

Roads

Master Specification

RD-ITS-C1 Installation and Integration of ITS Equipment

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RD-ITS-C1 Installation and Integration of ITS Equipment

1 General

1.1 This Part specifies the requirements for the installation and integration of Equipment for Intelligent Transport Systems (ITS). It shall be read in conjunction with the following Parts, as applicable to this Contract:

- | | |
|--------------|---|
| a) RD-ITS-D1 | Design for Intelligent Transport System (ITS). |
| b) RD-ITS-D2 | TrafficNet Infrastructure Building ITS Design. |
| c) RD-ITS-S1 | General Requirements for the Supply of ITS Equipment. |
| d) RD-ITS-S2 | Electrical Switchboards. |
| e) RD-ITS-S3 | ITS Enclosures. |
| f) RD-ITS-S4 | Supply of Electronic Signs. |
| g) RD-ITS-S5 | Imaging Equipment. |
| h) RD-ITS-S6 | Supply of Field Processors. |
| i) RD-ITS-S7 | Supply and Installation of Vehicle Detector Systems. |
| j) RD-ITS-C2 | Mains Power for Traffic Management Equipment. |
| k) RD-ITS-C3 | Telecommunications Cabling. |

1.2 Unless specified otherwise, all installation shall comply with the most recent revisions (including published amendments) of the following standards and / or specifications:

- | | |
|--------------------|---|
| a) AS 1100 | Technical Drawing. |
| b) AS/NZS 1170.2 | Structural design actions - Wind actions. |
| c) AS 1428 | Design for Access and Mobility. |
| d) AS 1657 | Fixed platforms, walkways, stairways and ladders – Design, construction and installation. |
| e) AS 1742.2 | Manual of Uniform Traffic Control Devices – Traffic Control Devices for General Use. |
| f) AS 1742.15 | Manual of Uniform Traffic Control Devices – Direction Signs, Information Signs and Route Numbering. |
| g) AS 2312 | Guide to the Protection of Structural Steel against Corrosion by the use of Protective Coatings. |
| h) AS 2700 | Colour Standards for General Purposes. |
| i) AS/NZS 3000 | Electrical installations (known as the Australian/New Zealand Wiring Rules). |
| j) AS/NZS 3008 | Electrical Installations – Selection of Cables – Cables for Alternative Voltages up to and Including 0.6/1 kV – Typical Australian Installation Conditions. |
| k) AS/NZS 5100 | Bridge Design. |
| l) AS/NZS ISO 9001 | Quality Management Systems – Requirements. |
| m) AS/CA S008 | Telecommunications Technical Standard |
| n) AS/CA S009 | Installation requirements for customer cabling (Wiring Rules) |

Definitions

1.3 The following definitions apply to terms used in this Part:

Table RD-ITS-C1 1-1 Definitions

Term	Definition
CMS	Changeable Message Sign. Signs which may display preselected messages.
ELV	Extra-low Voltage: Not exceeding 50 V a.c. or 120 V ripple-free d.c.*
FAT	Factory Acceptance Test
LV	Low Voltage: Exceeding extra-low voltage, but not exceeding 1,000 V a.c. or 1,500 V d.c.*
OST	Operational Scenario Test
PSTN	Public Switched Telephone Network
RF	Radio Frequency
SAT	Site Acceptance Test
SIAT	Site Integration Acceptance Test
TMC	Traffic Management Centre (Norwood unless stated otherwise)
VMS	Variable Message Signs (LED). Signs which may display any message.
VSS	Variable Speed Limit Sign. Regulatory signs capable of displaying a range of predetermined speed limits for a section of road.

*From AS/NZS 3000

1.4 Refer to RD-ITS-D1 “Design for Intelligent Transport System (ITS)” for additional definitions.

2 Quality Requirements

- 2.1 Where the Contractor is responsible for determining any location, layout or site selection for any of the Equipment, the Contractor shall provide to the Principal fully detailed location / layout documentation.
- 2.2 Where appropriate, the documentation shall show general layout, reduced levels, Equipment position, coordinates or offsets, speed zones, conduit and pit locations, mounting structure positions and any protective barriers.
- 2.3 If appropriate, details of Equipment brackets and support connections shall also be provided.
- 2.4 Any drawings provided pursuant to this clause shall be prepared in accordance with the Principal's drafting standards and guidelines, available form: <https://www.dpti.sa.gov.au/standards>.
- 2.5 If not submitted beforehand, the documentation required by this clause shall be submitted at least 20 working days prior to the commencement of site work.
- 2.6 Provision of this documentation shall constitute a **Hold Point**.

3 Electrical and Telecommunications Requirements

General

- 3.1 All electrical installations shall be in accordance with RD-ITS-C2 “Mains Power for Traffic Management Equipment” and AS 3000 & AS3008.
- 3.2 All telecommunication installations shall be in accordance with RD-ITS-C3 “Telecommunication cabling” and AS/CA S008 & AS/CA S009.
- 3.3 Where there is a discrepancy between AS3000 and AS/CA S009 regarding installations where Telecommunications and Electrical services are installed in close proximity, that the more conservative of the two requirements will take precedence.
- 3.4 Work on any part of the system shall only be carried out by a person who is suitably qualified and licensed. Prior to the commencement of this work, the Contractor shall provide evidence of the appropriate license(s).
- 3.5 Provision of this evidence shall constitute a **Hold Point**.

Cables, Conduits and Pits

- 3.6 Conduits and Pits shall comply with RD-EL-S3 "Supply and Installation of Conduits and Pits". Electrical cables shall comply with AS 3008 and telecommunications cables shall comply with RD-ITS-C8 "Telecommunications Cabling".
- 3.7 Unless specified otherwise, the Contractor shall install all conduits, pits and cables necessary for the provision of communications and power to the Equipment.
- 3.8 The location of conduits and pits shown on drawings (if any) may be approximate only.
- 3.9 Prior to installation, the Contractor must clearly mark the proposed position of conduits and pits (including sizes and types) on the surface.
- 3.10 Following the marking out, and prior to the commencement of excavation, a **Hold Point** shall apply.
- 3.11 A pit shall be installed adjacent each item of Equipment. ITS cabinets shall have separate power and communications pits. Single devices may share a common power and communications pit providing segregation requirements are met.
- 3.12 Subject to obtaining prior written approval, the Contractor may install conduits directly between adjacent Equipment sites if the Equipment sites are separated by less than the distance from the equipment to the backbone; for example, a CCTV camera located adjacent to an ITS Cabinet.
- 3.13 All cables shall be continuous and without joints except at termination points or where the cable size is required to be reduced. Joints shall be accessible and not located within conduits. The Contractor shall:
- a) check conduits for damage and presence of foreign material;
 - b) clean the conduits as required before drawing cables through them;
 - c) not place excessive strain on any individual core, individual cable or cables during the drawing in process;
 - d) replace any cable damaged during installation;
 - e) label all cables and terminations with permanent markings, which shall not be hand written;
 - f) maintain adequate segregation between LV, ELV and data cables; and
 - g) leave adequate spare cable in loops in pits, to enable cost efficient and timely repair in the event that the cables is damaged or severed.
- 3.14 The Contractor shall supply and install a submersible line fuse holder in an electrical service pit located between the service point and the ITS cabinet / distribution board.
- 3.15 The electrical service pit shall be located as near as practicable to the service point.
- 3.16 The Contractor shall provide an earth stake in a pit adjacent each ITS cabinet and distribution board. The earth stake shall protrude into the service pit by a minimum of 150 mm.
- 3.17 Where specified, earth stakes in pits shall also be provided adjacent to other Equipment. Copper clad, copper plated earth stakes or solid copper strips shall be used as a minimum.

Fusing

- 3.18 Where Equipment is powered sequentially, each ITS cabinet / switchboard shall:
- a) be protected by a fuse / circuit breaker; and
 - b) contain a sub main fuse / circuit breaker. Where possible, these fuse / circuit breakers shall be "cascaded" in rating such that a fault in a submain will only result in the fusing / tripping of the sub main fuse / circuit breaker.
- 3.19 The design of the power reticulation to each device shall include a method of protection and / or isolation so that:

- a) in the event of a device being damaged or suffering an internal or cabling fault which activates (i.e. blows) a supply fuse, that the fuse blown only removes power to that device, and not others; and
 - b) in the event that a device needs to be isolated, the supply for that device can be easily and safely isolated at the device, and also at the pit from which the device is powered.
- 3.20 Acceptable methods of achieving the above are the installation of a fuse / circuit breaker at the device, and also installation of an inline submersible fuse installed in the pit from which the power supply for that device is derived.

Wireless Communications

- 3.21 If wireless technology has been specified to avoid the need for conduits and pits, the wireless communication and communications Equipment shall comply with the applicable Australian and ACMA Standards.
- 3.22 Wireless communication to devices shall be to the closest ITS Cabinet. Communications interface Equipment and antennae shall be installed at the ITS Cabinet to facilitate communications between the field processor and the device.
- 3.23 Wireless communications shall not be affected by normal maintenance activities.
- 3.24 Antennas shall not be co-located on see saw poles with other equipment.
- 3.25 Corresponding communications interface Equipment shall be installed at the device site. This Equipment shall be suitably interfaced to the device controller.

4 Integration

- 4.1 This Clause only applies where STREAMS compatibility is specified.
- 4.2 The Contractor shall provide evidence of STREAMS compatibility, which may include having satisfactorily passed STREAMS acceptance testing. If the Contractor proposes to use Equipment not already defined as STREAMS compatible, the Contractor shall arrange for STREAMS compatibility to be proven.
- 4.3 Evidence of STREAMS compatibility will constitute a **Hold Point**.
- 4.4 Each item of Equipment and / or associated system shall allow automatic operation via STREAMS and local manual operation independent of STREAMS. Unless otherwise specified, communication with STREAMS shall be by one of the following means (in the following order of preference):
- a) Direct Ethernet or serial connection to a Field Processor (FP);
 - b) Remote Ethernet or serial (for example, using a serial / fibre media converter) connection to an FP located elsewhere and / or workstation on the Principal's Telecommunications Network; or
 - c) Connection to the Principal's TMC.
- 4.5 Equipment that primarily provides data to STREAMS, e.g. vehicle detectors, shall provide event-driven messages to minimise or avoid potential polling between the Equipment and Field Processor / STREAMS.
- 4.6 Equipment that requires frequent polling shall communicate at a sufficient data rate for all the available data to be exchanged within a 2 second interval.
- 4.7 Event-driven messages shall contain a time stamp marking the time the event occurred. Where the communications from Equipment are mostly event-driven, a heartbeat (or status) message shall be emitted by the Equipment at least every minute.

5 Installation Requirements

General

- 5.1 Prior to installation, the Contractor shall ensure that all records demonstrating compliance with RD-ITS-S1 “General Requirements for the Supply of IS Equipment” and other relevant Parts for the supply of the Equipment have been provided.
- 5.2 Provision of this documentation shall constitute a **Hold Point**.

Location and Layout

- 5.3 The general layout and installation of the Equipment shall:
- a) comply with the requirements of Clause 6 or 7 (as specified);
 - b) be designed and installed to provide rapid, easy and safe access for maintenance purposes; and
 - c) minimise, and wherever practicable eliminate, the need for traffic control during maintenance activities.
- 5.4 Where the Equipment has components located on opposite sides of the carriageway, any physical connection shall be immune to any future road widening envisaged in the Contract.
- 5.5 Unless otherwise specified, where Equipment is mounted above the carriageway, the vertical clearance from the bottom of the support structure and / or the Equipment enclosure to the road surface shall be a minimum of 6.0 metres.

Wiring Enclosures

- 5.6 Each ITS device site shall be provided with conduit infrastructure necessary for the complete operation of the device.
- 5.7 Conduit infrastructure includes cable access from the backbone conduit network to the ITS field cabinet and / or field device.
- 5.8 Cable infrastructure shall be installed in accordance with RD-ITS-C8 “Telecommunications Cabling”.
- 5.9 After installation of cables, the associated conduits and / or glands shall be sealed to prevent vermin entry.
- 5.10 Cables for pole mounted devices shall connect to the device by entering the pole underground at its base, and exiting the pole either directly into the device enclosure (e.g. directly into a pole mounted equipment box), or exiting to the device at a height which prevents access to the conduit while standing at ground level.

Wiring Specification

- 5.11 The Contractor shall comply with LV and ELV wiring specification as per Table RD-ITS-C1 5-1 Cable wiring colour and minimum size.

Table RD-ITS-C1 5-1 Cable wiring colour and minimum size

Application Description		Colour	Conductor Min. Size
230VAC Power (Single Phase)	230VAC Active	Red	2.5mm ²
	230VAC Neutral	Black	2.5mm ²
	Earth	Green/Yellow	2.5mm ²
230VAC Control	230VAC Active	Red	0.75mm ²
	230VAC Neutral	Black	0.75mm ²

Application Description		Colour	Conductor Min. Size
48VDC	48VDC (+ve)	Orange	0.75mm ²
	0VDC (-ve)	Blue	0.75mm ²
24VDC	24VDC (+ve)	Grey	0.75mm ²
	0VDC (-ve)	Blue	0.75mm ²
12VDC	12VDC (+ve)	Pink	0.75mm ²
	0VDC (-ve)	Blue	0.75mm ²
5VDC	5VDC (+ve)	Light Blue	0.75mm ²
	0VDC (-ve)	Blue	0.75mm ²

Equipment Enclosures

- 5.12 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.
- 5.13 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 the Enclosure.
- 5.14 The plinth shall be large enough to allow for service personnel to walk on the plinth around the device while all doors and access areas are open.
- 5.15 Equipment Enclosures shall be positioned to minimise direct solar radiation and shall not be painted a dark colour.

Vehicle Barriers

- 5.16 Where road-side barrier treatments exist or are required adjacent the Equipment site, the barriers shall be in accordance with AS 3845.
- 5.17 Where vehicle barriers are to be provided on a road which is trafficked at the time of installation, the barriers (or temporary barriers) shall be installed prior to commencing civil works for the Equipment mounting foundations.

6 Vehicular Site Maintenance Access

- 6.1 This clause applies unless specified otherwise in the Contract Documents.
- 6.2 Permanent vehicle access points shall be provided within 50 m of each Equipment site to allow maintenance vehicles to enter and exit the Equipment site from the carriageway safely. The design of access points shall:
 - a) discourage unauthorised vehicles from accessing the site unless the site also contains a help phone or other public facility;
 - b) allow a safe distance for indication and deceleration of a maintenance vehicle in order to safely enter the site, and a safe distance and adequate clear vision of the road to accelerate and merge onto the road when leaving the site;
 - c) provide protection to the service vehicle and staff, e.g. by allowing the vehicle to park a safe distance from the road, or via a safety barrier;
 - d) ensure maintenance vehicles can enter and park in the site without protruding into trafficable carriageway lanes (including emergency lanes); and
 - e) not require traffic control during maintenance works.
- 6.3 The Contractor shall provide a suitable set-up area for the maintenance vehicle which:
 - a) is close enough for safe operation of maintenance activities;

- b) allows the vehicle to be parked within 3 m of the Equipment;
 - c) has the entrance / exit, access track and set-up area suitable for all-weather access for a maintenance vehicle pertinent to the maintenance activity, i.e. bitumen or concreted with adequate drainage;
 - d) is laid out so that the maintenance van has sufficient parking space so that it does not park over any pits in the set-up area when parked adjacent to the equipment; and
 - e) has any pits in the set-up area constructed to be trafficable (i.e. designed to be safely driven over by a maintenance vehicle without damage) and not installed in a manner which allows water to pool on or near the pit.
- 6.4 Any maintenance access bays provided shall be designed to accommodate a 12 m rigid truck as required to maintain equipment installed at that location. The maintenance bays shall be positioned such that they can be utilised without the need for adjacent lane closures and / or speed restrictions, and provide adequate sight distance to oncoming traffic to allow safe entry and exit from the main carriageway at the posted maximum speed limit.
- 6.5 Maintenance of ITS equipment shall not require the provision of temporary traffic management and / or speed restrictions to facilitate safe access with the exception of equipment located on cross carriageway gantries.
- 6.6 Other maintenance access options, including shoulder access for pits in the shoulder, or existing and new pedestrian and / or cycling pathways, may be considered on a case by case basis, and are subject to approval by the Principal.

7 Non-Vehicular Access

- 7.1 This clause only applies if the Contract Documents specify that vehicular site maintenance access is not required.
- 7.2 Permanent personnel access points from the carriageway to the Equipment site shall be provided within 5 m of each item of Equipment. Access points shall:
- a) be arranged to prevent vehicles from entering the site; and
 - b) avoid the need for traffic control during maintenance works.
- 7.3 A parking area suitable for maintenance vehicles shall be provided immediately adjacent the access point. The parking area shall:
- a) allow personnel to alight from both sides of the vehicle concurrently and access the site without entering trafficable carriageway lanes (including emergency lanes);
 - b) 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; and
 - c) be laid out so that the maintenance van has sufficient parking space so that it does not park over any pits in the parking area.
- 7.4 An access path shall be provided to each Equipment site for the safe movement of maintenance personnel between the carriageway access point and the Equipment. The access path and the area around the Equipment site shall:
- a) be evenly graded;
 - b) for the access path, not exceed 1:3 gradient;
 - c) for the area around the site, be suitable for maintaining the equipment per the intended maintenance strategy;
 - d) be suitable for safe, all-weather access; and
 - e) be fitted with safety barriers around the site if working on or near the site would be hazardous without the barriers.

- 7.5 Concrete steps may be provided to optimise path alignment. Where steps are provided, these shall be in accordance with the relevant standards and codes. A minimum 100 mm thick, rectangular concrete pad shall be provided for a minimum 1,200 mm width around all equipment enclosures and / or mounting plinths at the site. The access path and the area around the Equipment site shall be free of tripping and falling hazards.

8 Testing and Commissioning

General

- 8.1 The Contractor shall verify compliance with the requirement of the Contract by performing:
- a) Factory Acceptance Testing (FAT);
 - b) Site Acceptance Tests (SAT);
 - c) System Integration Acceptance Tests (SIAT); and
 - d) Operational Scenario Tests (OST).
- 8.2 The Contractor shall identify and provide all Equipment, materials and other works necessary to perform the tests, with the exception of a TrafficNet communication router if required and agreed in writing by the Principal.
- 8.3 Any damage incurred as a result of undertaking tests shall be rectified by the Contractor.
- 8.4 Where the manufacturer of test Equipment indicates that the test Equipment requires calibration, the Contractor shall provide a current NATA certified certificate of calibration.
- 8.5 All test documentation shall indicate clearly the date the test was conducted and identify the responsible personnel. The test reports shall be submitted within 7 days of completion of the testing.

Testing and Commissioning Plans

- 8.6 The Contractor shall prepare and submit testing and commissioning plan to the Principal for approval in accordance with Part PC-QA1 Quality Management Requirements: Section 6 Inspection and Testing.
- 8.7 At least 60 days prior to the commencement of testing, the Contractor shall prepare and submit testing and commissioning plans which provide timing and stages of the testings, where the testing is to occur, management of the testing process, expected results, details of the necessary tests, record sheets and procedures for the Equipment to the Principal for approval. All testing and commissioning work shall be undertaken in accordance with these plans.
- 8.8 Test plans and record sheets shall be suitable for recording compliance with the respective technical requirements of the Contract. The plans shall address as a minimum:
- a) IP connectivity;
 - b) electrical tests;
 - c) required latency and bandwidth;
 - d) test Equipment and / or system operation;
 - e) STREAMS defined fault testing;
 - f) compliance with the respective Contract Documents; and
 - g) maintenance tests, if maintenance forms part of this Contract.
- 8.9 Where the Contractor conducts testing and commissioning works in multiple stages or modules, individual plans may be prepared and submitted for each stage.
- 8.10 Test plans shall take into consideration 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.

- 8.11 The Contractor shall plan all testing and commissioning works to minimise disruptions or degradations to the operational management of the existing traffic movements within the site. The Contractor shall gain approval for any disruptions or degradations to the capability of the TMC to manage the Motorway via the TMC's change control processes prior to the commencement of any works.
- 8.12 The Contractor shall not cause ITS devices to show displays (for example messages or speed limits) visible to motorists without the prior approval of the Principal.
- 8.13 If the Principal is requested to provide resources (e.g. personnel, STREAMS site test application) to facilitate, assist with or witness testing, the resources required shall be clearly detailed on the testing and commissioning plan. Timing for the provision of Principal resources shall be agreed between the Principal and the project.
- 8.14 The provision of each of the testing and commissioning plans shall constitute a **Hold Point**.
- 8.15 The Contractor shall fully document all traffic management and any other provisions that are to be made during commissioning and test works to ensure the safety of all personnel on-site and any motorists using the network.

Acceptance Testing

General

- 8.16 The Contractor shall undertake acceptance testings on the equipment, including its interfaces with Department TMC computer systems and any CERS.
- 8.17 All acceptance testing shall be undertaken in accordance with the test plan and test specifications developed by the Contractor.
- 8.18 Test plans and test specifications shall be resubmitted to the Principal for approval if amendments are proposed.
- 8.19 Test harnesses (including, but not limited to, network load generation tools, simulations of field devices and simulations of sensor actuations) may be used only where prior approval is granted by the Principal.
- 8.20 All tests shall be conducted on devices/equipment, including the communications network, in their final configuration unless prior approval is granted by the Principal.
- 8.21 Where a test is conducted in an environment other than the final environment, the Contractor shall detail all differences between the test and final environments in the appropriate test plan.
- 8.22 The results of modules or stages of acceptance testing, including an Acceptance Test Certificate, shall be submitted to the Principal within seven days of the completion of the module of acceptance testing. The modules shall correspond to what was defined in the test plan.
- 8.23 The results provided shall include records of the actual performance of the device with reference to the acceptable measure of performance defined in the test plan.
- 8.24 Where a test yields unsatisfactory results, the Contractor shall be responsible for all works required to establish the cause of the defect, rectify the defect and retest until all items are completed to the satisfaction of the Principal.

Factory Acceptance Test (FAT)

- 8.25 The Contractor shall conduct Factory Acceptance Testing (FAT) prior to installation to show that devices and systems provided meet the Principal's requirements, as per the relevant specification.
- 8.26 FAT testing shall include, not limited to
 - a) Verify STREAMS certification
 - b) Record firmware and hardware type for equipment testing
 - c) Full equipment functionality testing, e.g. display, colour, luminance etc, via STREAMS Test Server

- d) Fault mode testing and verification of expected behaviours and fault reporting via STREAMS Test Server
- 8.27 As part of the final stages of FAT, the Contractor shall simultaneously connect and operate all network switches, all servers, and field processors and CCTV cameras at a minimum, and sample sets of field devices and test equipment.
- 8.28 This complete systems test at the FAT stage is critical to demonstrating system wide integration with the STREAMS platform and network functionality, allowing for simulation of worst case, failure, and system test case scenarios. The Principal shall be invited to attend the final pass of the FAT system testing.
- 8.29 Invitation to the Department for the witnessing of final FAT system testing shall constitute a **Hold Point**.
- 8.30 The Contractor shall establish a suitable FAT environment to execute tests in. The test environment shall include all test harnesses necessary to conduct the tests defined in the test plan, and where relevant, testing is to include connection and control via a STREAMS compliant Field Processor.
- 8.31 The Contractor shall detail the proposed test environment in the relevant test plan.
- 8.32 The Contractor may use individual devices to prove a device-type's compliance with the Principal's specification. For example, the Contractor may use a single Variable Message Sign (VMS) to prove that the type of VMS is compliant.
- 8.33 In the case of devices or equipment that will not be connected to STREAMS, the Contractor may supply an appropriate quality control certificate from the manufacturer / supplier and request that the Principal grant the product an exemption from the Factory Acceptance Test. If the Principal does not grant exemption, the Contractor shall prove that the product meets the Principal's requirements by completing a FAT for that product.
- 8.34 The Contractor shall conduct FAT to verify that the integrated network communications system in final configuration meets the Principal's requirements.
- 8.35 The Contractor shall conduct FAT to verify the assembled ITS cabinets meet the Principal's requirements.
- 8.36 The completion of FAT to the Principal's specification and the production of a detailed FAT Report shall constitute a **Hold Point**.
- 8.37 Upon completion of FAT, the entire system shall be placed under formalised configuration management, with any changes to equipment configurations, programming, firmware updates, or functionality being managed through a formal commissioning change process that involves the Principal. This applies to changes in the factory or on Site post installation.

Site Acceptance Test (SAT)

- 8.38 The Contractor shall carry out Site Acceptance Testing (SAT) for each site once all components of the ITS have been installed on-site and are in their final configuration.
- 8.39 The SAT shall only proceed if hardware and firmware are unchanged from the completed FAT, unless otherwise approved to proceed by the Principal. Any changes by the Contractor that are not approved by the Principal will require FAT testing to be undertaken.
- 8.40 The SAT shall confirm that all items remain compliant with FAT and deliver the required functions after installation and local integration on-site. This shall include all inspections required for quality and compliance with the specification for each component.
- 8.41 The Contractor shall record site location and installation details.
- 8.42 For sign type ITS equipment, the Contractor shall adjust and confirm sign mounting (tilt and alignment) to ensure designed sight distance is achieved, and shall also ensure signs are unobscured by any co-located roadside furniture, signage and tree.
- 8.43 The Contractor shall request Department representatives to witness testing and obtain signoff following the successful completion of SAT.

- 8.44 The completion of SAT to the Principal's specification and the production of a formal SAT Report shall constitute a **Hold Point**.

System Integration Acceptance Testing (SIAT)

- 8.45 SIAT shall only proceed if hardware and firmware are unchanged from the completed FAT and SAT, unless otherwise approved to proceed by the Principal. Any changes by the Contractor that are not approved by the Principal will require FAT testing to be undertaken.
- 8.46 SIAT shall be undertaken to demonstrate that device and system functionality is achieved in the STREAMS Test Server, including a Principal approved sample of failure modes.
- 8.47 STREAMS Field Response or Response Plans shall be executed, proving the ITS devices and system functions as expected.
- 8.48 SIAT shall be conducted once all equipment relevant to the functionality testing is installed and SAT tested in the final environment and configuration. The Principal shall provide input via a STREAMS Operator as may be required to complete this process.
- 8.49 The Contractor shall request Department representatives to witness testing and obtain signoff following the successful completion of SIAT.
- 8.50 The completion of SIAT as per the Principal's specification and the production of a formal SIAT Report shall constitute a **Hold Point**.

Operational Scenario Testing

- 8.51 After completion of the SIAT and once all devices have been transferred to the STREAMS Production Server, Operational Scenario Testing shall be undertaken from the TMC. Such testing will need to demonstrate that incident detection input into STREAMS automatically generates appropriate responses on the field devices. All possible functionality of either Response Plans or the Field Response engine within STREAMS for road management shall be tested.
- 8.52 TRANSMAX shall be engaged by the Contractor to develop and conduct the Operational Scenario Testing, and be present onsite or at the TMC during this event to supply onsite support and aid test scenarios. The submission of OST plan, 90 days prior to the planned test date, to the Principal's satisfaction shall constitute a **Hold Point**.
- 8.53 The Contractor shall provide all required site management including, but not limited to, traffic management, verification of sign displays and also attend these tests. Should these tests identify any defects associated with works completed by the Contractor, the Contractor shall rectify these defects.
- 8.54 The Contractor shall request Department representatives to witness testing and obtain signoff from the Department TMC Manager following the successful completion of Operational Scenario Testings.
- 8.55 The successful completion of the end-to-end testing by the Department TMC serves as the final scenario testing acceptance of the site by the Principal. The evidence of such acceptance shall constitute a **Hold Point**.

9 Fabrication and Installation of Support Structures

General

- 9.1 Support structures shall be fabricated and installed in accordance with ST-SS-S1 "Fabrication and Erection of Structural Steelwork".
- 9.2 A protective treatment in accordance with ST-SS-S2 "Protective treatment of Structural Steelwork" shall be applied to the supports.
- 9.3 The minimum height above ground of the Equipment shall be such as to prevent unauthorised access.
- 9.4 Wherever practicable, any electronic processor which is sensitive to heat shall be positioned to minimise direct solar radiation and shall not be painted a dark colour.

- 9.5 If the Equipment is to be mounted on an existing structure, the Contractor shall verify the suitability of the structure and the mounting arrangement for support of the Equipment.
- 9.6 Unless specified to be galvanized, all visible surfaces of the support structure shall be painted Dark Green (Colour No. G61 to AS 2700).
- 9.7 Grouting shall be done on the day of support structure/equipment installation. Conduits shall be rodded/roped and checked for usability after grouting. If cables are pre-installed in structures prior to installation on-site, cables shall be checked after grouting to be sure that they've not been grouted in-place.

Support Structures for Signs

- 9.8 The mounting brackets for the signs shall be incorporated in the design to minimise the need to drill or weld to the enclosure.
- 9.9 The underside of signs shall be at least 2.5 m above ground level. Access for cable to the signs shall be included in the design.
- 9.10 The Contractor shall determine the tilt angle and orientation of the signs to ensure that the line of sight is set at its optimum. The design of the sign support shall allow adjustment of the tilt angle and orientation after installation of the sign. Sun shields and optical visors shall be part of the sign design to ensure visibility in full sun at all times of the year.
- 9.11 Variable Speed Limit Signs (VSS) shall be installed on round poles unless otherwise specified. Exterior metal surfaces of Equipment shall be painted with a durable paint system that matches the support structure.

Gantries and Major Support Structures

- 9.12 Large signs supported on tubular single posts, tubular cantilever supports or gantries shall comply with AS 1742.2 and AS 1742.15. Unless specified otherwise, electronic signs mounted on major support structures shall have a service access platform.

10 Handover

- 10.1 The Contractor shall handover all ITS and related components, As-built documentation, and so forth in accordance with the requirements of the Contract Documents.

1,000 Hours Defect Free

- 10.2 Notwithstanding that handover of operational control of the ITS may have occurred, the Contractor shall remain responsible for all ITS infrastructure, and Completion will not be granted by the Principal, until the ITS system has run continuously for 1,000 hours defect free, indicatively beginning from the official Operational Handover to Traffic Management Centre.
- 10.3 The operation reset for 1,000 hour defect free period criteria is assessed using two methods defined in Clause 10.4 and Clause 10.5.
- 10.4 The first method of assessing whether the 1,000 hour defect free period is reset is based upon the number of major failure reoccurrence for a single device type. A Major Failure is defined as a failure of a device or system such that it cannot function under normal intended operation. As detailed in Table RD-ITS-C1 10-1, should any instances of major failure reoccurrences outlined in Table RD-ITS-C1 10-1 occur, the ITS device fault should be escalated to a system fault then 1,000 hours defect free period shall be reset. If the accumulation of reoccurrence has not exceeded the reset threshold over the 1,000 hour period, then the device is repaired or replaced under warranty.

Table RD-ITS-C1 10-1 Individual Device Faults

Device	Major Failure Reoccurred 1 Time	Major Failure Reoccurred 2 Times	Major Failure Reoccurred 3 Times	Major Failure Reoccurred 4 Times	Major Failure Reoccurred 5 Times	Major Failure Reoccurred >=6 Times
Power Supplies / Distribution / Cabling	Not Reset 1,000 hours		Reset 1,000 hours			
Media Converter						
Door Switches						
UPS						
RC3 Sign						
CMS / VMS						
VDS						
BT						
PTZ / Fixed / AVIDS Cameras						
Fibre and Copper Comms cables						
Power Cabling						
Lighting Systems						
Pump Monitoring and Control	Not Reset 1,000 hours		Reset 1,000 hours			
Layer 2 Switches						
Layer 3 Switches						
LUMS						
SEN (PLC)						
Field Processor						
TIRTL						
Wireless Equipment						
Security System						
Fire System						
Services						
CER Power Distribution						
UPS (CER)	Not Reset 1,000 hours	Reset 1,000 hours				
Generator						
NVR						
FLUX						

10.5 The second method of assessing whether the 1,000 hour defect free period is reset is based upon a point-based tally when faults occur on multiple device types across the project extent. Points for Major and Minor Failures are defined in Table RD-ITS-C1 10-2. Major failures are defined in Clause 10.4. Minor failures are defined as a fault has occurred on a device but it still functions (e.g. single LED fault for a VMS). If the accumulation of device failures reaches 100 points, the 1,000 hours defect free period shall be reset and the ITS system shall be defined as defective. If the accumulation of points has not exceeded the 100 point threshold over the 1,000 hour period, then the device is repaired or replaced under warranty.

Table RD-ITS-C1 10-2 Point Allocation for Device Failure

Device	Point per Major Failure	Point per Minor Failure
Power Supplies / Distribution / Cabling	15	N/A
Media Converter	10	N/A
Door Switches	10	5
UPS	15	5
RC3 Sign	15	5
LUMS	15	5
VDS	10	N/A
BT	15	N/A
PTZ / Fixed Cameras	15	5
AVIDS Cameras	30	10
Fibre and Copper Comms cables	20	N/A
Power Cabling	15	8
Layer 2 Switches	20	5
Layer 3 Switches	30	10
CMS / VMS	15	5
SEN (PLC)	10	N/A
Field Processor	30	10
TIRTL	10	5
Wireless Equipment	30	10
Security System	30	15
Fire System	30	15
Mechanical Services	20	N/A
CER Power Distribution	20	N/A
UPS (CER)	20	10
Generator	20	10
NVR	40	20
FLUX	40	20
Lighting Systems	10	N/A

- 10.6 Process to categorise device failure into minor failure / major failure, and escalate device failure to system failure is outlined in Appendix 3.
- 10.7 The Contractor shall obtain STREAMS fault records (in the form of an Excel spreadsheet) from the Department TMC for all the ITS within the project scope on a weekly basis over the 1,000 hour period. The Contractor shall analyse the faults, add a description and reasoning for each of the faults and return the spreadsheet to the Principal within 5 days of receiving the weekly fault record. The Principal will then score the faults and keep a tally of Minor and Major Faults to inform decisions regarding achievement of the 1,000 hour defect free period. The evidence of completion of the 1,000 hours defect free period shall constitute a **Hold Point**.
- 10.8 The Contractor shall provide As-built documentation prior to handover, including location data (specific identification codes and GPS co-ordinates in a format determined by the Principal Asset Management Section) and technical data (i.e. manufacturer, model, hardware, firmware, software version and so forth) of all field equipment. The timely provision of As-built documentation shall also be pre-requisite to achieving Completion.
- 10.9 The Contractor shall provide an ITS technician to support Department maintenance personnel for up to three months following Completion, at the discretion of the Principal.

Records and Asset Labels

- 10.10 The Contractor shall supply to the Principal a detailed list of ITS devices (refer to Appendix 1: ITS Equipment Prefix) and geographic locations in accordance with RAMA-AM-PRC-005 Road & Marine

Assets – Asset Data Collection Manual and in the format of RITS Data Collection Template (Template to be provided by the Principal upon request).

- 10.11 The Contractor shall supply the size and artwork of the adhesive asset labels to the Department for approval (refer to Appendix 2: Department Asset Label Template). The approval of the asset label artwork shall constitute a **Hold Point**.
- 10.12 Asset Labels shall be yellow quality reflective type with black print and clear gloss laminate.
- 10.13 Once the size and artwork is approved by the Department, the Contractor is responsible to supply and affix the labels to each device prior to, or immediately after, installation.

11 Training

- 11.1 The Contractor shall provide training for Department TMC operators and field technicians as specified in RD-ITS-S1 “General Requirements for the Supply of ITS Equipment”.
- 11.2 At a minimum training shall be provided on:
- a) an overview of the ITS system operation;
 - b) site familiarisation including safe site access of all installed devices and equipment, including the CER;
 - c) preventive maintenance and fault diagnosis for all devices and associated software installed on the Project; and
 - d) demonstration and interrogation of diagnostic procedures, systems and / or software.
- 11.3 The above training shall apply irrespective of whether identical or similar equipment is already in use in installations controlled by the Principal.
- 11.4 The Contractor shall provide an ITS training plan outline to the Principal. The submission of the training plan outline shall constitute a **Hold Point**.

12 Warranty and Spares

- 12.1 Warranty and spares shall be provided in accordance with the requirements of the Contract and RD-ITS-S1 “General Requirements for the Supply of ITS Equipment”. Warranty periods commence at the date of Completion.

13 Hold Points

- 13.1 The following is a summary of Hold Points referenced in this Part:

Table RD-ITS-C1 13-1 Hold Points

Document Ref.	Hold Point	Response Time
2.6	Layout / Design Documentation	10 Working Days
3.5	Provision of appropriate licence(s)	2 Working Days
3.10	Prior to excavation for conduits and pits	1 Working Day
4.3	Evidence of STREAMS compatibility	3 Working Days
5.2	Supply Conformance Documentation	5 Working Days
8.14	Testing and Commissioning Plans	10 Working Days
8.29	Invitation to the Department for the witnessing of Factory Acceptance Testing complete system test	10 Working Days
8.36	Factory Acceptance Testing close out	10 Working Days

Document Ref.	Hold Point	Response Time
8.44	Site Acceptance Testing	10 Working Days
8.50	System Integration Acceptance Testing	10 Working Days
8.52	Submission of OST Plan including Transmax engagement	10 Working Days
8.55	Operational Scenario Testing	10 Working Days
10.7	Provision of 1,000 hours defect free evidence	10 Working Days
10.11	Approval of all asset label artwork	10 Working Days
11.4	ITS Training Plan	10 Working Days

14 Verification Requirements and Records

14.1 The following is a summary of records (in addition to those supplied at Hold Points) to be supplied by the Contractor to demonstrate compliance with this Part:

Table RD-ITS-C1 14-1 Verification Requirements

Document Ref.	Records
11.9	List of ITS devices and geographic locations in accordance with RAMA-AM-PRC-005 Road & Marine Assets – Asset Data Collection Manual and in the format of RITS Data Collection Template.

15 Appendix 1: ITS Equipment Prefix (refer to RD-ITS-D1 for ITS Asset Numbering)

Table RD-ITS-C1 15-1 ITS Equipment Prefix

Device / Asset Type	Asset / Label Number	Location GPS coordinates, Road, Direction of travel, at chainage or nearest side road
Variable Message Sign	VMS###	
Changeable Message Sign	CMS###	
Variable Speed Limit Sign	VSS###	
CCTV Camera	CAM###	
Fatality Free Day Sign	FFS###	
Weather Detector	WED###	
ITS Cabinet (formerly Outstation)	ITS### (formerly OS###)	
Power Distribution Board	PDB###	
Help Phone (formerly emergency phone)	HLP###	
Outback Road Condition Sign	RCS###	
Over Height Detector	OHD###	
Arrestor Bed Detector	ABD###	
Generator	GEN###	
Video Incident Detector or Thermal Incident Detector	CAM###	
Emergency Signal	ES###	
Advance Warning Sign	AWS###	
Switchboard	SWB###	
Lane Use Management System	LUMS###	
Bluetooth Station	BT###	
Wire Rope Monitoring System	WRMS###	
Point to Point Camera	PPT###	
Safe-T-CAM / Truck Scan	STC###	
Red Lighting Safety Camera	RSC###	
Travel Information Sign	TIS###	
Tunnel Status Sign	TSS###	

16 Appendix 2: Department Asset Label Template

16.1 There are two standard sizes for Department asset stickers,

- a) Large - including Department asset number and TMC 1800 number, size 250 (H) x 300 (W); and
- b) Small - Department asset number only, size 85 (H) x various width depending on the number of characters

16.2 Example of large format label size ITS574 @ 300mm x 250mm



16.3 Example of small format label size CAM1031 @ 85mm x 280mm



17 Appendix 3: 1000 hrs defect free device failure categorisation process

