Appendix A

Transport and Main Roads Specifications

MRTS222 Electronic School Zone Signs

March 2020

Contents

[Type Approval Compliance Checklist 1](#_Toc33777069)

Type Approval Compliance Checklist

| **Row number** | **MRTS222** – **Compliance Requirement** | **Reference**  **clause** | **VERIFICATION METHOD** | | | | | **Product Compliance (Y,TBC,N,N/A)** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Visual Inspection** | **NATA approved certificate (or equivalent)** | **Field/Bench Test** | **Detailed Drawings** | **Manufacturer conducted tests records / other documents** |
| **Structural / Mechanical** | | | | | | | | |
| 1 | The signs shall comply with the requirements of MRTS14 and the Design Guidelines for Roadside Signs. | ***6.1*** |  |  |  | **X** |  |  |
| 2 | Where required, pits and conduits to accommodate power and communication cables shall be supplied and installed according to the requirements of MRTS91. | ***6.1*** | **X** |  |  | **X** |  |  |
| 3 | The mechanical and physical requirements defined in MRTS201 apply to this standard. This includes the enclosure and its fixing arrangement. | ***6.1*** | **X** |  |  | **X** |  |  |
| 4 | 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. | ***6.1*** | **X** |  |  |  | **X** |  |
| 5 | The equipment and enclosures shall be of suitable design to protect against vandalism, and prevent infestation by vermin. Ingress protection (IP) rating for enclosures shall be no less than IP55 as defined in AS 60529. This includes all cable penetrations and equipment that may be located external to the enclosure. Physical LED protection shall be such that optical performance of the sign is unaffected. The signs shall be fitted with anti vandal features to reduce and deter vandalism to the sign and solar panel. | ***6.1*** |  | **X** |  |  |  |  |
| 6 | For type 1 signs, the sign face material shall be aluminium. The flashing light assembly and accessories shall not cause the sign face to warp. The diameters of the flashing lanterns associated with each sign of sizes A, B or C, shall be in accordance with TC1783. | ***6.1*** | **X** |  |  |  | **X** |  |
| 7 | Associated sign control electronics shall be housed in an enclosure and in a manner which allows access for maintenance. Doors shall be capable of being hinged from either the left or right, but unless specified otherwise, shall be hinged from the left. The enclosure shall be fitted with a door switch to indicate if the enclosure door is open or improperly closed. All doors accessible to the public shall be lockable. | ***6.2*** | **X** |  | **X** |  | **X** |  |
| 8 | Venting and air circulation arrangements shall be such that the thermal ratings of the electronics are not exceeded. Use of filters and forced cooling such as by use of fans is not allowed. Peltier devices or other similar means may be used for moisture control. Door seals are to ensure sustained ingress protection for the service life of the sign. | ***6.2*** |  |  |  |  | **X** |  |
| 9 | Static and wind design loads shall be in accordance with AS 1170.1 and AS 1170.2. | ***6.6*** |  |  |  |  | **X** |  |
| 10 | Each sign and associated equipment shall be capable of being pole mounted. | ***6.7*** | **X** |  | **X** |  |  |  |
| 11 | Mounting hardware shall provide means to adjust the vertical and/or horizontal alignment of each sign and solar panel(s) during commissioning and subsequent maintenance activities. | ***6.7*** | **X** |  | **X** |  |  |  |
| 12 | Solar module(s) shall be mounted above the top of the sign at a height of no less than 4.0 metres. The solar module angle of elevation shall be suitably adjusted in order to optimise performance at the latitude where the sign is to be installed. The design of the solar modules shall include a deterrent mechanism for stopping birds from resting on the solar module structure. The solar module and mounting structure shall be fitted with anti-vandal features. | ***6.7*** | **X** |  |  |  |  |  |
| 13 | Unless otherwise specified the pole material and galvanised finish shall be as per MRTS 97 and its referenced documents. Poles shall be designed and approved by a structural RPEQ. All footings shall be consistent with MRTS 92 but shall be designed and approved by a structural RPEQ. | ***6.7*** |  |  |  |  | **X** |  |
| 14 | Structural design(s) suitable for installation on roads with a speed limit of up to 80 km/h shall be provided. | ***6.7*** |  |  |  | **X** |  |  |
| 15 | There shall be a fitting which allows the swivel adjustment of the azimuth about the vertical of 360o without stops. The swivel point shall be designed and fitted with a method which will stop the subsequent rotation of the solar PV module. | ***6.7*** | **X** |  | **X** |  | **X** |  |
| 16 | Details of the design environment (batter slope, soil type, etc.) and mounting structure for each sign shall be shown in the design documentation. This includes the complete sign’s structure: footings, solar panel, cabinet, poles, sign face, all brackets, fixings and fastenings and any other structural components.  The design documentation shall be certified by an RPEQ engineer and submitted to the Principal’s representative for acceptance before installation. | ***6.7*** |  |  |  | **X** |  |  |
| 17 | Each sign shall be durably marked internally to show sign type, serial number, date of manufacture RCM-Tick compliance, and firmware release version. The details shall allow traceability of the sign manufacture according to the Contractor’s quality system. | ***6.9*** | **X** |  |  | **X** | **X** |  |
| 18 | The rear of each sign shall be affixed with a unique identification number as nominated by the Principal and a telephone number to call in the event of a fault or damage to the sign. The label shall be designed to last 10 years in the range of environmental conditions described in MRTS201. The label shall be clearly legible from 1.5 meters above ground level, a distance of 5 meters from the base of the sign. | ***6.9*** | **X** |  |  |  |  |  |
| 19 | Solar modules shall have a deterrent mechanism for stopping birds from resting on the module. | ***12.2.2*** | **X** |  |  |  |  |  |
| **Displays** | | | | | | | | |
| 20 | NATA optical performance certificates shall be submitted before delivery to site. **Hold Point 2** | ***4.1*** |  | **X** |  |  |  |  |
| 21 | The sign shall only display the regulatory school zone speed applicable at the school zone where the signs are installed. | ***5.1*** | **X** |  |  |  |  |  |
| 22 | The enhanced school zone speed limit sign face shall be as outlined in TC1783. TC1783 is the same as R4-Q01 except that the enhanced sign has   * a set of flashing lights or wig-wags above the “school zone” wording; and * has one or more LED based rings located within the confines of the static annulus. | ***5.2.1*** | **X** |  |  | **X** |  |  |
| 23 | The annulus and wig-wag LEDs shall be red and yellow respectively. | ***5.2.1*** | **X** |  |  |  | **X** |  |
| 24 | The annulus and wig-wags shall flash continuously during the designated school zone periods and at no other times. The flash rate of the annulus and the wig-wags shall be the same, meaning that the annulus will flash simultaneously with one of the wig-wag LED lanterns. The wig-wags shall flash alternately. | ***5.2.1*** | **X** |  |  |  | **X** |  |
| 25 | If LEDs are used for the flashing lights, the luminance of the LEDs, when measured under laboratory conditions shall comply with the requirements of AS5156 | ***6.1*** |  | **X** |  |  |  |  |
| 26 | The apparent width of all displayed elements including text shall match the respective sign display defined in the MUTCD. The minimum legibility (sight) distance shall be sufficient for both the respective school zone speed and the default speed limit before the sign. | ***7.1*** | **X** |  |  |  | **X** |  |
| 27 | The sign shall display only the regulatory speed applicable during the school zone designated time period. | ***7.1*** | **X** |  |  |  |  |  |
| 28 | The display technology shall be light emitting diode (LED). To achieve the required sign luminance levels, the display pixels may be formed by arranging one or more LEDs in a cluster. | ***7.2*** | **X** |  |  | **X** |  |  |
| 29 | Each individual LED shall be driven with a continuous current with no peak and/or magnitudes exceeding 70% of the LED manufacturer's maximum continuous rating. For LEDs in a 5mm or smaller diameter package, peak magnitudes of the LED current shall not exceed 20mA. | ***7.3*** |  |  |  |  | **X** |  |
| 30 | Only fonts accepted by the Principal’s Representative shall be used. | ***7.4*** | **X** |  |  | **X** |  |  |
| 31 | Numerals for Type 1 signs shall be as per R4-Q01 | ***7.4*** | **X** |  |  | **X** |  |  |
| 32 | The annulus shall not be less in size than that required for an equivalent static sign. | ***7.4*** | **X** |  |  | **X** |  |  |
| 33 | There shall be no discernible flickering of the displayed numerals or static portion of the annulus. Background flickering as a result of checking the ‘on’ and ‘off’ pixel status shall not be visible. | ***7.5*** | **X** |  |  |  |  |  |
| 34 | The red, yellow and white colours for all sign types shall fall within the chromaticity coordinates specified in Section 2 of AS5156 | ***7.6*** | **X** | **X** |  |  | **X** |  |
| 35 | The annulus for the Type 1 sign shall comply with the requirements of TC1783. | ***7.9*** | **X** |  |  | **X** |  |  |
| 36 | The annulus rings in all cases shall be constructed so that LEDs connected in series are separated by at least 3 LEDs from other circuits. | ***7.9*** | **X** |  |  | **X** |  |  |
| 37 | The flash rate for elements of the sign that are required to flash shall be configurable and shall initially be set to 50/50 (lit/unlit) with a cycle time of 1 second. | ***7.10*** | **X** |  |  |  | **X** |  |
| 38 | The optical performance for all sign types shall be determined by measurement under laboratory conditions of the parameters listed in AS5156:   * minimum luminance ratio * minimum and maximum luminance and luminous intensity uniformity; and * colour as per AS5156   The performance of the sign displays shall meet or exceed the parameters listed in Table 8.2. Witness Point | ***8.1*** |  | **X** |  |  |  |  |
| 39 | The luminance of the LEDs, when measured under laboratory conditions shall comply with the requirements of AS 5156 | ***8.2*** |  | **X** |  |  |  |  |
| 40 | The LED intensity must be controlled to provide constant apparent brightness and maximum legibility distance for the range of the ambient light under which the sign must operate. | ***8.3*** | **X** |  | **X** |  |  |  |
| 41 | The levels of brightness, the number of light sensors, and the automatic dimming control functionality shall be in accordance with the LED intensity control requirements in AS 5156. | ***8.3*** |  | **X** |  |  |  |  |
| 42 | The luminance intensity half angle shall be comlied with the requirements of AS 5156. | ***8.4*** |  | **X** |  |  |  |  |
| 43 | The effect of sunlight or other light sources shining on the optical elements shall be controlled such that inactive pixels do not appear active. | ***8.5*** | **X** |  |  |  |  |  |
| 44 | For Type 1 signs, provision shall be made for each lantern to be fitted with a visor to minimize sun-phantom and veiling illuminance effects or to reduce the possibility of a flashing signal being seen by traffic for which it is not intended. | ***8.5*** | **X** |  |  |  | **X** |  |
| 45 | The visor shall be sufficiently rigid to withstand distortion due to wind and extreme temperatures. | ***8.5*** | **X** |  |  |  | **X** |  |
| 46 | The interior surface of visors shall be finished so as to minimize reflections of the illuminated signal. | ***8.5*** | **X** |  |  |  | **X** |  |
| **Control** | | | | | | | | |
| 47 | The calendar function shall be able to be programmed three years in advance. The school days shall be confirmed during the commissioning activities and retained as part of the non-volatile information stored in the sign. | ***7.1*** | **X** |  | **X** |  | **X** |  |
| 48 | Facilities shall be included to detect failures within the display control system with the sign blanking the display when major faults are detected. | ***7.7*** | **X** |  | **X** |  |  |  |
| 49 | In the case of Type 1 signs, loss of 20% of the annulus LEDs or 20% of either of the wig-wag lantern LEDs shall cause the sign to blank. | ***7.7*** | **X** |  | **X** |  |  |  |
| 50 | The sign shall blank the display for the following conditions:   * a sign processor fault * corruption of the calendar, time function; and * failure of 20% of LEDs of the annulus and/or any digit or when displayed digit cannot be readily recognised. | ***7.7*** | **X** |  | **X** |  |  |  |
| 51 | The sign shall also blank the whenever the battery voltage is lower than the set threshold. However, upon battery recharge, the sign shall resume normal operation. | ***7.7*** | **X** |  | **X** |  |  |  |
| 52 | Ambient light sensor failure should not result in blanking of the display. Upon failure of the ambient light sensor, the sign should fall back to time-of-day brightness levels. | ***7.7*** | **X** |  | **X** |  |  |  |
| 53 | If required, the sign shall log all operational and fault events, including the date and time that the event occurs. Details of these events shall be available via the Remote Sign Management System. The logging capacity shall be such that the logged data is of a minimum of one month duration. These events include, but are not limited to:   * activation of the school zone period (all signs) * activation of display during school zone period (Type 3 sign) * speed data (Type 3 signs) with adjustable bins where minimum bin width is 1 km/h * Lower Energy Alarm (sign will not work in 24 hours if the battery does not receive charge in that time) * loss of power (main and auxiliary) * power restoration (main and auxiliary) * high or low battery voltage occurrence * door opening * Daily Power Consumption * failure to communicate with the remote control centre * LED failure * light sensor failure * dimming level * loss of solar module * high enclosure temperature * local or remote connection, commencement and termination | ***7.8*** | **X** |  | **X** |  | **X** |  |
| 54 | Logs shall be recorded in Australia Eastern Standard Time (AEST) | ***7.8*** | **X** |  |  |  |  |  |
| 55 | The sign shall also log the sign enclosure temperature each minute. | ***7.8*** | **X** |  | **X** |  |  |  |
| 56 | The sign shall be provided with a 24 hour internal clock. The clock shall be able to be synchronised with the TMS system clock or other appropriate time source as determined by the Principal. Time error shall be no more than 1 second over a period of 1 week. | ***7.12*** | **X** |  | **X** |  | **X** |  |
| 57 | Where specified, a 3-position key operated facility switch that complies with MRTS201, shall be provided to enable selection of the following 3 display functions:   * off – display blank; control via all communications ports inhibited; status and diagnostic commands via all communications ports remain functional * test mode – display active; control via all communications ports inhibited; status and diagnostic commands via all communications ports remain functional; and * normal – display active; displayed message selected via the maintenance communications port and/or the control communications port. | ***7.13*** | **X** |  |  |  | **X** |  |
| 58 | The control system requirements defined in MRTS201 apply to this standard. Additional sign control system requirements for equipment provided under this standard are described below. | ***9.0*** |  |  |  |  |  |  |
| 59 | The sign shall be capable of autonomous operation and allow local as well as remote access by diagnostic software and remote sign management software respectively. Each sign shall be uniquely identifiable electronically and shall be able to create a character string for use by the remote sign management software for this purpose. | ***9.1*** | **X** |  | **X** |  |  |  |
| 60 | The sign shall allow local control via a maintenance communications port using a laptop or a handheld device. Local control shall be gained using the diagnostic software. The system shall provide secure access to the signs to prevent unauthorised access to the signs. | ***9.2*** | **X** |  | **X** |  |  |  |
| 61 | All sign diagnostics and configuration parameters able to be changed in the field shall be accessible when the sign is selected for local control. Remote control of the sign shall be disabled when the sign is selected for local control. When local control is selected any previously programmed autonomous operation is disabled. | ***9.2*** | **X** |  | **X** |  |  |  |
| 62 | Disconnection of a laptop or handheld device shall cause the sign to revert to autonomous operation. | ***9.2*** | **X** |  | **X** |  |  |  |
| 63 | Ending of the maintenance session shall not require further interaction from the user, nor in anyway interrupt operation or require rebooting of the sign but immediately let the sign to revert to autonomous operation. | ***9.2*** | **X** |  | **X** |  |  |  |
| **Communications** | | | | | | | | |
| 64 | The signs shall be capable of autonomous operation and allow local and remote update of the clock and calendar. | ***5.1*** | **X** |  | **X** |  |  |  |
| 65 | Each sign shall be capable of being accessed remotely via a communications port. The sign shall allow remote updates of the calendar and synchronisation of time with the remote sign management software. | ***9.3*** | **X** |  | **X** |  |  |  |
| 66 | The sign shall be able to service requests by the remote sign management software including status reports and a log of events. | ***9.3*** | **X** |  | **X** |  |  |  |
| 67 | The sign shall be able to send unsolicited status message/alarm to the remote sign management software should an event occur that requires blanking of the display~~,~~ annulus, numerals, or lanterns (wig wags). | ***9.3*** | **X** |  | **X** |  |  |  |
| 68 | The sign shall support remote connectivity via 4G and, optionally, 3G, GPRS, ADSL or the Principal’s Telecommunications network. The sign shall have session management ability in order to protect the system against unauthorised access via the communication ports. | ***9.3*** | **X** |  | **X** |  |  |  |
| 69 | The software shall   * request passwords as part of the access and configuration authorisation process; and * be compatible with Microsoft Windows® operating system environment, or equivalent. Any software provided shall be capable of operating on all such operating systems. | ***9.4.1*** | **X** |  | **X** |  |  |  |
| 70 | Diagnostic software shall be supplied with the sign for the purpose of sign configuration, commissioning and maintenance activities. | ***9.4.2*** | **X** |  | **X** |  | **X** |  |
| 71 | The diagnostic software shall fully implement all the sign functions required for the commissioning and maintenance of the sign. The diagnostic software shall be configured to request passwords as part of the sign access and configuration authorisation process. | ***9.4.2*** | **X** |  | **X** |  | **X** |  |
| 72 | If required, the diagnostic software shall be capable of suggesting ranges for each parameter as applicable when programming and not allow these limits to be exceeded. The diagnostic software shall have the capability to save and upload sign configurations to and from the respective school zone signs. | ***9.4.2*** | **X** |  | **X** |  | **X** |  |
| 73 | A desirable feature of the diagnostic software is a test program. This would facilitate testing of all the essential sign features including ability to activate, deactivate all pixels, select the number of the annulus inner rings to flash and to vary LED brightness. | ***9.4.2*** | **X** |  | **X** |  | **X** |  |
| 74 | The software shall allow the request of a full log of events and querying of events according to set criteria such as by sign(s), time, date, event type, or by duration. | ***9.4.2*** | **X** |  | **X** |  | **X** |  |
| 75 | It is intended that some of these signs will be connected to STREAMS in the future. As a result, detailed protocol information is to be provided in order to enable a STREAMS device driver to be written. The provision of this detailed protocol information may be used in the assessment of the product, both for tender evaluation purposes and for assessment of the product against this MRTS. | ***9.4.3*** |  |  | **X** |  | **X** |  |
| 76 | A remote Sign Management System must be supplied. The remote Sign Management Software should:   * detail the location and current status of all signs (operational, idle, fault condition) * show signs on a map-based GUI | ***9.4.3*** | **X** |  | **X** |  |  |  |
| 77 | Implement multiple levels of user access such as   * administrator * maintenance * standard user * read only | ***9.4.3*** | **X** |  | **X** |  |  |  |
| 78 | Allow querying of events according to set criteria such as by sign(s), time, date, event type, or by duration | ***9.4.3*** | **X** |  | **X** |  |  |  |
| 79 | Poll the signs in the field every 24 hours to verify the communications link and that the sign has not failed.  Failure of the sign management system to gain a response from the sign shall result in an event being logged in the system that highlights that the sign status is unknown and possibly failed or damaged | ***9.4.3*** | **X** |  | **X** |  |  |  |
| 80 | Allow updating and programming of each sign calendar; and | ***9.4.3*** | **X** |  | **X** |  |  |  |
| 81 | Backup / export / import of sign configuration and calendar. | ***9.4.3*** | **X** |  | **X** |  |  |  |
| 82 | Communication with the sign shall be in accordance with a protocol accepted by the Principal’s Representative and the requirements of MRTS201. | ***9.5*** | **X** |  | **X** |  | **X** |  |
| 83 | The telecommunications requirements defined in MRTS201 apply to this standard. | ***13.0*** |  |  | **X** |  | **X** |  |
| **Power/Electrical** | | | | | | | | |
| 84 | Options to energize the sign shall include Mains power and solar power. The electrical requirements defined in MRTS201 Clause 10, apply to this standard. Additional solar power requirements relevant under this standard are described below. | ***12.1*** | **X** |  | **X** |  | **X** |  |
| 85 | The sign shall be able to operate normally for voltage variation of between -13% and +25% of normal supply voltage. Battery back-up shall be provided for the real time clock and processor to allow orderly power down in the case of loss of power supply. | ***12.1*** | **X** |  | **X** |  |  |  |
| 86 | Power supply and control wiring connection/disconnection shall be designed without requirement for personnel to be holders of an electrical licence to perform this task. This will generally require the use of modular type connections. | ***12.1*** | **X** |  | **X** |  |  |  |
| 87 | Electrical Protection, Switching and Isolation and Lightning Protection shall be provided in accordance with AS 4509.2. High Rupture Capacity (HRC) fuses only shall be used for circuit protection. The switchboard shall be labelled with nominal voltage and current, DC or AC as well as the requirements of Fire Emergency Information required by AS 5033. | ***12.1*** | **X** |  | **X** | **X** | **X** |  |
| 88 | An electrical wiring diagram shall be provided in each enclosure, with details specific to each installation. | ***12.1*** |  |  |  | **X** | **X** |  |
| 89 | Detailed designs of the electrical wiring including the solar power and charging assembly shall be reviewed and signed by the Contractor’s RPEQ. They shall then be submitted and approved by the Principal or their delegate for verification and acceptance. | ***12.1*** | **X** |  |  | **X** | **X** |  |
| 90 | The total warranty for the solar power system shall be at least 5 years. | ***12.2*** |  |  |  |  | **X** |  |
| 91 | The solar power system shall be capable of operating the sign autonomously without recharge for a minimum period of 7 days throughout the entire warranty period. | ***12.2*** | **X** |  |  | **X** | **X** |  |
| 92 | The selection of the batteries shall be consistent with AS 4086.1 and subject to the following additional conditions   * the Secondary Battery technology shall have a high cycle life (>2000) and of a low-maintenance type * the battery must be able to handle high levels of Depth of Discharge (DOD) * the battery shall be of the type suitable for charging by solar cells; and * Batteries with liquid electrolytes shall NOT be used. | ***12.2.1*** | **X** |  |  | **X** | **X** |  |
| 93 | Batteries (and capacitors) shall be installed to minimize risk of   * impact by a motor vehicle * theft or vandalism; and explosion. | ***12.2.1*** | **X** |  |  | **X** | **X** |  |
| 94 | The choice, configuration, installation and testing of PV modules shall be consistent with AS 4509.1, AS 4509.2 and AS/NZS 5033. | ***12.2.2*** | **X** |  |  | **X** | **X** |  |
| 95 | All PV module fittings and adjustments shall be designed, manufactured and tested with appropriate theft prevention methods. | ***12.2.2*** | **X** |  |  | **X** | **X** |  |
| 96 | For single panel installations the open circuit voltage must be confirmed, when connected to the cable loom | ***14.4*** |  |  | **X** |  | **X** |  |
| **General/System Integration** | | | | | | | | |
| 97 | Detailed designs of the sign, equipment layout, fabrication and assembly drawings, calculations, specifications of component parts and certifications shall be submitted and approved by the Principal or their delegate for verification prior to manufacture. | ***4.1*** |  |  |  | **X** |  |  |
| 98 | Drawings shall specify the: sign face, enclosure, solar module(s), radar modules where necessary, posts and mounting accessories. The sign face drawings shall detail pixel rings, LED pixel arrangements showing horizontal and vertical pitch and character strokes as appropriate. | ***4.1*** | **X** |  |  | **X** | **X** |  |
| 99 | The Contractor’s specifications shall include the manufacturer and model of: LEDs to be used, power supply (charge controller and batteries), modems, communication ports, cable termination, enclosure and mounting accessories and wig-wags as appropriate. | ***4.1*** | **X** |  |  | **X** | **X** |  |
| 100 | Unless specified otherwise, a sample of the sign complete with software and hardware necessary for configuration, fabrication and assembly drawings, calculations, specifications, user manuals and certifications shall be submitted to the Principal for acceptance. **Hold Point 1** | ***4.1*** | **X** |  |  | **X** | **X** |  |
| 101 | Unless otherwise specified, the design life of components shall be as follows;   * LEDs/pixels: a minimum of 10 years * door switch: 50,000 operations * other electrical systems: a minimum of 10 years * sign enclosure: a minimum of 20 years * structural supports: a minimum of 40 years. | ***6.5*** |  |  |  | **X** | **X** |  |
| 102 | Type 3 signs shall have radar unit for speed detection |  | **X** |  |  |  | **X** |  |
| 103 | Where specified Type 1 shall have radar unit for speed detection |  |  |  |  |  | **X** |  |
| 104 | Where supplied radar unit shall be able to detect vehicles travelling at speeds ranging from 30 km/h to 160 km/h. |  |  |  | **X** |  | **X** |  |
| 105 | Radar unit where supplied shall have accuracy of better than 3% |  |  |  | **X** |  | **X** |  |
| 106 | Radar unit where supplied shall have range adjustable between 50 m and 100 m |  |  |  | **X** |  | **X** |  |
| 107 | Radar unit where supplied shall be able to detect approaching vehicles on multiple lanes |  |  |  | **X** |  | **X** |  |
| 108 | Radar unit where supplied shall be reported on QTDF format with resolution of 1 km/h. |  |  |  | **X** |  | **X** |  |
|  |  |  |  |  |  |  |  |  |
|  | **Colour Legend** |  |  |  |  |  |  |  |
|  | Already approved by TMR | Y |  |  |  |  |  |  |
|  | Demonstrated or achieved but not yet confirmed by TMR as approved | TBC |  |  |  |  |  |  |
|  | Not yet demonstrated, achieved or approved | N |  |  |  |  |  |  |
|  | Not required for ITST evaluation (e.g Structural Evaluation ) | N/A for ITST |  |  |  |  |  |  |
|  | Not required to be demonstrated or achieved | N/A |  |  |  |  |  |  |
|  | Heading or sub-heading row |  |  |  |  |  |  |  |