TCS 039 - 2019

Specification for

The Supply and Installation

Of

Ice Warning Stations

January 2019
Rev A

keeping victorians connected

TCS 037 – 2019

Foreword

This specification has been developed by VicRoads. It is one of a number of technical specifications, and associated standard drawings, which set out the requirements for roadside ITS devices, traffic signal equipment and other electrical equipment and associated devices and control systems.

This specification is intended for use in all relevant works undertaken by or on behalf of VicRoads.

VicRoads Standard Drawings, Specifications and Guidelines are available for downloading from VicRoads website at the following link: https://www.vicroads.vic.gov.au/business-and-industry/technical-publications/electrical-and-intelligent-transport-systems

Specification updates. VicRoads specifications and associated standard drawings are subject to periodic review. To keep the specifications up to date, amendments or new editions are issued as necessary. It is therefore important for users of VicRoads specifications to ensure that they have the latest version and associated amendments.

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PREFACE

A. TELECOMMUNICATIONS EQUIPMENT

A.1 All telecommunications equipment shall comply with relevant requirements of the Australian Communications and Media Authority (ACMA). Such equipment shall be labelled with a Regulatory Compliance Mark.

B. CHANGES TO THIS SPECIFICATION

B.1 The main changes to this specification from the previous version are listed below:

- Addition of Active Advanced Warning Signs/Ice Warning Stations modified slip base pole
- Changes to communication from dial up to TCP/IP
- STREAMS monitoring incorporated

C. REVISION HISTORY

C.1 The following table details versions to this specification:

Revision	Date	Revision Owner	Description
Original	Jan 2002	VicRoads SJS	First release
A	Jan 2019	VicRoads SJS	Specification revised

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Contents

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

1.1.1 This document covers the requirements for the supply, installation and commissioning of Ice Warning Stations for use within the State of Victoria.

1.2 GENERAL

1.2.1 The purpose of Ice Warning system is to detect weather conditions conducive to the formation of black ice.

1.2.2 Motorists are notified of the potential for ice on the road via roadside signs incorporating flashing yellow aspects.

1.2.3 A typical installation consists of one 'Master Station' and one or more 'Slave Stations', operating as a single system.

1.2.4 A typical Ice Warning Station system compromises of all sensing equipment, processing equipment, signs, LED aspects, cables, housings and all peripheral mounting facilities together with the associated control or communications equipment to enable operation of the system.

1.2.5 Remote control and monitoring of the system shall be facilitated via STREAMS through Ancillary ITS Device Protocol.

1.2.6 All Ice Warning Stations shall be fully compatible with VicRoads ITS Platform (See Appendix A).

1.3 INTELLECTUAL PROPERTY

1.3.1 In relation to all Intellectual Property used in/or to operate the system, the contractor grants to VicRoads non exclusive licence to "use, modify and/or sell" or do anything else that without the licence, could be breach of the licensors Intellectual Property.

1.3.2 Intellectual Property shall include, but not be limited to, the following:

- Software.
- Source code(s).
- Schematic diagrams.
- Circuit diagrams.
- Wiring diagrams.
- Listings of components and sub-components.
- Any and all operational and maintenance documentation.

SECTION 2 RELATED SPECIFICATIONS AND DRAWINGS

2.1 GENERAL

2.1.1 The supply and installation of the Ice Warning System shall conform with all relevant Australian Standards.

2.1.2 All installation works shall conform to the relevant VicRoads specifications and related specifications and standards as indicated throughout this document.

2.2 AUSTRALIAN STANDARDS

2.2.1 The following related Australian Standards are defined:

AS/NZS 1170.2	Structural design actions – Wind actions
AS 1742.2	Manual of uniform traffic control devices, Part 2: Traffic control devices for general use
AS 1743	Road signs - Specifications
AS/NZS 2053.2	Conduits and fittings for electrical installations Part 2: Rigid plain conduits and fittings of insulating material
AS/NZS 2144	Traffic signal lanterns
AS 2700	Colour Standards for general purposes
AS/NZS 3000	Wiring rules
AS/NZS 3100	Approval and test specification—General requirements for electrical equipment
AS 60038	Standard voltages
AS 60068.2.29	Environmental testing—Tests—Test Eb and guidance: Bump
AS 60068.2.6	Environmental testing—Tests—Test Fc: Vibration (sinusoidal)
AS 60529	Degrees of protection provided by enclosures (IP Code)
AS/NZS 61000.6.1	Part 6.1: Generic standards—Immunity for residential, commercial and light-industrial environments
AS/NZS 61000.6.3	Part 6.3: Generic standards—Emission standard for residential, commercial and light-industrial environments
AS/NZS 61558	Safety of power transformers, power supply units and similar

2.3 VICROADS SPECIFICATIONS AND DRAWINGS

2.2.1 The following VicRoads documents are referenced:

Drawing No TC-1065	Slip Base Pole Assembly - Ground Set Mounted
Drawing No TC-1127	Visor Types and Dimensions
Drawing No TC-2100	Standard Cabinet Label
TC-2040	Ice Warning Device W5-V116
Supplement to AS 1743	VicRoads Supplement to AS 1743:2001 (August 2017)
ITS Device Protocol	Ancillary ITS Device Protocol
TC-2041	Double Ice Warning Device W5-V117
Standard Drawings	VicRoads TC Series Standard Drawings
Specifications	VicRoads TCS Series Specifications

SECTION 3 ACRONYMS

3.1 ACRONYMS

3.1.1 The acronyms used in this document shall be interpreted as follows:

ACMA	Australian Communication and Media Authority
AS	Australian Standard
ELV	Extra Low Voltage
EMC	Electromagnetic Compatibility
IP	Ingress Protection
ITS	Intelligent Transport System
IWS	Ice Warning Stations
LED	Light Emitting Diode
NTP	Network Time Protocol
NZS	New Zealand Standard
RCD	Residual Current Device
TCP/IP	Transmission Control Protocol/Internet Protocol
TMC	Traffic Management Centre
UPS	Uninterrupted Power Supply

SECTION 4 SYSTEM OVERVIEW

4.1 GENERAL

4.1.1 This section describes the general operation of a typical Ice Warning System. For the purpose of this overview a system consisting of a master station and multiple slave stations is assumed.

4.1.2 A typical Ice Warning System installation layout is shown in Figure 1 below.

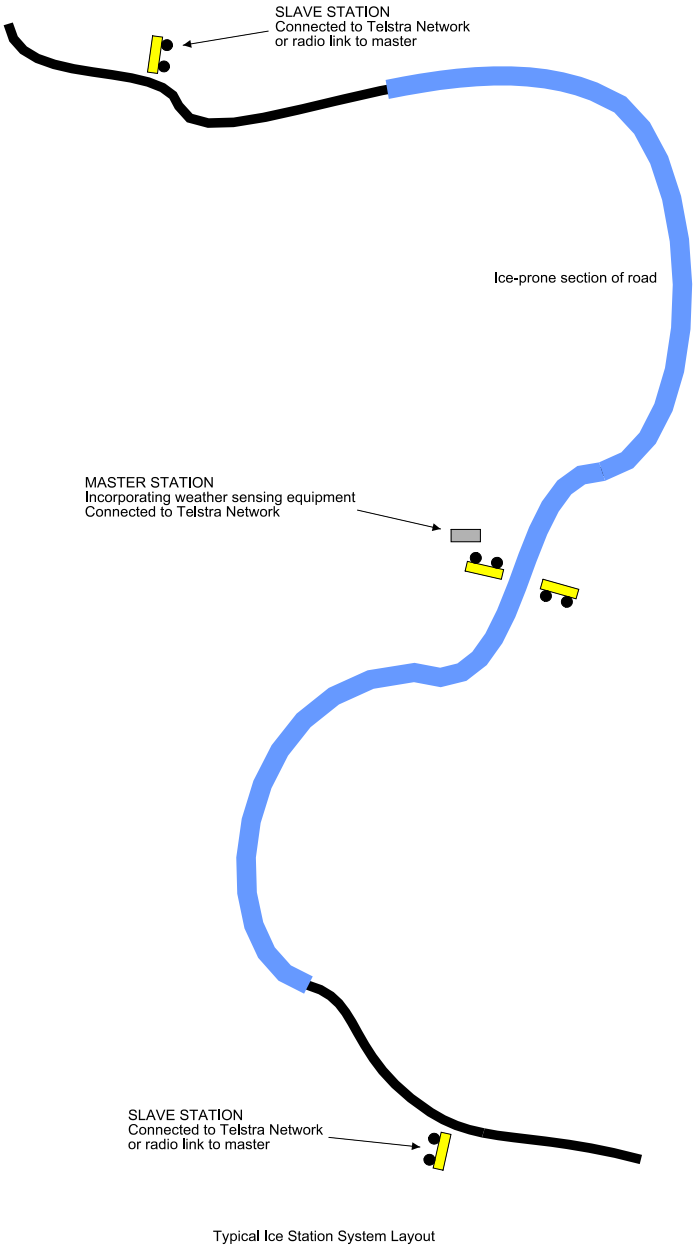

Figure 1 Ice Warning System Layout

4.1.3 The specific site details and layout for each individual installation shall be as detailed in the tender documents.

4.2 TYPICAL CONNECTION ARRANGEMENTS

4.2.1 Where both the master and slave stations are connected to the communications network, the system shall operate as follows:

1. The master station detects ice or environmental conditions conducive to the formation of ice;
2. The master station switches on all local signs/flashing yellow lanterns and sends a request to STREAMS to turn on slave ice warnings signs.
3. STREAMS then sends a request to each of the associated slave stations to turn the local signs/flashing yellow displays on;
4. Master Station no longer detects ice;
5. Master Station send a status update to STREAMS and reports that ice is no longer detected;
6. STREAMS activates a preset timer;
7. When the timer has expired the STREAMS will notify the master station and the slave stations and switch all signs/flashing yellow displays off.

4.2.2 Where the master station is connected to the communications network and the slave stations are connected to the master station via a radio link, the system shall operate as follows:

1. The master station detects ice or environmental conditions conducive to the formation of ice;
2. The master station;
   - switches on all local signs/flashing yellow lanterns
   - switches on slave station signs/flashing yellow lanterns via a radio link; and
   - notifies STREAMS that ice has been detected;
3. Master Station no longer detects ice;
4. Master Station notifies STREAMS and gives the status update;
5. STREAMS activates a preset timer;
6. When the timer has expired the STREAMS will notify the master station to switch off all signs/flashing yellow displays. The master station will also switch off all slave station signs/flashing yellow displays via the radio link

SECTION 5 SYSTEM REQUIREMENTS

5.1 GENERAL

5.1.1 The Ice Warning System and all components thereof shall be a type that has previously been approved by VicRoads.

5.1.2 The system shall typically consist of one Master Station for the purpose of sensing road pavement and weather conditions conducive to the formation of black ice, and Slave Stations located at appropriate distances in each direction, to relay advanced warning to motorists.

5.1.3 The number and locations of all ice warning stations shall be detailed in individual tender documents.

5.1.4 The contractor shall be responsible for all resources necessary for the satisfactory installation and commissioning of the system, including:

a) design, manufacture and installation of all sensors, signs, mountings, housings, processors and associated communications equipment;
b) all on-site civil and electrical works;
c) all necessary works for the provision of power;
d) all necessary works for the provision of communications; and
e) testing and commissioning of the system.

5.2 MASTER STATION

5.2.1 The Master Station shall incorporate the following elements:

a) A comprehensive system for weather condition sensing, incorporating interpretive hardware and software that is capable of detecting:

- the presence of ice on the road pavement; and,
- the environmental conditions with a potential to form ice.

b) The above system shall include, as a minimum, sensing devices to detect the following:

- Pavement temperature,
- Sub-pavement temperature,
- Moisture on the pavement,
- Air temperature,
- Relative humidity, and
- Rain

c) Ice Warning Station Controller which will interface with the weather sensing equipment.

d) Warning signs (facing approaching traffic), with each sign incorporating two or four VicRoads type approved 200mm single-aspect flashing yellow LED lanterns

e) Control and communication equipment to facilitate the relay of information and command between the Master Station and STREAMS, and between the Master Station and the Slave Stations.

5.3 SLAVE STATION

5.3.1 The Slave Stations shall each incorporate the following elements:

a) Warning signs (facing approaching traffic), with each sign incorporating two or four VicRoads type approved 200mm single-aspect flashing yellow LED lanterns.

b) Control and communication equipment to facilitate the relay of information and command between the station and STREAMS or between the Master Station and the Slave Stations.

SECTION 6 SIGN REQUIREMENTS

6.1 STATIC SIGNAGE

6.1.1 All static ice warning signs shall be in accordance with VicRoads Supplement to AS 1743:2001 Drawing Number 442637 for free standing signs or VicRoads standard drawing TC-2041 for bridge mounted signs, and shall conform to all relevant requirements of AS 1743.

6.2 FLASHING YELLOW SIGNAL ASPECTS

6.2.1 The ice warning signs shall each incorporate either two or four VicRoads Type Approved single-aspect, yellow, 200mm, LED lanterns, as per VicRoads Supplement to AS 1743:2001 Drawing Number 442637 and VicRoads standard drawing TC-2041.

6.2.2 The lanterns shall be fitted with Type 1, 'open' visors in accordance with VicRoads Standard Drawing TC-1127.

6.2.3 The flashing yellow signal aspects shall operate at ELV level of 42Vac.

6.2.4 The LED lanterns shall be of a type previously approved by VicRoads, and shall conform to AS/NZS 2144.

6.3 SIGN SUPPORT POST

6.3.1 The sign support post shall be VicRoads type approved slip base modified pole and installed in accordance with the requirements of VicRoads Supplement to AS 1742.2:2009, Appendix D4.

6.3.2 The sign support structure shall be based on a Slip Base Pole Assembly Ground Set Mounted standard drawing TC-1065 with the following changes:

a) Above ground pole height of 5 meters;
b) Exclusion of spigot;
c) Top of the pole capped;
d) Standard lugs removed;
e) Alternative lugs as per Figure 2 below:

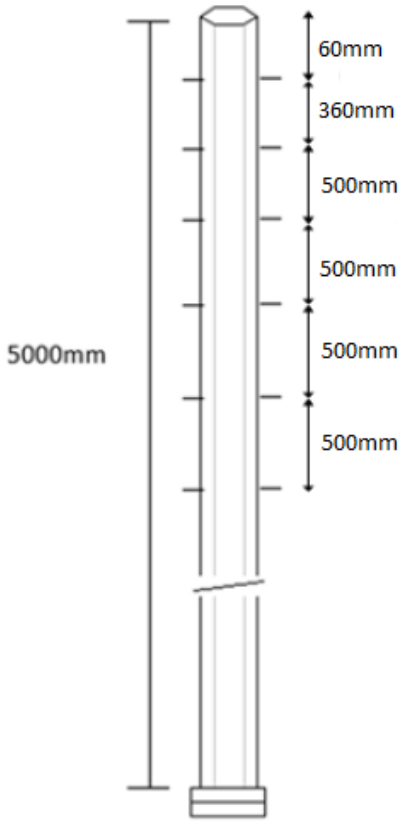

Figure 2
Dimensions and lugs spacing for AAWS and Ice Warning support pole

6.3.3 The dimensions of the lugs of sign support structure shall be as shown in Figure 3.

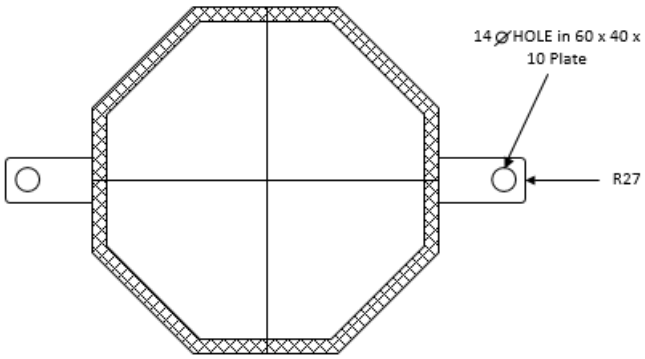

Figure 3
Dimensions of lugs for AAWS and Ice Warning support pole

SECTION 7 CONTROL AND COMMUNICATION

7.1 GENERAL

7.1.1 Ice Warning Station Controller shall be capable of performing and processing all of the functions for detection of weather conditions conducive to the formation of black ice.

7.1.2 Ice Warning Station Controller shall constitute the interface between the ice detection control system and the VicRoads ITS Platform (See Appendix A).

7.1.3 Prior to supply and installation, the contractor shall supply details of the proposed Ice Warning Station Controller, modems and telemetry radio units (where used).

7.2 COMMUNICATION

7.2.1 The contractor shall make provision for the connection of the Master Station, and Slave Stations (where applicable) to the communication network.

7.2.2 All conduit for communication cables shall be 32mm, heavy duty grade, rigid, white UPVC communication conduit to AS/NZS 2053.2 and shall comply to the current ACMA publications and standards.

7.3 ITS COMMUNICATIONS PLATFORM

7.3.1 All Ice Warning Stations shall be fully compatible with VicRoads ITS Platform (See Appendix A).

7.4 DATA TRANSMISSION

7.4.1 Communications is required between the Ice Warning Stations system and VicRoads VPN network and shall be via a TCP/IP compatible network link, such as cellular wireless connection.

7.5 TIME ACCURACY

7.5.1 Ice Warning Stations shall be able to synchronise its internal clock with VicRoads provided NTP server via NTP protocol.

7.5.2 All data shall be time stamped in milliseconds.

7.6 CONFIGURATION

7.6.1 Configuration tools shall be provided by the manufacturer.

7.6.2 The configuration tools shall enable configuration of device parameters and detection layout via IP network.

7.6.3 The configuration tools shall operate correctly on VicRoads standard operating environment.

7.7 RADIO COMMUNICATION LINKS

7.7.1 Where low-powered radio communications between the Master and Slave are required by the contract, the contractor shall supply and install suitable radio telemetry units at each site.

7.7.2 The radio units chosen by the contractor must have a suitable range for communication between the Master Station and each Slave Station, without the necessity for a radio licence.

7.7.3 The aerial type must ensure reliable communications between the units in all weather conditions, and must be securely mounted such that the base is at least 2.5 metres above ground level.

7.7.4 It is the contractor's responsibility to ensure that reliable radio communications can be guaranteed during all weather conditions, as their performance will be most critical when weather conditions are the most adverse.

7.7.5 Details of any proposed radio units must be supplied at the time of tender.

SECTION 8 ELECTRICAL REQUIREMENTS

8.1 GENERAL

8.1.1 In addition to complying with this specification, the signs and associated system shall comply to all relevant requirements of AS/NZ 3000 and AS/NZ 3100.

8.1.2 Transformers used within the sign and/or sign control system shall comply with AS/NZS 61558, " Safety of power transformers, power supply units and similar".

8.1.3 All cables and wires shall be insulated with a material not inferior to V-105 grade PVC and shall be suitably labelled.

8.1.4 The mains power supply provided will be 240 Volt, 15 amp, 50 Hz AC, and the system and/or sub-elements of the system shall be capable of operating satisfactorily from same within +/- 15%. The system shall be capable of being isolated from mains supply at ground level.

8.2 INTERNAL PROTECTION

8.2.1 All equipment shall be internally protected against damage resulting from:

- lightning strikes at or near the cabinets and signs;
- electrical transients on power cabling;
- electrical transients on signal wiring;
- radio frequency interference; and,
- static electrical discharge

8.3 POWER SUPPLY

8.3.1 The contractor shall be responsible for the installation of all power supply requirements. This includes cable, conduits, pits, circuit breakers and connections from the nominated point of supply to the cabinets and signs.

8.3.2 Prior to commencing works, the contractor will provide a sketch detailing the proposed ‘points of supply’, and cable routes.

SECTION 9 ENVIRONMENTAL REQUIREMENTS

9.1 AMBIENT CONDITIONS

9.1.1 The control system shall operate correctly in ambient temperatures in the range -15◦C to +60◦C, and with up to 90% relative humidity, and with up to 1 kW/m2 insolation applied to the maximum exposed surface.

9.2 EMC COMPLIANCE

9.2.1 All equipment covered by this specification shall comply with all relevant requirements of the Australian Communications and Media Authority (ACMA) for EMC and shall be labelled with a conforming RCM compliance label as detailed in Figure 2.

Figure 9.2 - RCM compliance label

9.2.2 The control system and/or communication components shall be provided with radio interference suppression to comply with the requirements of AS/NZS 61000.6.3.

9.2.3 The control system and/or communication components shall be provided with protection against transients and surges present on the 230Vac mains supply, electrostatic discharge and radiated or conducted radio frequencies to comply with the requirements of AS/NZS 61000.6.1:2006.

9.2.4 The control system shall meet the requirements of the prescribed tests as detailed in the following standards:

a) electrostatic discharge (AS/NZS 61000.4.2);
b) fast transients on the mains supply (AS/NZS 61000.4.4);
c) surges on the mains supply (AS/NZS 61000.4.5);
d) radiated radio frequencies (AS/NZS 61000.4.3); and
e) conducted radio frequencies (AS/NZS 61000.4.6).

9.2.5 A copy of the above ACMA determination shall be provided to VicRoads.

SECTION 10 DOCUMENTATION

10.1 GENERAL

10.1.1 Prior to installation, the contractor shall provide to VicRoads, for review and retention, copies of:

- wiring and cabling layouts and circuit diagrams;
- manufacturer's specifications (catalogue extracts) of LED lanterns detailing ratings and performance characteristics;
- details of all hardware to be installed; and,
- proposed ‘points of supply’ and cable route plans for both power and communications.

10.1.2 Prior to the commissioning of the sign and associated system, the contractor shall provide:

- The contractor shall provide documents on a proposed schedule for routine operational checks and preventative maintenance tasks that need to be performed on the signs and system equipment;
- a statement confirming the warranty provisions associated with the ice detection equipment, signs and associated systems; and
- a copy of the "Operation and Maintenance" manual for the sign, local control and monitoring systems detailing the functionality of all components and suggested maintenance schedule.

APPENDIX A

VICROADS ITS PLATFORM

(Informative)

A1 GENERAL

A.1.1 VicRoads ITS platform currently uses the STREAMS system.

A.1.2 STREAMS is owned and maintained by Transmax, a Queensland based company which is part of Queensland Main Roads.

A.1.3 STREAMS is an integrated control system which is being used by VicRoads to operate ITS Ice Warning Station devices.

A.1.4 All ITS field devices must be compatible with STREAMS.

A.1.5 Typical ITS field devices connected to and operated by STREAMS include:

- Variable Message Signs (VMS)
- Freeway Data Stations (FDS)
- Ramp metering/control signs
- Lane Control Signs (LCS)
- Advanced Active Warning System (AAWS)

A.1.6 A typical STREAMS connection schematic is shown in Figure A1.

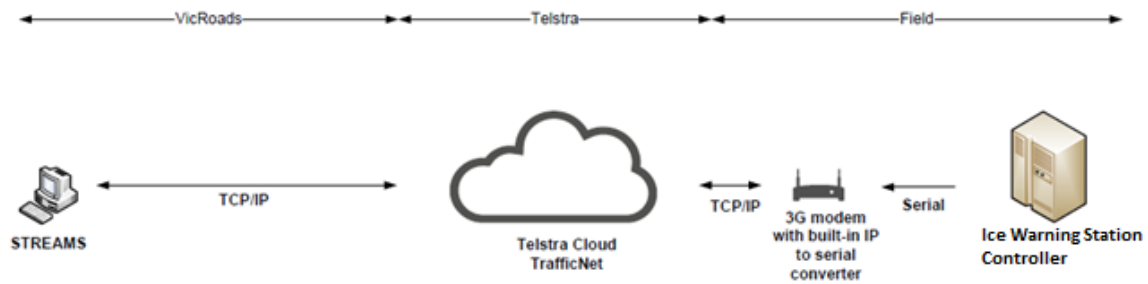

Figure A1 – Ice Warning Station connected to STREAMS

A2 VICROADS ANCILLARY ITS DEVICE PROTOCOL (VERSION 1.10)

A.2.1 VicRoads Ancillary ITS Device Protocol has been designed to manage simple road side devices.

A.2.2 Currently the protocol is used for Advanced Active Warning Signs (for rail crossings) (AAWS) and Ice Warning Station Systems.

A.2.3 This protocol has been created to cater for communications transport upgrades for remote AAWS and RTWS from dial-up to TCP/IP.

A.2.4 The protocol can be provided by ITS Improvement & Standards team.

APPENDIX B

REQUIREMENTS FOR TYPE APPROVAL

(Normative)

B1 GENERAL

B1.1 Ice Warning Stations for use on VicRoads projects are required to hold current VicRoads Type Approval.

B1.2 The Product Compliance evaluation process shall be carried out in accordance with VicRoads Guideline TCG 016.

B1.3 To enable assessment for the purpose of granting Type Approval, the supplier must provide the following:

a) A complete working sample of Ice Warning Station.
b) An outline drawing showing the general presentation and overall dimensions of the complete system.
c) Documentation to demonstrate that the Ice Warning Station has been manufactured and supplied under an approved quality assurance system.
d) Documentation to demonstrate that the system conforms to the requirements of VicRoads Specification. This may be by means of submitting test results from approved and appropriately qualified independent testing organisations, or providing the manufacturer's assurance that the product complies with each paragraph of the specification.

B1.4 Alternatively, the supplier may submit evidence of Type Approval of the same product by another Australian State Road Authority, together with details of volume and period of usage by other jurisdictions.

B2 REQUIRED NATA ACCREDITED TESTING

B2.1 Notwithstanding C1 above, the supplier shall submit test results from a NATA accredited testing organisation to demonstrate compliance with the following:

Clause	Requirements	Evidence
9.1	Temperature and humidity	Test Report
9.2	EMC Compliance	Test Report

B3 COMPATIBILTY WITH VICROADS ANCILLARY ITS DEVICE PROTOCOL

B3.1 The supplier shall provide evidence of compatibility with VicRoads Ancillary ITS Device Protocol.

B4 STREAMS COMPATIBILTY

B4.1 The supplier shall provide evidence of compatibility with STREAMS.

B5 ASSESSMENT PROCEDURE

B5.1 The assessment procedure for Ice Warning Stations will include, but not be limited to, the following:

- Assessment of construction, workmanship and critical dimensions.
- Evaluation of the submitted data against the requirements of the specification.
- Operation of the sign on VicRoads system.

B6 OTHER REQUIRED TESTING

a. VicRoads may require field testing to be carried out as part of its evaluation of the product.
b. VicRoads may require additional information or testing to be carried out as part of its evaluation of the product.
c. If the product is approved, a Certificate of Type Approval will be provided to the supplier. Until such time as this Certificate is issued, the product is not to be used in the State of Victoria.

APPENDIX C

INSTALLATION AND COMMISSIONING GUIDELINES

(Informative)

C.1 SITE INSTALLATION

C.1.1 The exact locations of all components of the Ice Warning System will be detailed in individual tender documents.

C.1.2 The contractor shall be responsible for the supply and installation of all equipment required for the IWS including but not limited to:

a) the ice warning signs;
b) LED yellow lanterns and associated control gear and flasher units;
c) posts and/or mounting structures;
d) weather condition sensing equipment and associated processing systems;
e) cabinets and enclosures at each site;
f) power cabling from the "point of supply" to the equipment;
g) communication cable from the communications network to the equipment; and,
h) all pits and conduits required for connection of power and communications.

C.2 COMMISSIONING

C2.1 The contractor shall be responsible for the commissioning of the whole system, including:

a) weather condition sensing, sign operation, communication and associated control equipment;
b) access for local operation and maintenance purposes;
c) testing the integrity of the signs and system;
d) submission of documentation relating to the maintenance and testing procedures for the system and the associated components.

C.3 FREE STANDING SIGN MOINTING REQUIREMENTS

C3.1 All signs shall be mounted on type approved slip base post, such that the base of the sign is 5 metres above ground level.

C3.2 It shall be the contractor’s responsibility to ensure that the posts are dimensioned appropriately to withstand wind forces for the region as defined in AS 1170.2.

C.4 BRIDGE SIGN MOINTING REQUIREMENTS

C3.1 Where the signs are to be mounted on bridge structures, the contractor shall be required to proof-engineer and fabricate all sign-mounting brackets in accordance with the relevant Australian Standards.

C3.2 The signs shall be installed such that:

a) The centre of each sign is aligned with the centre-line of the carriageway;
b) The signs are oriented at 90-degrees to the approaching carriageway;
c) Existing height clearances below the bridge deck are maintained;
d) The sign and structures do not allow or encourage pedestrian access from the bridge structure; and,
e) The installation does not adversely affect the structural integrity of the bridge.

C3.3 It shall be the contractor's responsibility to consult with, and obtain agreement from, VicRoads on the proposed method of sign support prior to the commencement of works.

C.5 CABINETS AND ENCLOSURES

C.4.1 Master Station

- At the Master Station, where ice detection hardware is installed, the contractor shall install ITS Field Cabinet in accordance with TCS 061.
- The cabinet shall be fitted with standard VicRoads locks.
- The foundation and conduit details shall be in accordance with VicRoads standard drawing TC-2002.

C.4.2 Slave Stations (Free Standing Signs)

- Where the signs are free-standing, all control equipment shall be mounted within a suitable weatherproof enclosure.
- For maintenance purposes, the cabinet shall be mounted on the rear of the sign such that the cabinet is accessible without the use of a ladder.

C.4.3 Slave Stations (Bridge Mounted Signs)

- Where the signs are to be mounted on bridge structures, the control cabinet shall be mounted on a 2B pedestal or other suitable arrangement to enable access from ground level for maintenance purposes.

APPENDIX D

RECOMMENDED MAINTENACE GUIDELINES

(Informative)

D1 Regular routine maintenance of recommended.

D2 The maintenance activities to be carried out for Ice Warning Stations should include, but should not be limited to the following:

(a) Check that the overall system is intact, secure, clean and undamaged;
(b) Ensure all cables and connectors are in good condition and firmly placed in sockets and connectors;
(c) Ensure all wiring and cabling is securely connected and supported;
(d) Ensure signal and connection strength;
(e) Ensure pole is secure at base and tighten rag bolts as necessary;
(f) Inspect and ensure locks, where fitted, are secure;
(g) Inspect, repair or replace all faulty, damaged or missing fixing accessories (i.e. washers, nuts and bolts etc.)
(h) Ensure there is power to assets;
(i) Perform preventative maintenance as per manufacturer's specifications; and
(j) Ensure Active Ice Warning Stations operation is legible;