAT results may be provided in lieu of an additional SAT sample.

This does not obviate compliance with Clause 4.2.1.

4.3 Multiple failures

Unless otherwise specified, where a particular item of equipment fails 3 times in a rolling 6 month period due to the same, a similar or a related fault commencing from Practical Completion, the Contractor shall replace that item of equipment with a new unit at its own expense within one month of being notified of the last failure.

Where more than 10% of similar items of equipment throughout the Facility exhibit the same or similar fault within any rolling 12-month period, the Contractor shall within one month of being notified of the last failure:

a) provide to the Principal, a written submission with evidence of Supplier testing explaining the cause of the fault(s), how it may be prevented from occurring in future and proposed remedial Works, and

b) undertake and complete the remedial Works at its expense.

The Contractor shall report the outcome(s) of the remedial Works, 12 months from the completion of the remedial work.

Where more than 20% of similar items of equipment throughout the Facility exhibit the same or similar fault within any rolling 12-month period, the Contractor shall within one month of being notified of the last failure:

a) provide to the Principal a written submission with evidence of independent testing explaining the cause of the fault(s) and demonstrating why all similar equipment should not be replaced, and

b) unless otherwise directed, replace at its expense all equipment deemed necessary by the Principal.

The Contractor shall report the outcome(s) of the remedial Works, 12 months from the completion of the remedial work.

The Contractor shall guarantee the repaired and/or replaced equipment for a period of 12 months or for the duration of warranty against defects, whichever is longer.

4.4 Warranty provisions

4.4.1 Scope of warranty

The Contractor shall warrant that all work performed, and all materials supplied by the Contractor as part of the Contract Work or Products will:

- comply in all respects with the requirements of the Contract
- to the extent that the quality of materials or standard of workmanship is not specified in the Contract, comply with the applicable industry standards, including (without limitation) the Building Code of Australia and any applicable Australian Standards, and
- be fit for the purposes for which they are required.

The Contractor shall warrant that it will use reasonable skill and care in performing all work associated with the Contract Work or products.

Unless otherwise specified, all products and associated components provided in accordance with the department's Technical Specifications listed in Table 3 shall be provided with warranty against defects. The warranty must cover expenses associated with:

- inspection and repair (or replacement) of the product
- transportation / removal of the product for repair / disposal, where required
- installation of the repaired (or replaced) product, and
- recommissioning of the entire system affected by the re-installed product.

The Contractor shall procure and deliver to the Principal a completed and executed warranty in the form of Form C7858 from the Supplier or manufacturer of the materials or goods.

> For large devices such as electronic road signage, an agreement may be established between the Principal and the Supplier regarding responsibilities and costs associated with removal, transportation, repair, and reinstallation.

4.4.2 Duration of warranty

The duration of warranty against defects for all products and associated components provided in accordance with the department's Technical Specifications listed in Table 3, except for those listed in Table 4.4.2, shall be a minimum 3 years, unless otherwise specified in the respective department's Technical Specification. The warranty period commences immediately following the Customer Acceptance Tests (CAT) which for this purpose is the same as the Date of Practical Completion.

The products listed in Table 4.4.2 shall be provided with a minimum 5 years warranty against defects.

Table 4.4.2 – Products requiring minimum 5 years warranty

Document ID	Product Name / Description
MRTS202	Variable Message Signs (VMS)
MRTS206	Variable Speed Limit and Lane Control Signs (VSL / LCS)
MRTS218	Vehicle Activated Signs (VAS)
MRTS222	Electronic School Zone Signs (eSZS)
MRTS226	Telecommunications Field Cabinets
MRTS227	Changeable Message Signs (CMS)
MRTS229	Electronic Traffic Control Signs (eTCS)
MRTS260	Temporary Variable Speed Limit Signs (TVSL)
MRTS262	Temporary Variable Message Signs (TVMS)

4.4.3 Commencement of the warranty

This warranty period commences immediately following the Customer Acceptance Tests (CAT).

4.4.4 Replacement or making good

The Contractor is obligated to replace or make good, to the reasonable satisfaction of the Principal, any of the Contract Work or Products which are found, within the Warranty Period, to:

- be of a lower standard or quality than referred to in Clause 4.4.1, or
- have deteriorated to such an extent that they are no longer fit for the purposes for which they were required.

The liability of the Contractor is reduced to the extent that deterioration is caused by:

- mishandling, damage before installation, or incorrect installation, in each case caused by others
- normal wear and tear
- incorrect operational procedures or maintenance, in each case not attributable to the Contractor, or
- any other cause beyond the control of the Contractor.

4.4.5 Costs

The Contractor promises to undertake, and meet the reasonable cost of, any work necessary to:

- carry out any part of the Works to enable the requirements of Clause 4.4.4 to be met, or

- restore or make good the Works after meeting those requirements.

Whichever the Principal requires.

4.4.6 Indemnity

The Contractor indemnifies the Principal against claims (including claims, actions and loss or damage) arising out of breach by the Contractor of Clauses 4.4.1 or 4.4.4.

4.4.7 Notice of defects

The Principal may notify the Contractor in writing if it considers there has been any breach of the warranty in Clause 4.4.1 or if the Principal requires the Contractor to replace or make good any of the Contract Work or Products under Clause 4.4.4.

4.4.8 Time to remedy

The Contractor must do everything to remedy any breach notified to it, or to carry out any replacement or making good required under Clause 4.4.7, within 14 days after receiving the Principal's notice.

4.4.9 Failure to remedy

If the Contractor fails to complete the work specified in the Principal's notice under Clause 4.4.7 within a period determined by the Principal to be reasonable in the circumstances, the Principal may give written notice to the Contractor that the Principal intends to have that work carried out by others. This notice must allow a reasonable period for the Contractor to respond.

If the Contractor fails to complete the work by the date specified by the Principal, or another date agreed by the parties, the Principal may have the work carried out by others, and the Contractor indemnifies the Principal for the reasonable costs and expenses of doing so.

4.4.10 Urgent action by Principal

The Principal may take any urgent action necessary to protect the Works, other property or people as a result of a breach of Clause 4.4.1.

The Contractor agrees that the Principal taking such action does not affect the warranty or any other obligation of the Contractor.

The Contractor indemnifies the Principal for the reasonable costs and expenses paid or payable in taking that action.

4.5 Product lifecycle

For all products defined by the department’s Technical Specifications listed in Table 3, except for those listed in Table 4.4.2, the Contractor shall provide a minimum 3 years full support beyond the date which the product vendor decides to stop marketing, selling, or producing the product.

For all products defined by the department’s Technical Specifications listed in Table 4.4.2, the Contractor shall provide a minimum 5 years full support beyond the date which the product vendor decides to stop marketing, selling, or producing the product.

The product vendor's decision to stop marketing, selling, or producing the product, the Contractor shall not impact on any warranty provisions outlined in Clause 4.4.

5 Statutory compliance

The electrical installation shall comply with the requirements of the *Electrical Safety Act 2002*.

The complete electrical design and implementation of the equipment shall be in accordance with the main objects of the *Professional Engineers Act 2002* which applies both within and outside Queensland.

Telecommunication equipment shall comply with the relevant regulatory requirements and standards of Australian Communications and Media Authority (ACMA).

All radio communications shall comply with the relevant regulatory requirements of ACMA.

All software shall be licensed on behalf of, and in the name of, the Principal.

Electromagnetic interference produced by the equipment shall not exceed the limits prescribed in AS/NZS 1044 and by the ACMA. Equipment shall be immune to electromagnetic interference from other sources.

The placement of Regulatory Compliance Marks (RCM) on equipment shall be in accordance with AS/NZS 4417.

6 Functional requirements

The functional requirements for each system and/or device are specified in the departments Technical Publications.

Each system and/or device shall be documented with Operational or Maintenance information as per Clause 17 of this Technical Specification, before installation.

7 Equipment

7.1 General

Equipment shall be suited to the functional requirements and Site requirements. Where multiple items of equipment are required throughout the Contract, the same make and model of that equipment shall be used in each instance.

7.2 Mounting arrangements

Where equipment is commercially available in a format compatible with the mounting arrangements provided within the intended housing enclosure, it shall be provided in that format.

7.3 Ancillary equipment

All cables, pigtails, connectors and the like necessary to connect to ITS Devices and/or Systems for normal operations, commissioning, maintenance activities and the like shall be provided by the Contractor and become the property of the Principal. The details of all cables, pigtails, connectors and their 'pin outs' and interconnections shall be documented in planning and verified upon installation.

The verified documentation shall be supplied to the Principal.

Similarly, all hardware, software and documentation necessary for normal operations, commissioning, maintenance activities and the like shall be provided by the Contractor and become the property of the Principal.

8 Operational requirements

8.1 Environmental conditions

The equipment shall be capable of continuous, normal operation in the conditions described below:

a) installed directly in sunlight

b) ambient air temperature range between - 5°C and 50°C

c) enclosure air temperature Refer Clause 13.9 and Appendix B Clause 5

d) ambient ground temperature not exceeding 40°C

e) a range of temperature and humidity prescribed in AS 2578 (Withdrawn)

f) maximum wind conditions likely to occur at the installation Site

g) Queensland coastal environment with salt deposit densities in the range of 2.0 to 3.0 g/m²

h) varied light intensity due to shadows

i) a humidity of up to 95% non-condensing

j) conditions, both permanent and temporary, that may be unique to the specified location, for example instances of thick smoke and electromagnetic interference, and

k) vibrations reasonably expected in the installed location

The equipment performance shall be unaffected by a humidity of 90% combined with an ambient air temperature of 40°C followed by a sudden drop in temperature of up to 10°C.

Equipment operation shall cause no adverse effect on the surrounding environment in which it is installed. Likewise, equipment shall not be affected by adverse environmental conditions expected at the intended installation location.

8.2 Performance and availability

Unless otherwise specified, equipment designed for measurement or data collection shall operate with at least 95% accuracy. For other types of equipment, performance shall meet the functional requirements specified in the relevant Technical Specification.

Equipment and/or systems, that do not have a designated Safety Integrity Level (SIL) under AS 61508, shall have an operational availability of at least 99% excluding downtime caused by to mains power outages or failures in the Principals' telecommunications network.

Failures shall be rectified in accordance with Clause 4.3 and Clause 19.

Equipment and/or systems that have a designated SIL rating shall have an operational availability that is consistent with its respective Safety Requirements Specification.

8.3 Failure modes

The equipment and/or associated system(s) shall:

- where specified, enter or display a default mode during power, operational and/or telecommunications failure
- automatically shut down in a safe manner upon power, operational and/or telecommunications failure, and
- automatically restart in a safe manner upon restoration of power supply, operation and/or telecommunications.

8.4 Security

8.4.1 Scope of products

The requirements outlined in this clause apply to all ITS device and/or system connected to the Principals' telecommunication network and that process, store, or transmit privacy-related data. These devices and systems shall be developed in accordance with IEC TR 62443: *Industrial communication networks – Network and system security management systems*.

8.4.2 Organisational information security management system (ISMS)

Suppliers are required to maintain an organisational Information Security Management System (ISMS) aligned to ISO 27001. This ISMS must include preventative, detective, and response controls, supported by an ongoing risk-based assurance programme across people, processes, and technology.

8.4.3 Security control objectives

Suppliers shall:

- Implement and validate a robust security development lifecycle.
- Provide control system products that meet the defined security level capabilities required by the Principal, based on applicable industry standards.
- Ensure components meet and can be demonstrated to meet the required security level capabilities where specified in the specific Technical Specification, and
- Provide ongoing lifecycle support for control systems and component products.

8.4.4 Standards-based approach

Suppliers shall adopt a standards-based approach to protect ITS assets, in alignment with IEC 62443. This includes:

- Applying security levels proportionally based on functional impact to protect Intelligent Transport Operational Technology assets, with safety and safe outcomes prioritised within Transport and Main Roads risk appetite.
- Implementing security controls in accordance with IEC 62443, where specified in specific Technical Specification.

8.5 Functional safety

The design, manufacture, testing, commissioning, certification and operation of all Devices and/or Systems shall comply with requirements described in AS 61508.0 for the respective Safety Integrity Level (SIL), specified and/or agreed by the Principal.

Unless otherwise specified in the Safety Requirements Specifications, all materials, equipment and work activities forming part of an ITS device and/or system shall meet the SIL for that device and/or system.

In accordance with Clause 7.1 above, all materials and/or equipment shall meet the highest SIL for similar Devices and/or Systems provided under this Contract.

The Contractor shall certify that the Device and/or the System satisfies the respective SIL rating.

The 'Proven Use' method of certification described in AS 61508.0 may only be used where the Contractor can provide comprehensive documentary evidence of all operating / fault / maintenance history of the same device and/or system to be provided under this Contract. Similar to the requirements of Clauses 4.2.1and 4.2.2, certification shall be provided for each variant of a device and/or system.

In interpreting AS 61508.0, 'should' shall be read as 'shall'. Where AS 61508.0 allows for relaxations / exemptions of the standard, such relaxations / exemptions are not permitted.

9 Control system

9.1 Communication interfaces

9.1.1 Communication with STREAMS

Each item of ITS equipment and/or associated system shall allow autonomous operation and local manual operation independent of STREAMS. All field equipment shall interface with STREAMS or other systems as specified in the relevant Technical Specification.

Where ITS equipment is to communicate with STREAMS, it shall be by direct ethernet or direct serial (RS232, RS422) connection to a co-located Field Processor (FP). Where this is not practical the Contractor may seek approval from the Principal to use one of the following alternative means (in the following order of preference): **Hold Point 1**

1. Remote Ethernet or serial (for example, using a serial / fibre media converter) connection to an FP located elsewhere on the Principal's Telecommunications Network.
2. Digital I/O connection to a collocated FP.
3. Direct connection to a STREAMS Node via Principal's telecommunications network.
4. Connection to a STREAMS Node via a third-party telecommunication network (for example PSTN, PAPL, GSM, 4G, 5G and/or satellite).

Where specified in the Contract an alternate telecommunications channel independent of the Principal's telecommunications infrastructure shall be provided.

Most ITS devices are typically connected to the Transport and Main Roads traffic management system STREAMS. However, some, such as Bluetooth and other data collection devices, are not. These are broadly defined in the subsection below.

9.1.2 Communications with Other Control Systems

For ITS equipment not connected to STREAMS, the equipment shall interface with a control system defined in the project-specific contract. The Contractor shall ensure that the equipment complies with the communication protocols, integration requirements, and functional specifications of the designated control system. Any deviations from the specified control system or its requirements shall require prior approval from the Principal.

9.2 Physical interfaces (OSI layer 1)

Unless otherwise specified, input and outputs shall be electrically isolated from the controlling device. Physical interfaces shall utilise industry-standard connections.

Physical interconnections shall be captive, (in the following order of preference):

- automatic 'click' type (such as RJ-45)
- manual 'click' type (such as retention clips), and
- screw-type.

9.3 Communications cabling

Communications cabling shall comply with the relevant parts of AS/NZS 3080, AS/CA S008, AS/CA S009 and MRTS234 *Communications Cables* as applicable.

9.4 Digital I/O signals

Unless otherwise specified, digital inputs / outputs shall be volt-free 'clean' contacts. Contacts shall be chosen to be 'Normally Open' or 'Normally Closed' such that systems fail to a safe, predetermined default state.

Digital signals connected to Field Processors shall be in accordance with MRTS232 *Provision of Field Processors*.

Where digital I/O is provided between ITS Devices and/or Systems, and a Field Processor is co-located with such an ITS device and/or system, the digital I/O signals shall also be connected to the Field Processor.

The Field Processor (FP) shall be provided with at least 6 digital inputs. The FP shall have a minimum of 2 spare digital inputs and 2 spare digital outputs. The spare digital inputs and outputs shall be in addition to the digital inputs and outputs required for the design.

9.5 Field processor device driver

The Contractor shall develop a 'Field Processor Device Driver' to allow connection of the respective ITS Device to the Field Processor. The Field Processor Device Driver shall enable full-duplex communications for all control and status interrogation commands relevant to the ITS Device, as described in the respective Technical Specification documents and the design documentation.

The Field Processor Device Driver shall utilise a serial protocol (in accordance with Clause 9.6) and/or digital I/O as appropriate to the relevant ITS Device.

9.6 Serial protocols between the ITS device and the field processor (OSI layer 2)

Wherever possible, serial protocols shall utilise widely recognised industry-standards.

The serial protocols shall incorporate inherent error-detection against one and 2 bit errors.

Cyclic Redundancy Check (CRC) error checking shall be incorporated and/or used wherever possible.

ITS Devices with built in EIA/ RS-422 interfaces are preferred. Unless otherwise specified, field devices shall use either EIA/ RS-422 or 4 wire EIA/ RS-232 communication channels.

Where communications channel distances are greater than 3 metres, EIA/ RS-422 shall be used. Consequently, if the ITS Device supports only EIA/ RS-232, a RS-232 to RS-422 converter shall be provided.

ITS Devices that support only half-duplex services (such as 2 wire EIA/ RS-485) shall not be used.

In the case of a RS 422 serial connection, control signals of RTS and CTS, should be used.

In the case of a RS 232 serial connection, control signals of RTS, DTR, DSR, CTS, RLSD should be used.

The serial data stream may be either 7 or 8 bit asynchronous, with any combination of parity and stop bits. The chosen data stream shall be clearly identified in the design documentation.

A data stream with 8 data bits, no parity bit and one stop bit is preferred.

The data stream shall be broken into framed, error checked messages.

The framing protocol shall have the following characteristics:

- the frame shall be clearly recognisable within the data stream
- the error checking shall be robust. CCITT CRC16 is preferred over XOR or other simple check sums, and
- framing characters shall be 'escaped' so that they are clearly identifiable within the frame.

The preferred escape scheme has the frame characters never appearing in the data stream, other than at the frame boundaries:

- all messages shall have a response to determine communication success or failure, and
- the message set shall contain status messages to indicate the operational state of the ITS Device, device components and/or ITS System.

An example protocol (assuming an addressable ITS Device) follows:

Control characters: ASCII

Escape character: DLE (0x10)

Escaped value (for example: V) sent as: (DLE, DLE + V).

Start of transmission:	SOH (0x01)
Source Address:	n bytes (usually n is 2)
Destination Address:	n bytes (usually n is 2)
Start of Text:	STX (0x02)
Command 1:	n bytes (usually n is 1)
Data 1:	0...n bytes
Optional Start of Text:	STX (0x02)
Optional Command 2:	n bytes (usually n is 1)
Optional Data 2:	0...n bytes
Error checking scheme:	CCITT CRC16
End of Transmission	ETX (0x03)

Acknowledgment (ACK) and Failure (NAK) shall be application level messages encapsulated in a full frame. End of Frame character is not included in the CRC.

9.7 Messaging requirements

Wherever possible, ITS Devices that primarily provide data to STREAMS, for example vehicle detectors, shall provide event - driven messages to minimise / avoid polling between the device and Field Processor / STREAMS. Devices that require frequent polling shall communicate at a sufficient data rate for all the available data to be exchanged within a 2 second interval.

Event-driven messages shall contain a time stamp marking the time the event occurred.

Where communications from an ITS Device are mostly event-driven, a heartbeat (or status) message shall be emitted by the ITS Device at least every minute.

9.8 Transmission acknowledgement

Important message outputs (digital and serial) shall be acknowledged by the receiving device within a determined period. Failure to receive acknowledgement shall be recognised by the transmitting device and initiate an 'Output Communications Fail' alarm.

9.9 Local facility switch

Where specified, a local facility switch shall be provided at the nominated enclosure to allow local manual over-ride operation. The facility switch and associated key shall indicate the currently selected function in accordance with Clause 13.7.

Unless otherwise specified, intermediate messages shall not be displayed when changing the switch position.

Where an ITS device is connected to a Field Processor the selected position of the facility switch shall be provided to STREAMS in accordance with Clause 9.4.

9.10 Failure modes / resilience

Alarms shall be flagged. Alarm flags shall remain active through power failure / restoration, even where the condition that raised the alarm is reset. The flag shall be able to be cleared and acknowledged by the Principal's TMC operator and/or maintenance staff.

The device and/or system shall comply with the operational requirements for failure modes described in Clause 8.3.

Upon restoration of power, the control system, equipment and/or associated systems shall inhibit any new alarms until steady-state is achieved.

Where a device and/or system is controlled via a remote connection and the telecommunications link fails, it shall automatically re-establish communications as soon as possible.

9.11 Internal system clock

Where an internal system clock is specified for an ITS device, it shall automatically synchronise as specified by the Principal and maintain an accuracy better than ±1 second over a one week period.

Where an internal system clock for an ITS device is not synchronised, it shall maintain an accuracy of better than ±1 second per week and a maximum drift of ±5 seconds per month under normal operating conditions. The clock shall also exhibit long-term stability and be capable of retaining accurate time during power interruptions for a minimum of 150 hours using an internal backup power source.

9.12 Computers

9.12.1 Desktops and laptops

Unless otherwise specified, computers located in the Principal's TMC and laptop computers will be provided by the Principal.

The computers may use supported Microsoft Windows® operating systems, current at the time of use. Any software provided by the Contractor shall be capable of operating on all such operating systems. The Contractor accessing any part of the Principal's ICT facilities and devices shall comply with the relevant ICT information standards and policies.

9.12.2 Hand-helds

The Contractor shall provide all devices required for configuring the device and/or system in the field.

In addition, where specified, the Contractor shall provide each hand-held operator interface device necessary to interrogate and/or operate the ITS device and/or system.

All hand-held devices, including mobile devices, used for ITS device configuration shall adhere to stringent security standards to protect against unauthorised access, data breaches, and malicious activities. Additionally, all mobile applications used for configuration shall comply with the OWASP Mobile Application Security Verification Standard (MASVS) and address risks identified in the OWASP Mobile Top 10, ensuring secure authentication, data storage, and communication. The solution must provide robust encryption, secure APIs, and proactive threat detection to safeguard sensitive ITS operations. Runtime Application Self-Protection (RASP) is an acceptable method to enhance security by providing real-time monitoring, threat detection, and self-protection during application runtime.

10 Electrical requirements

10.1 General

Clarification of the requirements on RPEQ certification for designed systems and products.

All electrical Works shall comply with the Electricity Legislation as defined in Table 2, and the relevant parts of AS/NZS 3000, AS/NZS 3015, AS/NZS 3100 and AS/NZS 3760 as applicable.

Where the electrical installation is to be used on construction Sites, comply also with the relevant parts of AS/NZS 3012.

Detailed designs of the electrical systems and products shall be certified by the Contractor's RPEQ before being submitted to the Administrator for acceptance prior to construction. **Hold Point 2**

10.2 Mains power

Unless otherwise specified, mains power shall be provided at each ITS device Site. The supply shall be designed to meet the requirements of each individual field Site and as shown in the relevant design drawings. Mains power shall be provided in accordance with MRTS210 *Provision of Mains Power*.

Where a new installation draws supply from an existing departmental switchboard, the Contractor shall document both the existing and new equipment supplied from the existing switchboard to the full extent. The Contractor shall liaise with the department on the extent of the required updates to existing drawings prior to commencing the design.

The Contractor shall be responsible for updating the power consumption with the relevant energy supplier.

10.3 Protection against electrical transients and over-voltage

Where the Site is assessed to AS/NZS 1768 to be susceptible to lightning, incorporate measures to protect against electrical transients and over-voltage. Protection shall follow the recommended practices and general guidelines for the protection of persons and property from hazards arising from exposure to lightning in accordance with AS/NZS 1768 and AS 4070.

Surge protection devices shall be provided on each end of copper cables connecting equipment, both power and communications cables, where they enter a protected area.

For requirements and relevant standards refer to TRUM Vol 4 Part 3.

10.4 Switchboards, wiring and terminals

Unless otherwise specified, switchboards shall be provided a degree of protection of IP56 in accordance with AS 60529.

Switchboards (and their internal wiring and terminals) shall be provided in accordance with MRTS210 *Provision of Mains Power* and MRTS226 *Telecommunications Field Cabinets*. Terminals and cabling installed external to the switchboard enclosure shall be provided in accordance with MRTS256 *Power Cables*.

10.5 Uninterruptable Power Supply (UPS)

Uninterruptible power supplies shall comply with the requirements of MRTS213 *UPS for Roadside Devices*.

10.6 Alternate power sources

10.6.1 Solar power supply

Standalone solar power supplies shall comply with the requirements of MRTS263 *Standalone Solar (PV) Power Systems*.

10.6.2 Battery power supply

Unless otherwise noted, where batteries are specified to provide power at the ITS device Site as a backup to mains supply, the following shall apply.

10.6.2.1 Batteries

Batteries shall:

a) meet the relevant requirements of AS/NZS 5139, AS/NZS 4509.2 and AS IEC 62619

b) be 12V or 24V as specified for the application

c) be suitably rated for the application

d) be suitably matched to the battery charger

e) if lead acid type, be of AGM or Gel technology

f) if lithium type, be complete with a battery management system, to ensure battery requirements are complied with throughout the battery life cycle including low voltage disconnect, over voltage protection, short circuit protection, reverse polarity protection, internal cell balancing, cell thermal protection, and the like

g) be rated for minimum 3000 cycles to 50% DoD for lead acid and 80% DoD for lithium technology (C_{20}) at 20°C

h) have a round trip efficiency of > 80% for lead acid and > 90% for lithium

i) have self-discharge rate < 3% per month

j) be of standard size and capacity and easily field replaceable

k) operate the connected load at the Site continuously for:

   i. 16 hours without recharge for Sites within one hour's drive from the Principal's nearest maintenance facility, or

   ii. 72 hours without recharge for Sites greater than one hour's drive from the Principal's nearest maintenance facility.

l) be complete with isolation and overcurrent protection in accordance with AS/NZS 4509.2.

10.6.2.2 Mains battery charger

Mains battery chargers shall:

a) meet the relevant requirements of AS/NZS 4509.2

b) use a safety isolating transformer complying with AS/NZS 61558.2.6 to ensure the output does not exceed ELV

c) be suitable for continuous operation

d) have battery temperature compensation complete with temperature sensor if required for battery technology

e) be suitably matched to the battery. (Note that lead-acid chargers are not acceptable for lithium batteries; only chargers that have been designed for and are matched to the lithium battery are acceptable)

f) ensure the battery is charged efficiently in accordance with the manufacturer's requirements without being overcharged or damaged due to overheating, while simultaneously supplying the load

g) have reverse polarity protection

h) have high temperature protection

i) have protection against short-circuit and overload

j) have over voltage protection

k) have 1.5 m of appropriately sized cable to AS/NZS 60227.5 with standard plug to IEC 60884 for ac connection, and

l) have 1.5 m of appropriately sized dc cables one red and one black with crimped lugs for connection to the battery.

10.6.2.3 Battery monitoring system

The battery monitoring system shall:

a) be complete with protection to prevent the batteries from being over discharged – maximum 50% DoD for lead acid and 80% DoD for lithium technology, and

b) provide alarms for mains failure, 40% DoD for lead acid and 70% DoD for lithium technology, and battery shut down.

Where required under the Contract to send an alarm, provide a remote alarm indication that connects to the Principal's TMC via one or more of the following mechanisms:

a) an autodialled with voice recorded message

b) STREAMS, and/or

c) any other mechanism agreed upon by the Principal.

Where specific equipment specifications require monitoring / logging of data, integrate these battery alarms into that system.

10.6.2.4 Battery system installation

Battery system installation shall comply with the relevant parts of AS/NZS 4509.1 and AS/NZS 5139.

10.6.3 Generator power supply

Where a generator power supply is specified, the following shall apply:

a) the generators supplied for alternative power systems shall comply with MRTS259 *Transportable Generator*, and

b) the installation of generators supplied for alternative power systems shall comply with AS/NZS 3010.

11 Telecommunications requirements

11.1 Principal's telecommunications network

The components of the Principal's telecommunications network to be provided by the Contractor shall comply with MRTS245 *ITS Telecommunications Network (ITS TN)*.

The Principal Telecommunications Network shall provide:

a) a telecommunications port to each piece of field equipment as per the requirements specified in the respective MRTS documents

b) connectivity from all field equipment telecommunications ports (as stated in (a)) via the Layer 3 OSI Routing switch(es) to the Traffic Management Centre, including any redundant links required, and

c) all telecommunications between a) and b).

11.2 Public telecommunication services

Where necessary, the Contractor shall act as the Principal's agent in arranging for connection of a public telecommunications service to the Site in the name of the Principal. Within 14 days of a written request, the Principal will provide relevant details to enable the Contractor to complete the forms required by the public telecommunications service provider.

Temporary connections to a public telecommunications service shall be in the name of the Contractor.

Provision for telecommunications lines shall be provided in accordance with the requirements of AS/NZS 3085.1, AS/CA S008 and AS/CA S009.

11.3 Telecommunication cables

Telecommunication cables provided by the Contractor shall comply with the requirements of MRTS234 *Communications Cables*.

11.4 Data speeds

All ITS devices shall support communication at industry-standard bit rates appropriate to their function and application. For serial communication interfaces (e.g., RS232, RS485), devices shall operate at bit rates ranging from 9.6 kbps to 115.2 kbps, or higher if required. For modern Ethernet-based systems, devices shall support a minimum of 100 Mbps, with 1 Gbps or higher recommended for bandwidth-intensive applications. Wireless communication protocols, where applicable, shall comply with industry standards such as Bluetooth (1-2 Mbps), Wi-Fi (54 Mbps to 9.6 Gbps), or 5G (up to 10 Gbps). The selected bit rate must ensure reliable, low-latency data transfer and be compatible with the overall system architecture, while adhering to recognised industry standards for interoperability and performance.

11.5 Network Devices

Layer 2 and Layer 3 Network devices, such as switches and routers shall comply with the requirements of MRTS245 *ITS Telecommunications Network (ITS TN)*.

11.5.1 Network Termination Units (NTUs)

All ITS devices requiring connectivity to the telecommunications network via a telecommunications provider network, shall interface through a Network Termination Unit (NTU). The NTU shall provide a reliable and secure connection to the telecommunications provider's infrastructure and comply with all relevant industry standards and regulatory requirements.

12 Mechanical and physical requirements

The materials and methods of construction of the materials, equipment and enclosures shall be such that they have the strength and durability to withstand expected conditions of transportation, installation, and operation when installed in the intended environment. The equipment and enclosures shall be of suitable materials and design to protect against vandalism and prevent infestation by vermin.

All surfaces shall be free from sharp corners and projections that may catch clothing, body parts and/or otherwise cause injury.

Contact between dissimilar metals shall comply with the requirements of AS/NZS 1664. Suitable washers and fixings shall be used to prevent damage and corrosion to all surfaces and surface treatments applied to the enclosure.

Mounting structures provided by the Contractor shall comply with the requirements of MRTS97 *Mounting Structures for Roadside Equipment* and MRTS61 *Gantries and Support Structures for Road Signs, Tolling Systems and ITS Devices*.

13 Enclosures

13.1 General requirements

All enclosures provided under the Contract shall be designed and constructed to present a neat and consistent appearance.

Wind, traffic or other induced forces or vibrations shall not impair the performance of any enclosure or the equipment it houses.

Drain holes shall be provided in the bottom corners of all enclosures or any place where water could be dammed by framing members. Drain holes shall not compromise the 'IPxx' rating of any enclosure and shall prevent entry of vermin.

13.1.1 Dimensions

Unless otherwise specified:

a) enclosures shall allow the equipment to operate, and be maintained within the enclosure on Site

b) a clear buffer space of at least 80 mm shall be provided between all equipment and equipment mounting arrangements, and the enclosure walls and access cover(s) / door(s)

c) equipment within any enclosure shall not be greater than 1800 mm above the standing surface for maintenance personnel, and

d) equipment in ground mounted enclosures shall be a minimum of 200 mm above finished ground level.

13.1.2 Design loads

Design loads shall be in accordance with AS/NZS 1170.1 and AS/NZS 1170.2.

13.1.3 Lifting and transportation points

Where the fitted-out enclosure (including all operational equipment such as batteries) cannot be manually lifted and held by a single person (within workplace health and safety limits) during installation, lifting anchors shall be provided. Anchors shall be capable of supporting the fitted-out enclosure complete with all operational equipment such as batteries. The lifting anchor(s) shall be integral with the enclosure and prevent moisture ingress to the enclosure. Seals around the lifting anchor(s) are not permitted.

Where transportation anchor points are required, these shall be integral with the enclosure.

13.1.4 Enclosure access points

The design and layout of the enclosure shall enable full and safe access to the enclosure and permit extraction of any of the internal equipment and cables for installation, testing and/or maintenance purposes by a single technician, with due consideration of the mounting arrangement of the enclosure. Door(s) shall be provided on all metallic enclosures. Door(s) shall NOT be provided on non-metallic enclosures.

The access cover / door and fixings shall be of sufficient strength, stiffness and design to prevent unauthorised entry. Doors shall not exceed 900 mm in width but shall extend as far as practicable to the extremities of the enclosure. Folding doors are not permitted. Enclosures shall comply with the following:

1. cover fixings shall be captive with the cover when the cover is removed, and
2. an access cover / door that is accessible to the public shall be lockable, and flush with the enclosure in the closed position.

Door(s) shall be hinged in the vertical plane using concealed hinges. Hinges shall be of a design such that the hinge pins cannot be removed. Door(s) shall be of the same material and finish as the enclosure. Seals on outer-most doors shall close against the folded edge of a self-draining channel.

Doors shall also be able to be secured in the open position with a captive, non-sliding mechanism. Unless otherwise specified, door(s) shall be able to be secured open, at 110 degrees from its closed position.

Unless otherwise specified, enclosure access points shall be mounted at a height that allows easy access for maintenance personnel when standing on the ground and/or gantry adjacent to the enclosure.

Equipment shall be arranged so that cables shall not interfere with the doors.

The enclosure and door(s) shall be arranged and oriented to comply with Clause 15.4.

13.2 Door hinges and locks

Locking / unlocking of each door shall be effected by single key operation. The lock shall operate a 3 point latching mechanism with pins extending from the top, centre and bottom of the non-hinged side of the door. The door shall house a flush mounting handle incorporating a dust cover and capable of accepting a half Euro Profile locking cylinder (DIN 18252 / EN 1303) with restricted keying. The 3 point latching mechanism and handle shall be 316 Stainless steel.

2 keys shall be supplied with each enclosure, keyed to the department's requirements (only if using standard mechanical keys).

13.2.1 Installation of CyberLocks

Electronic Half Euro Profile CyberLocks are to be installed on cabinet doors where required by the department. Once installed each CyberLock is required to be labelled with the manufacturer's designated barcode / serial numbers supplied. These labels are to be located inside the enclosure door adjacent to the CyberLock with easy accessibility for barcode scanners. Serial identification numbers for both CyberLocks and enclosures shall be documented and supplied to the Principal upon delivery.

CyberLocks must be configured to be opened anticlockwise.

Cyberkeys are not to be supplied with the enclosure.

13.2.2 Programing CyberLocks

CyberLocks are to be programmed by Transport and Main Roads authorised representatives. If another entity separate to the department has possession of Site during construction, the department has the option to enable third-party access to the Site for the duration of the project. Upon project completion / handover, the locks will then be reprogramed to remove third-party access to the enclosures.

13.2.3 Cyberkeys

Cyberkeys can only be programmed by Transport and Main Roads. All keys will be assigned to individuals not corporations or organisations.

All keys used / acquired by any third-parties need to be registered / configured by the department before use.

13.3 Weather resistance

All doors and openings in the enclosure shall be provided with a durable and resilient weatherproof, neoprene seal. The seal gasket material shall maintain its elasticity and memory over the specified life of the enclosure in its operating environment. All equipment contained within the enclosure shall be protected from moisture, dust, dirt, and corrosion.

In normal operational service, the enclosure shall provide a degree of protection of not less than that required for the classification of IP55 in accordance with AS 60529.

Certificates of Testing prior to installation shall be provided as a part of the acceptance test documentation.

13.4 Surface finish of enclosure

The surface of the enclosure shall have a durable finish and comply with AS 4506, which shall be achieved by either:

- application of a surface treatment, or
- the use of appropriate material for the enclosure.

Where the enclosure material does not require an applied finish to achieve the durability requirements, the enclosure material shall be such as to allow an additional finish to be applied to the surface in the field without the need for special preparation.

Where an applied finish is provided, the enclosure shall be treated with the appropriate surface or primer preparation for the material of construction.

All fabrication, including welds, cuts, folds, drilling and the like shall be completed prior to such surface preparation.

The primer / undercoat shall be applied to the surface in accordance with the manufacturer's specifications. The paintwork shall be a ripple-free finish of minimum 60 micron thickness, excluding surface preparations or primers.

The paintwork shall be:

- powder coat type for installations that are difficult to reach for surface maintenance, for example, enclosures mounted on a gantry or pole, and
- wet paint type for all other areas.

Suitable washers shall be used to prevent damage to any surface treatments applied to the enclosure or mounting structure.

13.5 Cable management system

A cable management system shall be provided down the full height of both sides of the enclosure adjacent to each access door and/or opening. The cable management system shall be capable of housing a 50 mm diameter cable loom as a minimum. It shall be installed such that it does not interfere with any equipment or internal racking system. Additional horizontal cable management of a similar type to vertical cable management shall be provided as appropriate to house horizontal cable runs.

The horizontal and vertical, electrically insulated, cable management system shall be provided within the enclosure to enable cables to be installed, secured and augmented or replaced in a neat and easy manner without damaging or replacing cable fixings. The cable management system shall not be filled in excess of 50% capacity at completion of commissioning. Labels shall not be affixed to the cable management system. However, labels may be fixed to cable management system covers where such covers are permanently tethered to the cable management system.

Cables shall enter from the underside of the enclosure through proprietary cable glands. Conduits shall be accordingly arranged to allow direct cable entry. The gland plate shall be easy to manoeuvre with only one hand with all cables installed in glands. More than one gland plate may be provided per enclosure. Fixings shall be captive with either the gland plate or enclosure.

Where access is not easy to both sides of the gland from the usual working access point, cable glands shall be installed in a removable gland plate of 3 mm thick aluminium. A 120 mm minimum cable zone, clear of any obstacles, shall be provided within the enclosure beneath the gland plate.

Cables shall be prevented from contact with sharp edges, and/or all surface(s) that may cause damage to the cable. Power cables and communication cables shall not be routed through the same cable gland.

Where a system or component may need to be extended from the enclosure for maintenance or calibration, it shall be provided (installed) with enough spare cable to allow such extension. Adequate space shall be provided to ensure that any slack in cabling is safely and neatly stored / installed.

13.6 Telecommunications

Enclosures that incorporate conduits for entry of telecommunication cables shall comply with the requirements of the AS/CA S008 and AS/CA S009.

13.7 Local facility switch

Where provided, the facility switch shall be positioned to allow access without opening the enclosure, and without compromising the 'IPxx' rating of the enclosure. 2 keys shall be provided with each switch.

A label indicating the effect of each switch position shall be fixed adjacent the switch, such that the information aligns with the apex of the switch shaft for each available switch position. The information to be shown is as specified in the relevant Technical Specification.

13.8 Labels and signs

Identification alphanumeric characters shall be adhered to the upper-right, outside corner of the fixed side of field enclosures so they can be seen when approached from the normal direction of travel on the carriageway. Characters shall be as typically provided for traffic signal controller enclosures (cabinets).

All other labels shall be fixed by screws adjacent to but not on the respective equipment. Screws in areas accessible to the public shall be of vandal-resistant design. The label shall be located such that it cannot be mistaken as referring to another device.

Labels shall be laminated plastic or brushed aluminium, coloured as follows:

a) Warning notices: White letters on red background

b) Other labels: Black on white background.

Label lettering shall comply with the heights in Table 13.8. For other related labels refer to Standard Drawing 1673 *Traffic Signals / Road Lighting – Labels*.

Table 13.8 – Label lettering height

Label	Lettering height
Enclosure or Cabinet ID (visible from carriageway)	50 mm
Name of Enclosure (cabinet)	15 mm
Equipment labels	6 mm
Warning notices	4 mm

13.8.1 Low voltage danger sign

Where a LV power source is connected / terminated within the enclosure, a danger sign that complies with the relevant requirements of AS 1319 shall be fixed to:

a) the inside of the access door, and

b) on the cover over exposed live parts other than at ELV.

Where 2 sources of supply enter the enclosure, a single label stating "Caution: Two Sources of Supply" shall be affixed in accordance with Standard Drawing 1673. Each entry cable shall also be identifiable to indicate its respective source.

13.8.2 Optical fibre marking

Where an optical fibre cabling is connected / terminated within the enclosure, appropriate markings and labels shall be fixed to the enclosure in accordance with AS/CA S009.

13.9 Enclosure internal operating environment

13.9.1 General

The enclosure design shall maintain the ambient environment inside the enclosure to within the rated operating conditions of the equipment it houses, in all weather conditions and ambient temperatures likely to be experienced in the installed location. The layout of the equipment shall maximise the cooling capabilities of each item of equipment. Thermal tests shall be conducted in accordance with the requirements in Appendix B.

13.9.2 Air exchange cooling

Where air exchange cooling is used, the cooling system shall provide a positive pressure within the enclosure, and use a filtered, forced air system which complies with the following:

- fans and filters shall be easily accessed and replaced without disturbing other equipment
- filters shall be replaceable without opening the enclosure, but shall also be vandal resistant
- filters shall be of a type, to allow normal operation of equipment within the enclosure with annual filter replacement
- at least one filtered inlet vent shall be provided on opposite, fixed sides of the enclosure at a minimum of 300 mm above ground level
- at least one filtered outlet vent shall be provided on opposite, fixed sides of the enclosure at a maximum of 150 mm from the top of the enclosure, and
- fans shall be installed adjacent the inlet vents.

13.9.3 Equipment

Thermostats shall be of bi-metal sensor type with contact closures suitable for the electrical loads of the supplied cooling system. Each thermostat shall have a minimum set point range of 10°C to 30°C.

Filter material shall be classified EU4 in accordance with DIN 24185, and meet the following requirements:

- Filter Material Density: 350 g/m²
- Filtration efficiency: 88% @ 2 µm particles.

Inlet and outlet vents shall be sized to allow filters to have a minimum time between replacement of 12 months when operating in a roadside environment.

Fan motors shall be of a construction that exhibits minimal amount of electrical noise output and shall be EMC shielded to prevent interference with electronic component within the enclosure.

The fan motor and bearings shall be suitable for 100% operating duty in the intended operating environment. The fan motor and bearings shall have a MTBF of 45000 hours based on intended use, at a 90% running duty cycle.

Fans shall be of ball-bearing type.

13.9.4 Operation and performance

Each thermostat shall operate the connected cooling device(s) once the internal ambient temperature (measured 100 mm from the top of the enclosure) reaches the set point.

A prototype of the enclosure and cooling system to be provided under the Contract shall be subjected to Factory Acceptance Testing (FAT) to demonstrate compliance with the requirements of the Contract. **Hold Point 3**

13.10 Mounting surface and facilities

Ground mounted enclosures up to and including the size of a Telecommunications Field Cabinet, shall be suitable for mounting onto a plinth having 4 mounting studs arranged in accordance with a traffic signal controller.

Ground mounted enclosures with size in excess of such a Telecommunications Field Cabinet, shall be provided with a suitable, custom made plinth and fixing arrangement.

The mounting studs shall be located within the enclosure to provide protection from vandalism.

All ground mounted enclosures shall be mounted on a concrete plinth to a minimum of 75 mm above the surrounding concrete working area specified in Clause 15.9.

Conduit entries shall be via the bottom of the enclosure in accordance with Clause 13.5.

13.11 Metallic enclosure

Metallic enclosures shall comply with the requirements of this Clause 13.11.

13.11.1 Construction

The enclosure and internal structure framework shall be constructed from steel or marine grade aluminium sheeting. All steelwork and fixings (except aluminium and stainless steel) shall be hot dip galvanised. The internal framework shall be contained entirely within the external sheeting. All external seams shall have a continuous weld. The sheeting shall be stitch welded to the internal structural frame. Welded steel joints shall be cleaned and primed with zinc-rich primer.

All structural components fabricated from steel shall comply with the requirements of MRTS78 *Fabrication of Structural Steelwork*. Aluminium enclosures shall be designed to AS/NZS 1664. Other metallic enclosures shall be designed to AS 4100 for the limit state design, or AS 3990 for the working stress method. The design loads shall be in accordance with AS/NZS 1170.1 and AS/NZS 1170.2.

The alloy and temper of the aluminium shall be suitable for the application. Internal structural members shall be manufactured from the same material as the enclosure.

Contact between dissimilar metals shall comply with the requirements of AS/NZS 1664. Suitable washers and fixings shall be used to prevent damage and corrosion to all surfaces and surface treatments applied to the enclosure.

The enclosure may be of either single or twin wall construction.

13.11.2 Surface finish of enclosure

Where a finish is applied to a surface other than stainless steel or aluminium, it shall consist of a zinc-rich primer applied to clean surfaces. Where a finish is applied to aluminium, it shall be suitably treated as detailed in AS/NZS 1664 and AS 1627.0 with chromate conversion applied prior to the application of the finish.

Any deterioration to the surface finish due to atmospheric conditions and/or local environmental conditions shall not affect the structural integrity or visual appearance of the finished enclosure, for a minimum period of 20 years.

Colours shall be as defined in AS 2700:

- Exterior colour: Smoke Blue (T33), and
- Interior colour: Smoke Blue (T33).

13.11.3 Storage pocket

A metal pocket shall be provided on the inside lower half of each access door to provide space for the storage of small equipment and Site documentation. The pocket shall be at least 20 mm deep and sized to completely shroud unfolded, laminated A3 sized drawings with long edge in the horizontal plane.

The pocket shall include at least 4 equ-spaced finger slots from within the bottom of the pocket to 50 mm from its top to assist in the removal of contents. The pocket shall be self-draining.

13.12 Enclosure lighting

Each enclosure shall be provided with internal LED lighting suitable for performing maintenance activities within the enclosure without the need for additional lighting. Illumination shall be from above each access door of the enclosure and minimise direct spillage from within the enclosure.

Luminaires shall be:

- rated under 7 watts
- hard wired to the lighting sub-circuit, and
- automatically operated in conjunction with the respective access door(s).

Luminaires shall be mounted such that they do not interfere with equipment racking, cabling and maintenance activities.

Door switches shall be of weatherproof construction with a minimum rating of IP56. Each switch shall have 2 sets of contacts and a minimum MTBF of 10000 switching operations.

13.13 Telecommunications field cabinets

Where telecommunications field cabinets are specified, these enclosures shall also comply with the additional requirements of MRTS226 *Telecommunications Field Cabinets*.

14 Storage

The Contractor shall take all reasonable care to store equipment and materials in a safe, dry and secure location until required for installation. Equipment and materials shall not be stored directly on the ground.

15 Installation requirements

15.1 Pre-installation

The Contractor shall allow the Administrator access to inspect all equipment prior to installation. **Witness Point 1** The Contractor shall replace all damaged equipment and/or materials.

15.2 Equipment

Equipment and associated systems shall:

- be designed and installed to provide quick, easy and safe access for maintenance purposes, and
- minimise, and wherever practicable eliminate, the need for traffic control during maintenance activities.

Where the equipment and/or associated system has components located on opposite sides of the carriageway, any physical connection shall be immune to any future road widening envisaged in the Contract.

The crossroad connections shall be made in conduits either in the sub grade of the road or under the road.

15.3 Wiring enclosures

Each ITS device Site shall be provided with conduit infrastructure (including pits and ducts) necessary for the complete operation of the device. Conduit infrastructure includes cable access from the backbone conduit network to the ITS field Enclosure / Cabinet and/or field device. Cable infrastructure shall be installed in accordance with MRTS91 *Conduits and Pits*.

After installation of cables, the associated conduits and/or glands shall be sealed to prevent vermin entry.

15.4 Equipment enclosures

Ground mounted equipment enclosures shall be installed on a concrete plinth. The gap between the plinth and enclosure shall be vermin-proof and prevent corrosion of the enclosure or its fixings.

Enclosures shall be installed such that when all doors are fixed in the open position, visibility of the approaching traffic flow is maximised for maintenance personnel working in and around the enclosure.

For flood-prone locations, the equipment enclosure shall be installed above the identified flood risk level (e.g., Q20, Q50, Q100). The specific mounting height above the flood risk level shall be designed in accordance with relevant standards and guidelines.

15.5 Clearance height

Unless otherwise specified, where an ITS device is mounted above the carriageway, the vertical clearance from the bottom of the support structure and/or the device enclosure to the road surface shall be a minimum 6.1 m.

For tunnels, the ITS structure, including all support elements and device enclosures, shall be installed completely outside the kinematic zone or carriageway to ensure safe passage of vehicles and compliance with relevant standards.

15.6 Site selection

The general layout, positions, reduced level for the footing, speed zones for the ITS device and details of the barriers shall be shown on the Contractor's design documentation. The Contractor's proposed ITS device locations shall be verified by Site inspection. **Hold Point 4**

The final ITS device location, size and mounting type, and location and positioning of related protection barriers shall be shown on the design documentation. The final design documentation shall be submitted to the Administrator in accordance with the requirements of the Contract.

Mounting structures shall be in accordance with MRTS61 *Gantries and Support Structures for Road Signs, Tolling Systems and ITS Devices*.

Where devices are installed over trafficable areas such as a carriageway or bicycle / pedestrian pathway, the device shall be fitted with a secondary fixing system that will minimise the risk of the device failing and resulting in a hazardous situation.

15.7 Vehicle barriers

Where vehicle barriers associated with the ITS device are to be provided, these shall be installed prior to commencing civil Works for the device's mounting foundations. **Hold Point 5**

15.8 Site maintenance access

Where practicable, vehicular or non-vehicular access points shall be provided for maintenance access. The practicability of providing such access points shall be determined through a risk analysis and feasibility study conducted by the contractor and approved by the Principal. These assessments shall consider site-specific factors such as:

- Safety risks to maintenance personnel and road users
- Physical constraints of the site (e.g., terrain, structures, or environmental conditions)
- Cost implications and constructability
- Traffic flow and operational impacts, and
- Compliance with relevant standards and guidelines.

15.8.1 Vehicular access

Where deemed practicable, permanent vehicle access points shall be provided within 50 m of each ITS equipment Site to allow maintenance vehicles to enter and exit the equipment Site from the carriageway safely. Vehicular access points and associated vehicle setup areas described in this clause need not be provided along structures such as a bridge, tunnel or an overpass.

Access points shall:

- be arranged to prevent all vehicles from entering the Site in the usual approach direction of carriageway traffic
- be secured to prevent unauthorised vehicular access

- provide a minimum sight-distance of upstream carriageway equal to the safe-stopping distance of the carriageway's design speed
- allow maintenance vehicles to enter and exit the Site without protruding into trafficable carriageway lanes
- be arranged in a manner which avoids the need for traffic control during maintenance Works, and
- wherever practicable be co-located with help phone bays.

Where road-side barrier treatments exist or are required adjacent to the equipment Site, these shall be in accordance with Queensland MUTCD Part 3 and AS/NZS 3845.

Where the access point adjoins a carriageway with design speed >60 km/h, the access point shall allow the vehicle to pass through the access point parallel to the direction of carriageway traffic flow.

A suitable set-up area for the maintenance vehicle shall be provided close enough to the equipment for safe operation of maintenance activities and allow the vehicle to be parked within 10 m of the equipment.

The vehicle entrance / exit point, access track and set-up area shall be suitable for all-weather access for a maintenance vehicle pertinent to the maintenance activity.

15.8.1.1 Fibre Optic Joint Access

Access points for fibre optic joints shall be designed to facilitate maintenance activities by allowing a maintenance vehicle to park directly adjacent to the fibre optic joint. This is to enable the fibre optic joint to be brought into the vehicle for maintenance purposes.

Access points for fibre optic joint maintenance shall:

- Permit the fibre optic joint to be moved a minimum of 10 m from its location in the pit or enclosure into the maintenance vehicle.
- Provide sufficient space for the maintenance vehicle to park safely and securely adjacent to the fibre optic joint without obstructing trafficable carriageway lanes.
- Be arranged to avoid the need for traffic control during maintenance works, and
- Ensure all-weather access for the maintenance vehicle, including the entrance / exit point, access track, and set-up area.

Wherever practicable, these access points should be co-located with other vehicular access points described in Clause 15.8.1 to optimise maintenance efficiency and minimise disruption.

15.8.2 Non-vehicular access

Where it is not practicable to provide a vehicular access and set-up point, the following requirements apply for non-vehicular access to ITS equipment Sites.

Permanent personnel access points from the carriageway to the equipment Site shall be provided within 10 m of each item of ITS equipment. Access points shall:

- be arranged to prevent vehicles from entering the Site, and
- minimise the need for traffic control during maintenance Works.

Where road-side barrier treatments exist or are required adjacent to the equipment Site, these shall be in accordance with Queensland MUTCD Part 3 and AS/NZS 3845.

A parking area suitable for maintenance vehicles shall be provided on the shoulder / verge adjacent to the access point.

The parking area shall:

- allow personnel to alight safely from both sides of the vehicle concurrently and access the Site without entering trafficable carriageway lanes
- be located to minimise the unprotected exposure of maintenance personnel to traffic flows; and
- provide a minimum sight-distance of upstream carriageway (from within the vehicle) equal to the distance required to allow the vehicle to accelerate to 80% of the carriageway's design speed.

Where road-side barrier treatments exist or are required adjacent the equipment Site, these shall be designed in accordance with Queensland MUTCD Part 3 and AS/NZS 3845.

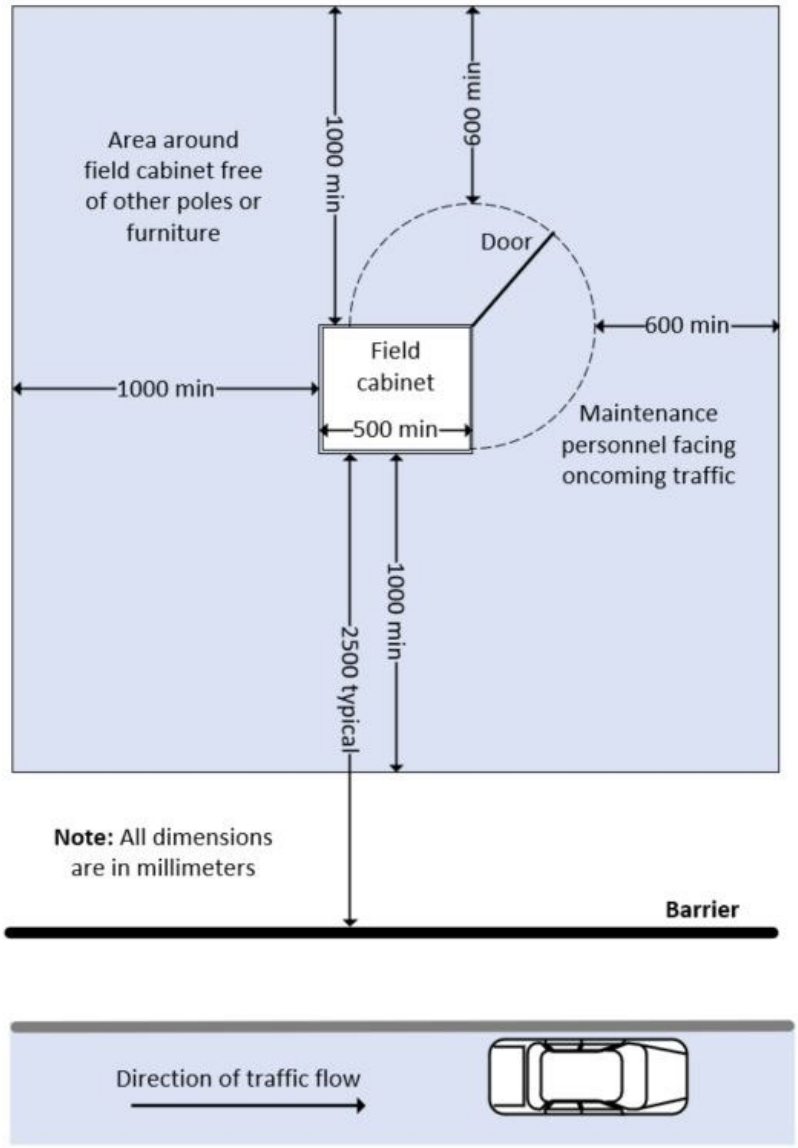
15.9 Maintenance area for equipment Sites

An access path shall be provided to each ITS equipment Site for the safe movement of maintenance personnel between a parked maintenance vehicle and the equipment. The access path and the area around the equipment Site shall be:

- evenly graded so as not to exceed 1:3 gradient. If this cannot be achieved, stairs shall be provided to AS 1657
- suitable for safe, all-weather access
- lit to category P4 of AS/NZS 1158
- resistant to damage from environmental effects such as erosion
- provided with a clearance area of minimum 600 mm width around open doors
- provided with a clearance area of minimum 1000 mm width around closed enclosures / cabinets, and
- arranged to provide sufficient space for inspection, maintenance, repair and rescue.

A visual representation of this clearance area is shown in Figure 15.9.

Figure 15.9 – Clearance area around field cabinets and switchboards



When determining clearance areas, distance shall be considered to physical objects, unsafe terrain and restricted zones. While maintenance activities are taking place on LV connected equipment, an exclusion zone is to be maintained that adheres to the requirements of the *Queensland Electrical Safety Regulation 2025*.

Concrete steps may be provided to optimise path alignment. Where steps and/or handrails are provided, these shall be in accordance with the relevant standards and codes.

A concrete slab shall be provided with dimensions given in SD1423 and SD1679.

The access path and the area around the equipment Site shall allow easy maintenance to remain free of trip hazards.

16 Testing and commissioning

16.1 General

The Contractor shall demonstrate compliance and operation of each ITS system, device and associated infrastructure with the requirements of the Contract by performing:

1. Factory Acceptance Tests (FAT)
2. Installation Acceptance Tests (IAT), which includes demonstration of
    a) Correct operation in the intended environment matching the FAT and SAT tests where applicable
    b) Electrical Safety Tests (EST)
3. Commissioning Tests (CT), and
4. Customer (field) Acceptance Tests (CAT).

In addition, where a device is to be interfaced to and/or operated by STREAMS, a STREAMS Acceptance Test (SAT) certificate shall be obtained from Transmax.

The SAT shall demonstrate hardware and software compatibility for all relevant STREAMS functions.

In addition to the general testing requirements, specific testing requirements for each device / system as detailed in the relevant Technical Specification shall be satisfied.

Where each device/system is successfully assessed to the relevant Technical Specification as part of a product-approval process, and the tests includes items of FAT and SAT, the contractor may exempt the approved device/system from further FAT and SAT.

The Contractor shall identify and provide all equipment, materials and other Works necessary to perform the tests. Any damage incurred as a result of undertaking tests shall be rectified by the Contractor.

Where the manufacturer of test equipment indicates that the test equipment can be calibrated, the test equipment shall be calibrated by a certified NATA laboratory. The certificate of calibration shall be current at the time(s) of the test(s). A copy of the relevant certificate(s) of calibration shall be included in the operations manuals (refer Clause 17.4).

The Electrical Safety Test (EST) shall record the results of all tests required by AS/NZS 3000 and TRUM Vol 4 Part 8. The Contractor shall provide a certificate of test in accordance with TRUM Vol 4 Part 8.

Where any part of an electrical installation achieves compliance by specific design and installation, the Contractor shall comply with the requirements of AS/NZS 3000 Clause 1.9.4.

16.2 Testing and commissioning plans

Prior to commencing each test listed in Clause 16.1, the Contractor shall supply a customised:

1. FAT plan **Hold Point 6**
2. SAT plan (where applicable) **Hold Point 7**
3. IAT plan (including Electrical Safety Test Plans) **Hold Point 8**
4. CT plan, and **Hold Point 9**
5. CAT plan. **Hold Point 10**

To the Administrator at least 28 days for review and acceptance prior to setting an agreed start date for each test.

If an electrical installation is designed in accordance with Clause 1.9.4 of AS/NZS 3000, the Contractor shall also submit test procedures to the superintendent at least 28 days for review and acceptance prior to setting an agreed date of testing on Site.

Each plan shall detail the customised tests, test sheets and procedures for each ITS device and associated infrastructure and the completed test documentation will be referred to as Certificates of Testing.

Each test shall be shown as a milestone on the Contractor's schedule of Works.

Test plans and record sheets shall be suitable for recording compliance with the respective technical requirements of the Contract.

The FAT plan and the IAT plan shall address as a minimum:

- enclosure IP Ratings
- enclosure structural and mechanical performance
- thermal / ventilation performance
- electrical tests
- enclosure surface finish tests
- equipment and/or system operation, and
- compliance with the respective functional and operational requirements.

Where equipment is provided during the maintenance phase, the test plans shall be amended accordingly.

Test plans shall include different traffic volumes and weather conditions where these may be reasonably expected to impact on the performance and/or accuracy of the device and/or system.

Certificates of Testing shall become a part of the acceptance test documentation.

16.3 Factory acceptance tests

Prior to delivery to Site, the Contractor shall demonstrate that the equipment meets the requirements of the respective FAT. **Witness Point 2**

The Contractor shall certify that the equipment meets the requirements of the respective FAT and include the following documents in the operations manuals prior to the delivery of the device to Site **Hold Point 11**:

- a statement confirming the warranty provisions associated with the tested device and associated equipment
- compliance details of all respective components as required or implied under this document, and
- FAT records conducted by the Contractor to demonstrate compliance to the requirements of the Contract.

16.4 STREAMS acceptance tests

Where a device is to be interfaced with STREAMS, the Contractor shall demonstrate that the equipment meets the requirements of the SAT to the satisfaction of TRANSMAX Pty Ltd. **Witness Point 3** As a minimum, the SAT shall address bench testing of the STREAMS Device Driver at TRANSMAX Pty Ltd's facility or any other location as agreed by the Principal.

Such devices shall not be delivered to Site until TRANSMAX Pty Ltd has provided a SAT Certificate for those Devices.

The Contractor shall certify that the equipment meets the requirements of the respective SAT and include the following documents in the operations manuals prior to the delivery of the device to Site **Hold Point 12**:

- a statement confirming the warranty provisions associated with the tested device and associated equipment
- compliance details of all respective components as required or implied under this document, and
- SAT records conducted by the Contractor to demonstrate compliance to the requirements of the Contract.

16.5 Installation acceptance tests

Once installed on Site, the Contractor shall demonstrate and certify that the equipment has been installed to allow correct operation. Generally, the equipment shall exhibit similar results in the intended operating environment as the results in the FAT, and where appropriate, the SAT.

The following documents shall be included in the operations manuals prior to commencement of the CT **Hold Point 13**:

- compliance details of all respective components as required or implied under this document, and
- additional STREAMS Device Driver test records conducted by the Contractor on Site to demonstrate compliance to the requirements of the Contract.

- Electrical test certification in accordance with the requirements of TRUM Vol 4 Part 8 and AS/NZS 3017, or in accordance with (AS/NZS 3000 Clause 1.9.4) – compliance by specific design and installation, where applicable.

16.6 Commissioning tests

The equipment shall be commissioned by integrating the operation, monitoring and control with other equipment and/or systems including STREAMS, as appropriate. This shall include initialising performance parameters to suit the site-specific function of operation. Commissioning shall prove the correct operation, monitoring and control as required to meet the requirements of the Contract.

The following documents shall be included in the operations manuals prior to commencement of the CAT **Hold Point 14**:

- compliance details of all respective components as required or implied under this document, and
- additional STREAMS Device Driver test records (as necessary) conducted by the Contractor on Site to demonstrate compliance to the requirements of the Contract.

16.7 Customer acceptance testing

Commissioned equipment and/or systems shall simulate continuous operation under normal operating conditions for a period of 15 consecutive days (hereafter referred to as CAT period).

Failure of the equipment and/or system to meet the requirements in the technical standards for more than 3 hours (accumulated) during the CAT period shall be cause for the CAT to be repeated for the full duration of the CAT period.

Once commenced, the CAT period need not be restarted provided that the failure is not caused as a result of the Contractor's Works in the following events:

- unavailability of the Principal-supplied equipment and/or systems including STREAMS, and/or
- failure (not attributable to the Contractor) of a telecommunication channel leased by the Contractor to transmit data.

The following documents shall be included in the operations manuals prior to handover **Hold Point 15**:

- a statement confirming the warranty provisions associated with the tested device and associated equipment; and
- compliance details of all respective components as required or implied under this document.

17 Documentation

17.1 ITS program

The Contractor's ITS program shall include:

a) detailed design drawings, design calculations, manufacturers specifications and schematic layout of components for review by the Administrator

b) applications for electricity supply

c) applications for telecommunications services

d) updates to operations manuals

e) updates to equipment or System descriptions

f) updates to maintenance and repair manuals

g) updates to program schedule

h) quality plans

i) testing and commissioning plans

j) FAT, IAT, CT, CAT and where applicable, SAT activities, and

k) equipment delivery.

The Contractor shall provide to the Administrator updates to the ITS program of Works on a fortnightly basis.

17.2 Calculations and design data

The Contract shall include in the final design documentation copies of all calculations, Safety Requirements Specifications as described in Clause 8.5, assumptions and design data relating to equipment provided in accordance with this Technical Specification.

All such information shall be certified by a RPEQ as meeting the requirements of the Contract.

The RPEQ shall only certify documents within their registered field of practice.

The Contract shall include in the final design documentation copies of documentation detailing the assessment and resulting design impacts of all devices and/or systems in accordance with AS 61508.0.

17.3 Design and manufacturing certifications

The Contractor shall include in the final design documentation (and include in the operations manuals) copies of relevant compliance certificates for equipment and materials, including:

a) radio frequency interference

b) electromagnetic compatibility

c) retro-reflectivity

d) paint thickness

e) Austel approvals, and

f) other relevant certifications.

The Contractor shall include in the final design documentation the following documents where relevant:

a) fabrication and assembly drawings, detailing all the components to be installed

b) manufacturer's specifications of the enclosure / cabinets and of all major components, detailing ratings and performance characteristics

c) a schematic layout of components, building details and interconnection diagrams

d) recommendations for routine maintenance tasks, and

e) recommendations on spare parts.

Prior to Practical Completion all documentation shall be updated to reflect any variations from the certified final design documentation. All updated manufacturer equipment manuals, maintenance manuals, procedures, design documentation, engineering drawings and system specific software and hardware configurations shall be supplied to the Administrator.

All engineering design drawings shall be certified by a RPEQ. The RPEQ shall only certify documents within their registered field of practice. Design drawings shall be arranged and presented to clearly allow such certification(s).

17.4 Operations manuals

Prior to Practical Completion, the Contractor shall provide the Administrator with copies of a comprehensive operations manual in electronic format. The manual shall be delivered on External Removable Storage Device (ERSD) devices or similar approved electronic media.

The electronic files must be organised in a clear and logical directory structure. To ensure compatibility and accessibility, file directory paths, including file names, must not exceed 255 characters in total length. The Contractor shall ensure that directory and file names are concise, descriptive, and free from unnecessary depth or complexity.

The ERSD shall be securely stored in appropriately labelled A4-sized storage pockets and included within the operations manual package. The Contractor must confirm with the Administrator that the format and structure of the electronic manual meet all specified requirements prior to submission.

17.4.1 Manual contents

The manuals shall consist of a dedicated section to cover each separate ITS application or equipment. Each physical volume of the manual shall be provided with a high-level Table of Contents that contains a comprehensive list of the ITS applications / equipment provided. The table of contents in each volume shall highlight the installation Sites for the ITS applications / equipment it contains. Each installation Site shall be further sub-divided with the following headings as appropriate:

1. Operating Procedures
2. Maintenance, Diagnostics and Troubleshooting
3. Repair Manuals for components or individual ITS Equipment, including circuit descriptions, Functional Block diagrams; Complete circuit diagrams to component level
4. Maintenance Manuals as detailed in Clause 19
5. Compliance Certificates
6. Recommended Spares
7. Calculations and Design Data
8. Test, Configuration and Commissioning Records
9. Drawings and System Schematics (including Functional System Block Diagrams)
10. Wiring and Termination Diagrams
11. Mains Power Details
12. Telecommunications Details
13. Training notes and Training presentations.

17.4.2 Electronic copies of manual

Unless otherwise specified, electronic copies of the following documentation shall also be provided in addition to Clause 17.4.1.

1. The Index and contents of the (ERSD) shall match that of the paper copy.
2. The electronic contents will be duplicated in 2 different copy formats.

The first copy shall be a PDF copy of the folder's Paper contents including separate PDF copies of the standalone Graphics (Drawings).

The Second copy shall be a duplicate of the first, but the file formats must remain in their original source formats such as file1.docx, file2.xlsx, file3.dwg including any associated original graphics files. PDF files must be provided as native PDF, exported directly from the source software and not scanned images.

3. The Narrative text of both versions shall be in a left justified size 12 (or larger) serif type font, similar to Times New Roman.

Information that specifically identifies each item, such as a serial number, firmware revision number or the like shall also be included in the manuals.

An example of the Table of Contents is included in Appendix A of this Technical Specification.

Where generic documents (such as the user manual for a specific ITS device) are relevant to more than one Site installation, only one copy need be provided in each copy of the operations manuals. Cross-reference(s) to the Site installation section in the operations manuals that contains the relevant documentation shall be provided in the other Site installation sections.

The Contractor shall update the Operator's Manual throughout the Contract as necessary to retain the manual's currency and accuracy.

IMPORTANT: The use of (ERSDs) for the transfer of Department of Transport and Main Roads information assets shall comply with the best practice requirements to ensure the confidentiality, integrity, and availability of information. The Contractor must adhere to all relevant security, access control, and compliance measures, and contact the Administrator for detailed guidance on these requirements.

17.5 Test, configuration and commissioning results

Copies of all test, configuration and commissioning results shall be provided in the respective section of the operations manuals.

Where results are hand written, the original copy shall be provided. Results recorded by hand shall be in blue ink.

17.6 Principal's maintenance manual

The Contractor shall update the Maintenance Manual throughout the Contract to retain the manual's currency and accuracy. Prior to final handover, the maintenance manual shall be provided to the Administrator.

This maintenance manual shall include content which is no lesser than that included in the maintenance manual implemented by the Contractor during the defects liability and/or maintenance phase(s) of the Contract.

17.7 Asset data

The Contractor shall provide asset data for all equipment installed as part of the Project. Such data must be structured and submitted in strict compliance with the asset data capture schema as prescribed by the Principal.

The Contractor is required to liaise with the Principal to obtain the necessary forms, templates, and associated guidelines. All fields within the forms must be completed accurately and in accordance with the instructions and specifications provided by the Principal.

Where the Contractor is required to utilise Building Information Modelling (BIM) for Intelligent Transport Systems (ITS), these shall be in accordance with the standards and guidelines provided by the Principal. In addition, the ITS asset model, which forms the basis of the asset data, must be structured and submitted in strict compliance with the asset data capture schema as prescribed by the Principal, to enable the Principal to manage the asset efficiently and effectively post-delivery.

18 Training

The Contractor shall develop a formal training plan to ensure that training is provided for each ITS Site location, item of equipment and/or system. The Contractor shall submit a copy of the training plan to the Administrator. The Contractor shall not commence training until 10 days after the date of approval of the training plan. **Hold Point 16**

The Contractor shall train 6 people (nominated by the Principal) as soon as practicable after successful commissioning of individual equipment and/or systems.

The Contractor shall only use Trainers who are qualified in Vocational and Workplace training under a recognised training framework, such as the Australian Qualification Training Framework (AQTF), or an equivalent framework that ensures high-quality training standards. The trainers must also be competent in the installed and commissioned systems and component parts.

The Trainers shall provide evidence consistent with the chosen framework to the Trainees and to the Principal that the training was completed, and trainees are assessed as competent to safely undertake that work. Records of those assessments and that evidence should be kept by the Trainer and the Contractor.

Additionally, in the absence of an existing framework specific to Intelligent Transport Systems (ITS) training, the Contractor shall ensure that a structured and comprehensive training framework is developed and implemented. This framework must align with industry best practices and ensure that the training delivered meets the required competency and safety standards.

18.1 Post-commissioning

The training shall provide attendees with instructions on:

a) operational capabilities and where appropriate Safety limits of each item of equipment

b) failure mechanisms and repercussions for each item of equipment; (for example, Points of Failure, Causes of Failure)

c) operational capabilities and where appropriate Safety limits of systems related to the equipment

d) failure mechanisms and repercussions of systems related to the equipment; (for example, Points of Failure, Causes of Failure), and

e) structure and relevant contents of the Operations, Repair and Maintenance manuals.

The relevant contents of the Operations, Repair and Maintenance manuals shall be provided to the trainees at least 7 days prior to the proposed training session.

18.2 Maintenance training

The Contractor shall offer the Principal (or Principal's nominees) the opportunity to accompany each maintenance activity during:

a) the defects liability period, and/or

b) the final 12 months of the maintenance period where such a period exists.

The Contractor shall provide comprehensive hands-on training / knowledge transfer during such activities **Witness Point 4** Involvement of the Principal in this manner will not in any way relieve the Contractor of the defects liability and/or maintenance responsibilities under this Contract.

In addition to the hands-on field training above, the Contractor shall develop a formal training plan to train 6 additional personnel for each Site location, item of equipment and system prior to hand-over. **Hold Point 17**

Training shall be sufficient to enable the Principal's attendees to:

a) diagnose faults and failures and undertake all necessary repair work

b) replace faulty modules / equipment, and

c) perform routine maintenance on the equipment and related systems.

19 Maintenance

19.1 General

The equipment and enclosures shall be designed to simplify installation and maintenance. All components shall be modular and able to be replaced or repaired within 15 minutes of maintenance staff arriving on-site.

19.2 Maintenance plan

The Contractor shall prepare an ITS maintenance plan that describes as a minimum:

a) how to respond to device and/or system failures

b) what resources shall be maintained

c) programmed maintenance including calibration or recalibration of sensors and instruments

d) call-out response times

e) maintenance personnel contacts, and

f) spares.

Where the Contractor performs maintenance during the defects liability and/or maintenance phase(s):

a) all work shall be performed in accordance with the maintenance manual and/or maintenance plan

b) Points of Failure, causes of failure and a complete replaced components list shall be recorded, and

c) the maintenance records shall be filed in the maintenance manual including Points of Failure, Causes of Failure.

Programmed maintenance shall reflect the manufacturer's recommendations; specific requirements described in the Technical Specification, and additionally, draw upon the Contractor's experience.

The programmed maintenance shall detail (as a minimum):

a) maintenance schedules

b) maintenance procedures, and

c) specific maintenance record sheets including Points of Failure and Causes of Failure.

The ITS maintenance plan shall comply with all requirements of the Contract for maintenance plans.

19.3 Spare components

The Contractor shall prepare a schedule of spare components for retention for service and/or fault maintenance purposes. Where the Contract includes a maintenance phase, the Contractor shall maintain a stock of such items during that phase. The Contractor shall guarantee that such spare components will be available for a minimum of 7 years after Practical Completion.

If any component is determined to be safety-critical through risk analysis or other assessments, the Contractor shall ensure that sufficient spares are provided to avoid unnecessary lead times that could compromise safety or operational continuity. The Contractor must liaise with the Administrator to confirm the classification of safety-critical components and the required stock levels.

19.4 Failure response maintenance

The Contractor shall classify equipment and/or system failures as either: critical, urgent or minor.

The failure and remedial action shall be documented with reference to the manufacturer's instructions and/or recommendations and included in the maintenance plan.

Symptoms of the fault, Points of failure, causes of failure and a complete list of replaced components shall be recorded.

Where a failure does not clearly align with the definitions below, and/or the device / system is different from those initially provided under the Contract, then the classification shall be negotiated between the Contractor and the Principal.

All hardware which has failed and been replaced within the contracted warranty period shall be made available to the Principal for examination prior to its return to the Supplier. The Contractor shall provide within one month a report on the reasons and conditions for the failure. The report shall also include any risks and/or maintenance issues that may impact on the overall Contract where similar components are used.

19.4.1 Critical failure

A critical failure is a failure that causes:

a) complete failure of a defined device and/or system, and/or

b) incorrect operation of a defined, safety critical device and/or system.

For example, failure of power supply, traffic sensor or Field Processor at a defined Site.

19.4.2 Urgent failure

An urgent failure is a failure that causes incorrect operation of the defined device and/or system.

For example, sensor drift outside acceptable performance limits.

19.4.3 Minor failure

A minor failure is a failure that causes occasional disruption to the correct operation of the defined device and/or system. For example, intermittent problems with telecommunications channels.

19.5 Maintenance records

19.5.1 Log books

The Contractor shall maintain log books that record:

a) engineering information related to any Site maintenance Works undertaken, and

b) performance documentation of the devices and systems.

The log books shall record technical interpretations of performance observations of the system and details of any performed programmed or non-programmed maintenance.

The log books shall be made available for viewing by the Administrator upon request.

19.5.2 Maintenance record sheets

The Contractor shall develop and utilise maintenance record sheets as part of the maintenance system for all equipment.

The sheets shall be completed by the same members of the Contractor's maintenance staff who actually performed the maintenance, so as to accurately record the specific Works completed.

Each maintenance record sheet shall be signed, dated and filed into the respective section of the Contractor's maintenance manuals on completion.

Symptoms of the fault, points of failure, causes of failure and a complete list of replaced components shall be recorded.

Those record sheets shall be passed to the Principal upon completion of the maintenance Contract.

20 Handover

Unless otherwise specified, as a condition of final handover from the Contractor to the Principal, all ITS infrastructure and devices shall successfully complete and pass the CAT as defined by the testing and commissioning plan. All additional tests directed by the Administrator or the Principal in accordance with the Contract (including those based on the operating and maintenance experience of the Facility) shall also be carried out by the Contractor.

20.1 Audit of operations manuals

As a condition precedent to final handover, the Contractor shall perform a complete audit and rectify accordingly, the accuracy / currency of the operations manuals, including:

a) data recorded during commissioning

b) as built drawings

c) purpose written software

d) electronic and hardcopy of all specific configuration settings of systems / devices

e) manufacturer's manuals (including maintenance manuals and procedures)

f) Electrical Verification Certificate

g) maintenance procedures developed by the Contractor, and

h) any other items requested by the Principal.

The Contractor shall make good any shortcomings in the Operations Manuals, including repairs, refurbishments or replacements performed by the Contractor during the Maintenance Period.

20.2 Training

As a condition precedent to final handover, the Contractor shall satisfy the training requirements specified elsewhere in this Technical Specification.

20.3 Principal's maintenance manual

As a condition precedent to final handover, the Contractor shall satisfy the requirements for maintenance and repair manuals for the Principal specified elsewhere in this Technical Specification.

Appendix A – Example Table of Contents for Operational Manuals

Operations Manual

Table of Contents

Volume 1	
CCTV	CCTV 1 – Mt Gravatt-Capalaba Road
	CCTV 2 – Gateway Bridge Southern Approach
	CCTV 3 – Gateway Bridge Southern approach
	CCTV 4 – Gateway Bridge Southern Approach
VMS	VMS 1 – Mt Gravatt-Capalaba Road
	VMS 2 – Gateway Bridge Southern Approach

CMS Vol 2

Operations Manual

Table of Contents

Volume 2	
CMS	CMS 1 – Mt Gravatt-Capalaba Road
	CMS 2 – Gateway Bridge Southern Approach
	CMS 3 – Gateway Bridge Southern approach

Appendix B – Provision for thermal testing of enclosures

B1 Introduction

This appendix contains procedures for evaluating the thermal performance of Intelligent Transport System (ITS) and Electrical enclosures for outdoor use in Queensland. It is based on a review of historical climatic conditions, the likely thermal performance range of various ITS and Electrical products and an analysis of existing thermal evaluation techniques.

B2 Definitions of terms and notations

Terms used in this Technical Specification are defined in Table B2 below.

Table B2 – Definitions

Term	Definition
Director (ITS Technologies)	The Director of the Intelligent Transport Systems Technologies Unit of Transport and Main Roads, Traffic Engineering Technology and Systems Section
Free Air	As specified in IEC 60068-1:1992, Clause 4.4
T_A	Average ambient temperature of the test chamber
T_I	Maximum internal temperature of the enclosure being tested
ΔT	Temperature difference ($T_I - T_A$)

B3 Reference documents

The requirements of the referenced documents listed in Table B3 below apply to this Technical Specification. Where there are inconsistencies between this Technical Specification and a referenced International and Australian Standard or a departmental Technical Specification then the requirements specified in this Technical Specification shall take precedence. Unless specified otherwise, the latest version of each document shall be applicable, including its amendments to date.

Table B3 – Referenced documents

Document ID	Document Name / Description
AS 2853	*Enclosures – Temperature-controlled – Performance testing and grading* (Withdrawn)
IEC 60068-1	*Environmental testing. Part 1: General and guidance*
AS 60068.2.2	*Environmental testing, Part 2.2: Tests – Tests B: Dry heat*
AS 60068.2.78	*Environmental testing – Part 2.78: Tests – Test Cab: Damp heat, steady state*
MRTS201	*General Equipment Requirements*
MRTS226	*Telecommunications Field Cabinets*

B4 Purpose of the test

The purpose of this Technical Specification is to ensure that ITS and Electrical enclosures used by Transport and Main Roads will be fit for the environmental conditions in which they will be deployed. The primary objective of testing is to determine whether the desired internal temperature of an enclosure is achieved and maintained across of range of ambient temperatures. Secondary objectives include:

- whether there is any damage or wear to any part of the enclosure, as a result of the test
- thermostat performance throughout the tests, and
- performance of the cooling system throughout the tests.

B5 Temperature range of ITS equipment

ITS and Electrical enclosures must maintain an internal temperature below the temperature operating range of equipment installed in the cabinet. Unless specified otherwise, the cabinet shall maintain an internal temperature (TI) below 50°C.

B6 Temperature control devices

The purpose of the temperature control devices is to maintain a desired internal temperature (T_I) by adjusting control parameters in accordance with variations in ambient temperature (T_A). The system generally comprises of electric fans and/or Peltier devices and thermostats but may also utilise passive design such as integral solar shields or double skin enclosure walls.

B7 Description of test parameters

B7.1 Temperature

Generally, the internal heat load of the cabinet combined with solar radiation will result in positive temperature difference. The temperature difference (ΔT) between the ambient (T_A) and the maximum internal enclosure temperature (T_I) should be maintained as specified in MRTS226 *Telecommunications Field Cabinets*. The relationship between these parameters can be expressed as:

$$\Delta T = T_I - T_A$$

The manufacturer shall nominate if the cabinet is rated for a standard or extended temperature range. Standard and extended cabinets will be tested to a maximum ambient temperature (T_A) of 38°C and 44°C respectively. Unless specified otherwise, the cabinet shall maintain an internal temperature below 50°C (T_I).

B8 Test procedure

B8.1 General

B8.1.1 Temperature Sensors

Temperature sensors shall have response times that are short in comparison to the thermal variations of the environment they measure.

The temperature sensors used in the test procedure shall be in accordance with Clause 5.2, Category 2, of AS 2853 (Withdrawn).

B8.1.2 Test Sites

A test Site is a location at which a temperature sensor is positioned for the purpose of temperature measurement. There are 2 types of test Sites, namely, Standard Sites and Supplementary Sites. The selection of these Sites for any type of enclosure shall be in accordance with Clause 5.3 of AS 2853 (Withdrawn). Unless specified otherwise, the calculation of the number of standard tests Sites (N) in accordance with AS 2853 (Withdrawn) shall utilise a cabinet grade (G) of 1 and 3 for standard and extended cabinets respectively.

B8.2 Default internal load of enclosure

ITS and Electrical enclosures are intended for housing equipment with varying heat emitting characteristics. The distribution of the heat load in an enclosure shall be as close as possible to the distribution of the load in the intended application. Unless otherwise specified, the default load of telecommunications field cabinets shall be 500 W, distributed as follows:

a) 250 W for the top section (the top third of the cabinet)

b) 125 W for the middle section (the middle third of the cabinet), and

c) 125 W for the bottom section (the bottom third of the cabinet).

The top, middle and bottom sections shall be evenly allocated for the entire height of the cabinet.

B8.3 Steady-state thermal performance testing

Steady State Thermal Performance Testing is used to confirm the cabinet will perform with maximum thermal loading. The general requirements and procedures for the test are as follows:

B8.3.1 General requirement

- Relative humidity shall be set to 80 ± 3% for standard enclosures, and 60 ± 3% for extended enclosures in accordance to AS 60068.2.78, and
- Ambient temperature simulation shall be in accordance with AS 6068.2.2 Test Bd.

B8.3.2 Procedure

The ambient temperature in the test chamber shall be maintained at the specified value ± 5% for at least 4 hours in accordance with Clause 7.2. The internal enclosure temperature (T_I) shall be stable for the final 2 hours of the test.

B8.4 Data acquisition

Before each test commences, the following checks shall be completed:

- The correct allocation of the heat load
- The activation of the temperature control system including the thermostat and fans, and
- The correct placement of the internal and external temperature sensors.

Data from each temperature sensor shall be captured at intervals of 30 seconds, for the duration of each of the tests.

B9 Documentation of test results

The presentation of the results shall specifically address the objectives of this Technical Specification as outlined in Clause 4, as well as providing the following:

- A record of all the temperature sensors and their time-stamped readings.
- The maximum internal temperature (T_I) at each 30s interval, as well as the identifier of the sensor producing the maximum temperature reading.
- The average internal temperature at each 30s interval.
- The average ambient temperature (T_A) at each 30s interval.
- The temperature difference between the cabinet and ambient temperature (ΔT) at each 30s interval.
- The difference between the maximum and minimum cabinet temperatures at each 30s interval.
- A plot of T_I, T_A and ΔT with time(s).
- The set-point of the thermostat used in testing.
- A diagrammatic layout which clearly shows the location of all the test sensors in the cabinet, test sources, cooling devices and air inlets.
- Details of the manufacturer and model of the test sensors and data logger.
- A clear, high resolution photo of:
  - the test enclosure both before and after the test
  - the location of all the test sensors in the cabinet, and
  - the testing equipment including; test chamber, radiation and conduction heat sources, and data loggers.

Test results shall be presented using an electronic Microsoft Excel Spreadsheet template provided by the Director (ITS Technologies). A double-sided A4 hard copy of the test report and an electronic copy of the report and the populated excel spreadsheet template shall be provided to the Director (ITS Technologies) upon completion of testing.