TS 05165:2.0

SPG 0706 and TS 01258:1.0 (CRN SC 015)

Standard

Installation of Trackside Equipment

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Document history

Revision	Effective date	Summary of changes
1.0	29 June 2023	First issue as TS 05165, superseding SPG 0706 *Installation of Trackside Equipment*, version 2.3. Version renumbered to 1.0 in line with new designation.
1.1	10 October 2023	Second issue. Changes from the previous version include; addition of installation requirements for axle counters; addition of ETCS level 1 and ETCS level 2 trackside equipment including: Balise signage –balise tail cables and balise mounting requirements; consolidation of common requirements between the MRA and CRA for the installation of trackside signalling equipment.
2.0	23 June 2025	Third issue.

Preface

This is a third issue.

This document supersedes the equivalent CRN standard TS 01258:1.0 (CRN SC 015) *Installation of Trackside Equipment*.

This standard sets out requirements for the installation of trackside signalling equipment.

The changes from the previous version include the following:

- added requirements for construction of signal foundations using cast-in-situ method to Section 6.9
- updated the reference to latest ground frame drawing M10-302.

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1 Scope

This standard sets out requirements for the installation of trackside signalling equipment, including signalling related control and communication equipment.

The document should be read in conjunction with TS 05166.

For works carried out in the MRA this document should also be read in conjunction with TS 05164.

For works carried out in the CRN this document should be read in conjunction with TS 01263.

2 Application

This document applies to TfNSW signalling and control system trackside assets being installed in the MRA and CRN.

This standard is intended for use by operators or maintainers and TAOs.

3 Referenced documents

The following documents are cited in the text. For dated references, only the cited edition applies. For undated references, the latest edition of the referenced document applies.

International standards

EN 61140 *Protection against electric shock – Common aspects for installations and equipment*

Australian standards

AS 1657 *Fixed platforms, walkways, stairways and ladders – Design, construction and installation*

AS 1744 *Standard alphabets for road signs*

AS 1906.1 *Retroreflective materials and devices for road traffic control purposes – Part 1: Retroreflective sheeting*

AS 3600 *Concrete structures*

Transport for NSW standards

TD 00004:2023 *Addition of 10-car intercity length – Amendment to TS 05333.1 (T HR SC 10001 ST) Signal Design Principles – Signals, v1.0*

TS 00003.1 *Concessions to Transport Standards – Part 1: Concessions Process*

TS 00012 *Signalling Signage*

TS 00026 *Ambient Environmental Conditions*

TS 01547.1 (T MU MD 00006 ST) *Engineering Drawings and CAD Requirements*

TS 01658 (T HR CI 12003 ST) *Civil Infrastructure Construction*

TS 03499 (ESC 210) *Track Geometry and Stability*

TS 03500 (ESC 215) *Transit Space*

TS 05163 (SPG 0703) *Signalling Documentation and Drawings*

TS 05164 *Construction of Cable Routes and Signalling Civil Works*

TS 05166 *Installation of Equipment Racks and Termination of Cables and Wiring*

TS 05167 (SPG 0708) *Small Buildings and Location Cases*

TS 05168 (SPG 0709) *Traction Return, Track Circuits and Bonding*

TS 05171 (SPG 0714) *Compressed Air Systems*

TS 05172 (SPG 0724) *Level Crossing Protection Equipment – Installation*

TS 05258 *Common Signals and Control Systems Equipment Requirements*

TS 05267 (SPG 0723) *Level Crossing Equipment Manufacture and Assembly*

TS 05269 (SPG 1011) *Cables for Railway Signalling Applications – Multi Core Signalling Cables*

TS 05270 (SPG 1012) *Cables for Railway Signalling Applications – Single and Twin Conductor Cables*

TS 05300 (SPG 1571) *Specification Light Signals*

TS 05303 (SPG 1588) *Points Mechanisms*

TS 05306 (SPG 1858) *Track Circuit Types, Characteristics and Applications*

TS 05312 (SPG 0711.2) *Plans, Programs, Documentation and Packages*

TS 05315 (SPG 0711.6) *Interface Requirements and Procedures for Alterations*

TS 05316 (SPG 0711.7) *Inspection and Testing of Signalling – Standard Forms*

TS 05333.1 (T HR SC 10001 ST) *Signal Design Principle – Signals*

TS 05333.6 (T HR SC 10006 ST) *Signalling Design Principle – Signalling Signs*

TS 05333.17 (T HR SC 10017 ST) *Signalling Design Principle – Train Detection Systems*

TS 05333.31 *Signalling Design Principle – ETCS Level 1*

TS 06178 (T MU MD 00005 GU) *Type Approval of Products*

UGL Regional Linx standards

Note: UGL Regional Linx standards are available on the UGL Regional Linx website.

CRN SO 002 *Train Control and Signalling Telemetry Systems*

CRN SP 049 *Signal Engineering Waivers*

TS 01046 (CRN CS 215) *Transit Space*

TS 01249: (CRN SC 006) *Signalling Documentation and Drawings*

TS 01250 (CRN SC 007) *Inspection and Testing – Roles, Responsibilities and Authorities*

TS 01251 (CRN SC 008) *Inspection and Testing – Plans, Programs, Documentation and Packages*

TS 01257 (CRN SC 014) *Type Approval Requirements for Signalling Systems and Equipment*

TS 01261 (CRN SC 018) *Level Crossing Equipment*

TS 01263 (CRN SC 021) *Cable Routes and Associated Civil Works*

TS 01264 (CRN SC 022) *Small Buildings and Location Cases*

TS 01333 (CRN SE 035) *Cables for Railway Signalling Applications*

TS 01334 (CRN SE 036) *Lights – Signals*

TS 01335 (CRN SE 037) *Point Mechanisms*

TS 01336 (CRN SE 038) *Level Crossing Equipment*

TS 01337 (CRN SE 039) *Track Circuit Types, Characteristics and Applications*

TfNSW drawings

TS 00137 (E1-451) *Overhead Wiring Structures – Double Channel Feeder or Signal Structure Ladder and Cage*

TS 05178.63 (M01-163) *Guard/Buffer Light Post – Manufacturing Details*

TS 05178.68 (M01-168) *2m Raised Ground Shunt Post Access Ladder – Manufacturing Details*

TS 05180.02 (M01-302) *Foundation Precast Concrete Details – Dwarf Colour Light Signal*

TS 05180.03 (M01-303) *Foundations Pre-cast Concrete Assy – Material Lists for 140 Posts*

TS 05180.04 (M01-304) *Dwarf Signal Pre-cast Concrete Foundation Assembly 114 Post*

TS 05196.12 (M04-012) *JA-JAH Trainstop Protection Ramp – Type 2*

TS 05196.22 (M04-022) *Train Stop Gauge for Setting StopArm Type C*

TS 05196.25 (M04-025) *Protection Ramp JA-JAH Trainstops on Concrete Sleepers*

TS 05196.27 (M04-027) *JA-JAH Trainstop Mounting on Concrete Sleepers Type 4*

TS 05196.28 (M04-028) *JA-JAH Trainstop Mounting Type 4 –Details*

TS 05196.33 (M04-033) *Trainstop Protection Ramp J Series Trainstops on Wooden Sleepers – Bidirectional Running*

TS 05204.00 (M05-500) *ETCS Balise Mounting Pad*

TS 05204.01 (M05-501) *Alstom Balise with Timber Mount Installation Diagram*

TS 05204.02 (M05-502) *Alstom Balise with Concrete Mount Installation Diagram*

TS 05204.03 (M05-503) *Alstom Balise Position and Orientation Acceptance Diagram*

TS 05204.04 (M05-504) *ETCS Trackside Junction Box Assembly Details*

TS 05204.07 (M05-507) *Alstom Balise – Plain Line Standard Placement Diagram*

TS 05204.10 (M05-510) *ETCS Trackside Above Ground Junction Box Installation Diagram*

TS 05204.11 (M05-511) *ETCS Trackside Junction Box Cable Termination Details*

TS 05204.12 (M05-512) *Balise Worst Case Placement Diagram at End of Platform*

TS 05204.24 (M05-524) *Balise Location ID Plate Manufacturing Diagram*

TS 05204.44 (M05-544) *Balise Location ID Plate Attachment Diagram*

TS 05204.45 (M05-545) *Alstom Balise Longitudinal Mounting Plate Assembly Diagram*

TS 05204.46 (M05-546) *Alstom Balise ID Plate Manufacturing Diagram*

TS 05204.48 (M05-548) *Between-Sleeper Vortok Spreader Beam – Alstom Balise Installation Diagram*

TS 05204.58 (M05-558) *Standard Placement of Alstom Balise at Guard Rails*

TS 05204.65 (M05-565) *Alstom ATP Temporary Speed Warning Balise Group Assembly and Fitment Diagram*

TS 05204.69 (M05-569) *On-sleeper Vortok Spreader Beam – Alstom Balise – Installation Diagram*

TS 05204.73 (M05-573) *ASDO Reference Balise Marker Plaque Manufacturing Diagram*

TS 05204.76 (M05-576) *ASDO Platform Limit Marker Plaque Manufacturing Diagram*

TS 05221.89 (M08-889) *Track Cable Protector Manufacturing Details*

TS 05221.90 (M08-890) *Drilling Template for Installation of Track Cable Protector on Sleeper*

M10-302 Ground Frame 2 Lever Arrangement Connections for 60kg 6100 Point (This drawing is available from the ECM Planroom. Access to the planroom is restricted to TfNSW employees and approved external organisations. To obtain access email planroom@transport.nsw.gov.au)

Other referenced documents

Sydney Trains, MN S 41604 *Alstom ETCS Trackside Maintenance Manual*

Sydney Trains, MN S 41606 *Balise Installation Constraint*

4 Terms, definitions and abbreviations

The following terms, definitions and abbreviations apply in this document.

A4 70 316 grade stainless steel describes that the metal material of the material or bolt is made of stainless steel of grade 316, cold worked to provide a minimum tensile strength of 700 (A4 stainless is often referred to as 316 stainless)

316 grade is the second-most common form of stainless steel. It has almost the same physical and mechanical properties as 304 stainless steel, and contains a similar material make-up. The key difference is that 316 stainless steel incorporates about 2 to 3 percent molybdenum which makes it more corrosion resistant.

ASDO automatic selective door operation

ATP automatic train protection

BMM big metal mass

BRM balise reference mark

CRN Country Regional Network

DPU data pick pp unit

DTRS digital train radio system

ETCS European train control system

four foot area between two rails of a track

ID identification

IRJ insulated rail joint

Jeumont Schneider a brand of high voltage impulse track circuit equipment used in the MRA and CRN

jointless track circuit brands of track circuits used in MRA and CRA which include Compagnie des Signaux et d'Enterprises Electriques (CSEE), ML Signalling (ML) and Westinghouse

LED light emitting diode

MLI main line indicator (used in the CRN)

MRA metropolitan rail area

OEM original equipment manufacturer

RIM rail infrastructure manager; In relation to rail infrastructure of a railway, means the person who has effective control and management of the rail infrastructure, whether or not the person –

a. owns the rail infrastructure; or

b. has a statutory or contractual right to use the rail infrastructure or to control, or provide, access to it.

TAO Technically Assured Organisation

TCB trackside connection box

TSR temporary speed restriction

TSW temporary speed warning

5 Quality of work, materials and installation life

The correct use of materials and workmanship should provide for a 40 year lifetime of the asset installation, while continuing to meet the safety, integrity, reliability, maintainability, operability and supportability specified in TfNSW standards.

The safety and protection of all staff shall be ensured during installation, testing, commissioning and maintenance of trackside equipment.

Quality of materials and workmanship shall also aim to ensure that the necessity for regular preventative maintenance tasks to retain the safety, reliability and usability of the asset over its lifetime is minimised.

In the MRA all relevant signal sighting, mechanical, site installation, layout or structural drawings shall be produced in accordance with TS 05163 and TS 05312 in the MRA and approved by persons with TAO authorisation.

In the CRN all relevant signal sighting, mechanical, site installation, layout or structural drawings shall be produced in accordance with TS 01249 and TS 01251 and approved by the CRN in accordance with their asset authorisation process for signalling.

All external metal components, hardware and components shall be hot dip galvanised to ensure the required 40 year design life is met without having to recoat or paint track side equipment.

Onsite drilling, cutting, welding or other machining or grinding of galvanized or zinc plated steel components shall not be permitted. The applicant’s concession or waiver application to the RIM shall detail how any drilled holes, machining, welding or grinding which exposes bare steel will be managed to ensure the design life is achieved without corrosion.

Where equipment is to be attached to other equipment or structures made from dissimilar metals there will be corrosion due to electrolytic action which will impact the durability of the installation. The dissimilar metals shall be separated with an insulating barrier or material to electrically isolate the dissimilar metals to ensure electrolytic corrosion does not occur.

5.1 Structure gauge

Equipment in the MRA shall be installed so that it does not infringe within the structure gauge defined in TS 03500.

Equipment in the CRN shall be installed so that it does not infringe within the structure gauge defined in TS 01263.

> Note: The size of the structure gauge envelope will vary according to location, track curvature, track superelevation, size equipment being installed and the vehicle outline of the rail vehicles using the line.

In the MRA network clearances shall be maintained where tracks converge in accordance with TS 03499.

Where physical or geographical limitations force the placement of equipment in the MRA within the structure gauge envelope is not to standard, a concession shall be obtained in accordance with TS 00003.1.

Where physical or geographical limitations force the placement of equipment in the CRN within the structure gauge envelope or the location of a clearance point is not to standard, then a signal engineering concession shall be obtained following the process in CRN SP 049.

5.2 Fasteners, nuts and bolts

All fasteners 8 mm in diameter or larger shall be hot dip galvanised or made from grade 316 stainless steel. For fasteners less than 8 mm diameter Zinc plating may be used.

Self-locking nuts, such as nyloc nuts, shall not be used with hot dip galvanised bolts unless the thread of the bolt is recut with a die nut before the nyloc nut is fitted. Where this is done, the thread shall be cold galvanised after the nut is fitted.

An anti-seize product shall be used between stainless steel threads and stainless steel nuts or inserts to prevent seizure.

Bolts and timber sleeper screws used to attach equipment to timber sleepers (or any timber at or close to ground level) shall be installed so that nuts are located on the top of the sleeper or timber. A special lock washer shall be installed under the head of the bolt to prevent rotation of the bolt. The nut shall be secured with antivibration medium strength thread locking fluid.

5.3 Signal room and equipment locks

Physical security of signal equipment and equipment rooms is important to maintain integrity of the installation and prevent unauthorised access to signalling equipment.

During the installation and testing phases of the signalling equipment construction locks shall be provided so that all relay rooms, walk-in enclosures, location cases and trackside equipment can be locked.

These construction locks will be replaced with locks accessible to maintenance staff of the RIM during the project commissioning and handover.

Lock hardware fitted to relay rooms and walk-in enclosures should be compatible for direct substitution with respective series of signalling security locks in the MRA or CRN.

5.4 Environmental conditions

Signalling equipment as described in this standard is exposed to the ambient environmental conditions described in TS 00026.

Strong winds up to 160 km/h are experienced in the railway network, including tunnels and cuttings.

In addition to the environmental conditions described in TS 00026 railway specific equipment for signalling is subject to pollution in tunnel environments, vibration and UV exposure.

All installed signalling equipment and trackside equipment shall be in installed accordance with TS 05258.

Trackside equipment installed in the danger zone of the rail corridor where there is an overhead traction system (mainly in the MRA) shall comply with requirements for class II electrical equipment as described in EN 61140. This is part of the risk control measures for electrical traction faults. Class II equipment is double insulated and does not require earthing for electrical safety.

6 Signals

New signals and MLIs shall use type approved LED modules for the signal lighting.

Incandescent globes shall not be used for new trackside signals, except in brownfield locations where the potential for signal ’read through‘ presents a safety or operational risk. In such cases, an engineering assessment shall be carried out to confirm that incandescent globes are the most suitable solution to mitigate the issue. Any exception to this, shall require a concession in accordance with TS 00003.1.

6.1 Signal location

The longitudinal location of signals and MLIs shall be defined by the signalling plan and the signal sighting forms. In the MRA the signal design proposed location shall be in accordance with the requirements of TS 05333.1 related to running signals and subsidiary signals where fitted.

The longitudinal location of signals shown on signalling plans may be adjusted as follows:

- to meet the sighting requirements of this document
- to avoid obstructions or placement on a bridge or viaduct or in other locations where access for the maintainer would present undue hardship
- to avoid the provision of a signal gantry or overhead wiring structure
- to avoid switched airgaps in the 1500 volt traction system on the approach side of a signal (TD 00004:2023 contains requirements for the additional 10 car trains as well as the 8 car sets which have amended TS 05333.1)
- to avoid placement adjacent to live overhead wiring and components provided this does not compromise braking distances or overlap requirements, nor unduly compromise headway requirements.

In the MRA the amended and finalised signal position and signalling plan is approved by the authorised TAO for the signal design. In the CRN the amended and finalised signalling plan is approved by the CRN in accordance with their asset authorisation process for signalling.

Finalisation of the signal positioning and approval of the signalling plan should be agreed prior to all of the following:

- the approval of the detailed site surveys
- surveying or marking of the signal foundation location or the surveying or marking of the location of any associated track circuit, train stop, location case or walk-in enclosure
- prior to any construction of cable route in the vicinity.

6.2 Signals, ETCS level 2 marker board – out of use marking

Installation of any signal, MLIs or ETCS level 2 marker board on an operational line shall be suitably covered and marked so that it cannot be confused with operational signals, MLIs or ETCS level 2 marker boards.

For signals and mainline indicators a large white retro reflective cross, each arm 1000 mm x 1000 mm, shall be securely attached either in front of or immediately below the top mainline lamp case. The large white cross shall remain in this position until the signal is brought into use.

Alternatively, the signal heads shall be covered with a purpose made black coloured, laminated woven or extruded, heavy duty minimum 0.2 mm thick, weatherproof, UV resistant plastic bag incorporating a large white retro reflective cross. The signal bag covers shall be installed displaying the cross in the direction of oncoming rail traffic.

The white retro reflective cross shall consist of two pieces of retro reflective tape, either self-adhesive or sewn on, each 50 mm in width and 450 mm to 600 mm in length.

Similarly any signal which is taken out of use, but not removed, shall be fitted with a diagonal retro-reflective white cross.

For semaphore signals, the white cross shall be attached across the face of the arm. Subsidiary signals and horizontal or vertical shunt signals shall be securely covered with opaque material until brought into use. Lamp globes shall not be fitted into signals until they are to be brought into use except that they may be temporarily fitted for the purpose of testing. Lamp globes shall be removed from any signal which is taken out of use.

MLIs shall be covered with a black UV stabilised material securely attached to the MLI. A white retro reflective cross shall be securely displayed in the direction of oncoming rail traffic.

For signals using LED modules for the signal indications, the printed circuit boards or LED modules can remain fitted to the signals. The white retro reflective cross shall be securely displayed in the direction of oncoming rail traffic.

ETCS level 2 marker boards that are not being tested or commissioned into use shall be covered with black UV stabilised material securely attached to the marker board and a 70 mm wide cross for horizontal boards and a 40 mm wide cross for vertical boards.

The retro reflective cross material shall be class 1 or class 400 retro reflective white tape or material in accordance with AS 1906.1.

6.3 Security of signals

Signal post cable connection doors and signal head doors shall be fitted with padlocks and locked immediately the signal is erected. Refer to the dimensional sketch of padlock in TS 05300 in the MRA or in TS 01334 in the CRN.

6.4 Ladders and landings

Signal ladders and landings shall be provided to give maintenance staff safe access and egress to and from all lamp cases, indicators and so on fitted to the signal. In the MRA signal ladders and landings shall be manufactured to the requirements of TS 05300 and AS 1657. In the CRN signal ladders and landings shall be manufactured to the requirements of TS 01334 and AS 1657. Where it is not possible to install the ladder immediately behind the signal post, alternative proposals shall be designed.

Ladders installed on signal posts shall be designed solely for access and maintenance purposes. They shall not be used as structural elements or braces to support or stabilise the signal, post or any other part of the installation. The signal post shall be independently designed to withstand all application loads without relying on the ladder for reinforcement. All lamp cases

shall be accessed from a landing which is below the lamp case. The maximum height of a lamp case to be accessed from ground level or a landing shall be 1700 mm.

6.5 Alignment of colour light signals – LED

6.5.1 Main signals

All signals shall be aligned to provide the train driver with optimum sighting of signal indications.

Refer to TS 05333.1 for details on signal sighting requirements.

The signal shall be viewed from a distance of 300 m, or at the maximum sighting distance, or from the signal in the rear, whichever distance is the lesser. There shall be unobstructed and clear sighting of the signal indication at a distance of 50 m through to 15 m from the signal.

Signal alignment should allow for the worst case visibility conditions which is often during bright sunlight with the green signal indication.

Correct signal alignment confirmation shall be carried out from a train approaching the signal.

Further requirements associated with conversion of incandescent signals to LED are in TS 05315.

6.5.2 Turnout signals (band of yellow lights)

Turnout signals shall be aligned for best sighting at 150 m to 200 m if indicating a route off the main line, and at approximately 30 m if indicating a route from a refuge or siding.

6.5.3 Turnout indicators (band of white lights)

Turnout indicators shall be aligned to provide best sighting at 200 m to 300 m or to the maximum available sighting distance if less than 200 m.

6.5.4 Subsidiary signals, horizontal and vertical shunt signals

Subsidiary signals, horizontal and vertical shunt signals (dwarf position and colour light signals) shall be aligned to provide best visibility at the point from which the driver is most likely to be viewing the signal.

In yards where trains may stand very close to shunt signals, mounting on a post may improve visibility. Shunt signal post construction shall comply with TS 05178.68.

6.5.5 ETCS level 2 marker boards

ETCS level 2 marker boards shall be aligned to provide the best sighting at approximately 70 m distance from the board. ETCS level 2 marker boards are only required in a degraded mode of operations (due to failure of the ETCS level 2 signalling system) where the maximum train running speed is 40 km/h.

6.6 Alignment (focusing) of incandescent colour light signals

All new signals shall use LEDs. Some existing signals may still have an incandescent globe.

The alignment distances assume that there is no other signal, or obstruction, within that distance. Where there is, the alignment distance should be reduced to the distance between signals or the distance to the obstruction.

6.6.1 Incandescent signal alignment – straight track and gently curved track

When aligning the signal for straight track the viewer shall be positioned approximately 300 m from the signal.

When aligning the signal for gently curved track the viewer shall be positioned approximately 260 m from the signal.

A standard non-spread lens shall be used.

The main part of the beam has a spread of approximately 1 degree which provides a beam width of 5.1 m at 300 m distance from the signal. At 200 m distance from the signal the beam spread is 3.4 m at 100 m distance from the signal the beam spread is 1.7 m.

A full lens indication is only available within the main part of the beam. At a distance of 260 m to 300 m the signal can be focused by standing at track level. There is sufficient spread to compensate for the difference between the ground level viewer’s eye level and train driver’s eye level. The signal shall be viewed at eye level by a standing person from a position immediately above the left hand rail.

There is an additional spread of lower intensity of 2 to 3 degrees which provides for shorter distance viewing. The width of this part of the beam is 3.5 m to 5 m at a distance of 100 m from the signal.

The close up view provided by the deflecting sector in the lens is only visible approximately 25 m from the signal.

6.6.2 Incandescent signal alignment – sharply curved track

When aligning the signal for sharply curved track the viewer shall be positioned 150 m to 200 m from the signal.

A spread light type of lens shall be used. A 30 degree spread lens should be used.

The main beam has a spread of 30 degrees giving a beam width of 25 m at a viewing distance of 100 m from the signal. The brightness of the signal close to the edge of the beam is reduced and may appear partially illuminated. Vertical black lines may also be visible.

The viewer’s eye level should be elevated to driver's eye level.

There is no deflecting sector in the spread light lens.

6.7 Signal installation

6.7.1 Location of signals

Running signals shall be placed to the left of the track in the direction of travel and positioned to provide the train driver with an unambiguous indication of the status of the track ahead.

Signals shall be located in accordance with the signalling plans, signal sighting and not infringe within the structure gauge as detailed in Section 5.1.

In the MRA the signal design shall position the signals in accordance with TS 05333.1.

In the MRA the signal post shall be installed between 2200 mm and 2500 mm when measured from the centre of the signal post to the running face of the nearest rail.

In the MRA exceptions shall be approved by the signal design TAO provided they do not infringe within the structure gauge and still meet the signal sighting requirements of TS 05333.1.

In the CRN the signal post shall be installed between 2800 mm and 3200 mm when measured from the centre of the signal post to the running face of the nearest rail.

In the CRN exceptions shall be approved by the RIM provided they do not infringe within the structure gauge.

6.7.2 Sighting limitations

Refer to TS 05333.1 for details on sighting signals.

The maximum reliable sighting distance for a colour light signal in full sunlight is limited to 500 m to 600 m. A crowded, multicoloured or very bright background environment will reduce this distance.

Gantry mounted signals are not clearly visible to train drivers if the train is required stop within 15 m of the gantry signal while waiting for the signal to change. The signal design shall take into account the operational requirements for trains having to stop 15 m away from the gantry signal to see it clearly. If the operational requirements require trains to stop within 15 m of the gantry signal the signal design shall specify the installation of a co-acting signal to indicate the signal to the driver as the gantry signal will be out of view.

Sighting of signals generally cannot be guaranteed for all types of rolling stock and locomotives when the position of the driver is within 5 m of the signal. Deflecting prisms in lenses, shall be used to improve the short range sighting.

In most circumstances selection of location, correct lens selection and focusing of the signal, varying the height of a signal or providing screening against background lighting will provide the train driver with clear sighting of the signal.

Co-acting and repeater signals shall be provided only in those cases where there is no alternative method of providing clear viewing to the train driver.

Signals located at the end of station platforms may require modification to station fencing and signage to provide sufficient sighting of the signal.

Signals installed facing East or West shall be assessed for potential washout issues caused by direct sunlight during morning or afternoon hours. Where sunlight exposure is identified as a risk to signal visibility or clarity, appropriate mitigation measures shall be implemented. These measures shall include, but are not limited to, the installation of long signal hoods to reduce glare and enhance visibility. The assessment and mitigation plan shall be documented using PR S 47117 FM201 and approved as part of the signal sighting process.

6.7.3 Location of signal – impact for maintenance staff and other assets

In addition to providing for the train driver's clear view of the signal, selection of signal location shall consider the safe access for maintenance staff to signalling equipment, equipment cupboards and locations.

Selection of the signal location shall provide for the requirements of the cable route, galvanised steel troughing, ground level troughing and equipment footings. The location of the signal shall not impact on the track ballast or the formation profile. The location of the signal shall not alter drainage of storm water.

Signals shall be located correctly in relation to overhead wiring airgaps. Details and measurements are in TS 05333.1.

Signals should be located to avoid the need for costly protective barriers being fitted to the signals. Where the signal location cannot be moved to avoid a fall or electrical hazard then a protective barrier shall be installed.

The rear of the signal and the signal ladder shall not be located within 2 m of equipment posts, impedance bonds, protection posts and sign posts. The provision of this clear space of 2 m is to reduce the potential for a fall or trip hazard and to reduce potential injury if a person was to slip or fall from the signal post ladder.

6.7.4 Protective barriers – general

Protective barriers and foundations shall be designed for wind velocities up to 160 km/h.

Barriers shall be assessed for insulation, bonding and spark-gap bonding requirements as part of the overall design.

If additional protective barriers are required for the signal, the TAO shall assess if the signal post and associated foundations can sustain the additional weight and loading. If not , the TAO shall redesign the signal post and associated foundation to ensure suitability with the protective barriers.

The addition of protective barriers to the signal shall require confirmation that the design of the signal post and signal post foundations is able to carry the additional weight and wind loading of the additional protective barriers.

6.7.4.1 Fall protection barrier

Where a signal is situated on an embankment, viaduct or similar and the distance from the top of the ladder or highest landing decking to ground level exceeds 6 m at any point within a 2 m radius of the signal post; additional protective barriers shall be provided.

Where the signal does not incorporate a work landing that is, only a ladder, the screen shall extend to the full height of the signal ladder, or higher where required.

Where the signal incorporates a work landing, the screen shall extend to at least 1 m above the deck of the topmost landing.

6.7.4.2 Electrical protection barrier

Signals shall not be located where any part of the signal structure and access (including an open door panel or the safety chain or bar, or the outstretched arm of a person servicing the signal) can be placed within 1 m of any live overhead, pull-off, stay or isolating insulator. A pull off or stay wire isolated by only a single small diameter insulator is classed as live overhead.

If it is not possible to locate the signal 1 m clear of any live overhead, a barrier in the form of protective cages or screening shall be provided to prevent inadvertent contact with live wiring.

Barrier infill shall be constructed of expanded sheet metal with openings typically no larger than 50 mm by 50 mm to limit an arm being placed through the infill screen and infringing the safe approach distance to the electrical hazard.

Where the signal does not incorporate a work landing that is, only a ladder, the screen shall extend either, at least 1000 mm above the signal ladder or at least 1500 mm above the height of the live wiring, whichever is the lesser distance.

Where a work landing is incorporated into the signal, the screen shall extend either 2 m above the deck of the topmost landing or at least 1500 mm above the height of the live wiring, whichever is the lesser distance.

Full details of any proposed screens, including insulation and bonding shall be approved by the TAO signal designer for the proposed screens.

6.8 Relative heights of signals

Adjacent signals on running lines of equal importance should be of equal height.

For bi-directional running on double line sections, adjacent signals should be of equal height.

The signal design and the inputs from the signal sighting may specify different heights for some signals to improve signal sighting. These different heights shall be specified by the signalling design.

For double aspect signals, the lower main red indication shall be the reference point for height measurements.

For single aspect signals, the main red shall be the reference point for height measurements.

6.9 Signal foundations

Signal foundations in the MRA may be constructed using either pre-cast concrete or cast-in-situ concrete, depending on project requirements and site-specific conditions.

For the pre-cast concrete foundation method, preliminary designs TS 05180.02, TS 05180.03 and TS 05180.04 have been prepared for various types of signals. Before implementing these designs, the TAO shall verify and certify that the designs are suitable for the site-specific conditions and comply with TS 01658.

For the cast-in-situ concrete method, preliminary designs M01-310 sheets 1 to 4 have been prepared. Prior to adoption, the TAO shall verify and certify that the designs are appropriate for the site-specific conditions and meet TS 01658.

If the preliminary designs are deemed unsuitable for implementation, based on the signalling plan and data from the site survey, the signal sighting, and geotechnical investigation, the TAO shall prepare suitable signal foundation design in compliance with TS 01658.

Upon completion, the signal foundation design shall be verified and certified.

Signal foundations in the CRN shall be installed in accordance with TS 01263.

Foundation bolts and fixings shall be hot dip galvanised.

For 140 mm signal posts the foundation bolts shall be 30 mm diameter or greater.

For 114 mm signal posts the foundation bolts shall be 24 mm diameter or greater.

For dwarf signal posts the foundation bolts shall be 16 mm diameter or greater.

6.10 Ladder footings

A concrete landing or footing pad for ladders used on signal posts shall be a minimum size of 600 mm x 900 mm x 150 mm, in accordance with AS 3600 and projecting 600 mm behind the

ladder. The concrete landing or footing pad shall not interfere with drainage, other equipment or maintenance access requirements.

Where more than one ladder is fitted to a signal post, a single concrete pad shall be formed and poured linking all ladders.

Signal gantry access ladder concrete landing or footing pads shall comply with TS 00137.

6.11 ETCS level 2 marker board foundations

The ETCS level 2 marker board post shall have a concrete foundation. The foundation shall be constructed using a bored hole to the design requirements usually at a minimum depth of 400 mm. The foundation shall incorporate a bolting arrangement for the mounting of the post.

6.12 Cabling distribution pit

Main running signal installations shall include a cable distribution pit between the signal base and the ladder unless the site installation drawings show an alternative location for the cable distribution pit. The pit shall be incorporated into the ladder footing. The pit shall be 600 mm deep and be of sufficient size to accommodate all incoming and outgoing conduits without being wider than the adjacent signal base or affecting the stability of the signal. Conduits include local cabling from the adjacent signal location for the signal, train stop, balises, track circuit, axle counter and telephone.

Shunt signals may have cable distribution pits specified on the signal design site installation drawings.

The balise conduit shall be installed from the pit to the proposed balise junction box.

Site installation drawings (in the MRA TS 05312, in the CRN TS 01251) shall be TAO approved for each typical installation drawing at each signal.

6.13 Tunnel signal installation

Tunnel signals shall be fixed to the tunnel wall through the bracket provided on the signal using stainless steel anchors. The method of fixing may be of a chemical or mechanical anchor system or similar. The depth and type of fixing shall be determined by the condition of the tunnel wall. Standard fixing depths as specified by the masonry anchor manufacturer shall be used in concrete or brickwork in good condition. For old, weathered or sandstock brickwork the anchor depth shall be at least 1.5 bricks.

Tunnel signals are exposed to strong wind loadings so the fixing of the tunnel signal to the tunnel wall shall be sufficiently secure to withstand ambient conditions described in TS 00026.

The tunnel signal lamp cases shall be clear of the tunnel wall by 20 mm to 30 mm at the closest point and mounted so that the top red aspect is between 2250 mm and 2550 mm above the rail level. The signal shall be vertical in both planes.

Where the top lamp case of the signal is more than 2 m above the floor level of the tunnel, a step, platform or ladder shall be installed to provide maintenance access to the tunnel signal.

The tunnel signal lamp case doors shall be able to open fully without obstruction.

7 Signal gantries

Signal gantries shall be provided where indicated by the signalling plans and signal sighting forms. The gantry shall span the minimum number of tracks consistent with obtaining clearances between mast and track required by the structure gauge requirements in accordance with Section 5.1.

Gantries shall be designed to accommodate the load of the gantry structure, cages, signals, walkway, handrails; ladders and maintenance personnel.

Gantries shall be designed to withstand a wind loading assuming a maximum wind speed up to 160 km/h as described in TS 00026.

The gantry design shall meet the appropriate terrain category for the location, plus any construction and temperature loadings. The design and a TAO authorised structural engineer's certificate or approval specifying that the gantry is suitable for its intended use and complies with civil structure standards shall be completed.

Either holes or brackets, or both, for attachment shall be included in the gantry structure during manufacture or the various items are to be clamped to the gantry.

Signals gantries and all ferrous attachments shall be hot dip galvanised after fabrication.

There shall no welding to or drilling of a completed gantry structure after fabrication, galvanising and erection.

Gantry foundations in the MRA or CRN shall be constructed in accordance with the custom civil or structure designs for each gantry.

Gantry masts shall be vertical in both planes. The gantry beam shall be horizontal and be either straight or have small positive camber. Masts shall be wedged, shimmed or packed on foundations to achieve levelling, then grouted between foundation and mast foot.

The gantries shall be positioned on the footings to allow a minimum of 25 mm of low shrinkage concrete grout to be installed between the concrete footing and the column base plate after levelling has been completed. All temporary packing (if used) shall be removed. Where the grout is load bearing than the grout used shall be capable of carrying the design load of the gantry mast.

7.1 Gantry access ladders

Gantries spanning three or fewer tracks shall include one access ladder to the gantry walkway. The walkway shall extend sufficiently from the ladder to access all cages on the gantry. All other gantries shall have ladders at each end of the gantry and continuous walkway between the ladders unless approval is granted for a single ladder and reduced walkway. A safety chain or bar shall be provided across the ladder opening in the balustrade.

Gantry access ladders shall not exceed 6 m in height without an intermediate landing, in compliance with AS 1657.

Gantry access ladders shall be fitted with safety cages. Refer to drawing TS 00137 for details of the ladder and safety cage for gantries.

Cages shall extend down no lower than 2 m above the ground level landing and shall be fitted with a lockable door panel to restrict unauthorised access. The lockable door panel shall be sufficiently light in weight so it is able to be manually opened and closed by a single person.

7.2 Signal gantry cages

Signal gantry cages shall be securely fastened to the gantry with galvanised steel bolts (or U-bolts if clamped), flat washers, spring washers and nuts.

Cages shall be installed so that they are vertical in both planes, except that where the gantry beam is cambered. No compensation is necessary for the angle caused by the camber unless this exceeds an angle of 0.2 degree.

The cage access ladder shall be wider than 380 mm between stiles, each stile section shall be greater than 50 mm x 12 mm, all rungs shall be greater than 20 mm diameter and rung spacing shall be less than 300 mm.

Where cages are cantilevered from the gantry, the ladder stiles shall extend to the topmost rail on the gantry handrail. There shall be greater than 175 mm clearance behind any rung on the ladder to any part of the cage or gantry.

The cage shall be pre-drilled for lamp case brackets. The cage shall be pre-drilled for attachment to the gantry.

7.3 Gantry walkways and handrails

Gantry walkways and handrails shall be attached to the structure in accordance with the fastening method defined on the relevant design drawing. The walkway and handrail shall comply with AS 1657.

8 Guards indicators and warning lights

In the MRA guards indicators and warning lights shall be in accordance with TS 05300.

In the CRN guards indicators and warning lights shall be in accordance with TS 01334.

Each guards indicator and warning lights shall be located as shown on the signalling plan or as directed.

Guards indicators shall use blue or white LEDs as detailed in TS 05300.

Warning lights for outdoor installations are round white indications and warning lights for tunnel installation are rectangular yellow indications as detailed in TS 05300.

Guards indicators shall be positioned so they can be clearly viewed by the train guard.

Guards indicators shall not be positioned where they will block a driver or guard view of any signal at the end of a station platform.

Consultation with the asset owner of the structure and a heritage impact assessment shall be obtained where it is required to mount indicators on heritage listed infrastructure.

Guards indicator and warning lights shall be covered or wrapped in black opaque woven or reinforced material until brought into use.

8.1 Guards indicators

Guards indicators are required where shown on the signalling plans or detailed site survey plans, or both. They are located or sighted in accordance with TS 05316. The location is documented on the guards indicator sighting form either attached to station structures or on separate posts on the station platform.

Refer to TS 05333.1 for guidance on location of guards indicators.

Guards indicator mounting posts as a minimum, shall be steel pipe (minimum 75 mm) with capped top or rectangle hollow section (minimum 75 mm x 75 mm x 3.2 mm) whichever best matches the particular station architecture. The guards indicator mounting post may be fitted with a cable termination box at the base of the post to assist construction or maintenance installation if the tail cable needs replacement.

Many rail stations have hot dip galvanised lighting posts and fixtures. For these stations a hot dip galvanised mounting post shall be provided for the guards indicator. For stations with painted posts the guards indicator post shall be painted the same colour as the station lighting posts.

On heritage listed stations, posts that more closely match the period architecture of the station may be required. The necessity for this is to be determined in consultation with the asset owner of the heritage station.

The post may be bolted to a concrete foundation or cast into a concrete foundation. The size of foundation shall be such that it can withstand a person swinging on the post without moving the foundation in the platform.

The underside clearance of the guards indicator lamp case with identification plate shall be between 2400 mm and 3000 mm above platform level. The edge of the lamp case shall be a minimum of 1000 mm along a horizontal plane from the platform coping edge (that is, behind the yellow safety line on the platform). For guards indicator lamp cases mounted from platform awnings the cable should be top entry and preferably incorporated within the support bracket to provide mechanical protection as shown in Figure 1.

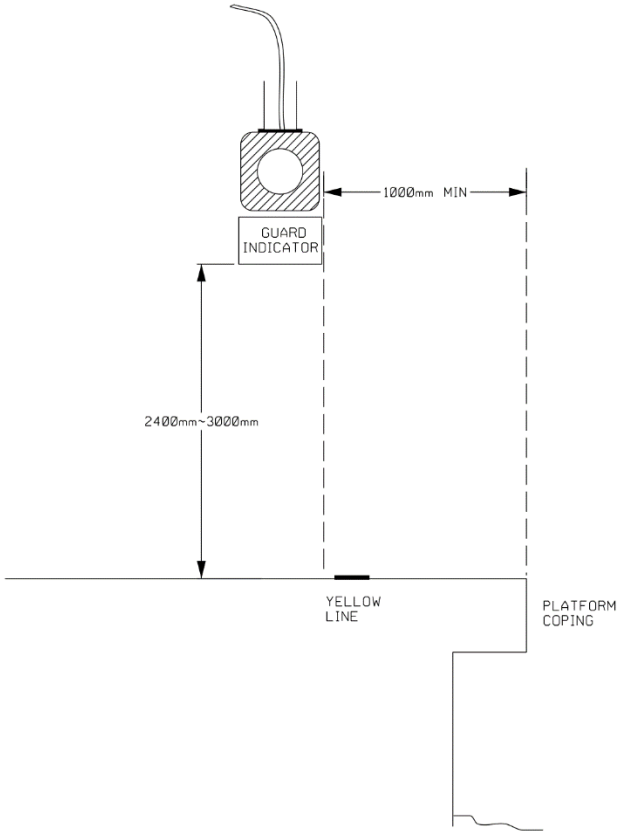

Figure 1 – Guards Indicator mounting position above station platform

Cabling to guards indicators shall be run in pipes buried in the platforms or in conduits or cable ducts in or on station buildings or other structures. Where the conduit enters the guard indicator the conduit should be within the mounting bracket to provide mechanical protection. Exposed conduits or cable ducts that are accessible to the public shall be made of steel to minimise damage and vandalism. The conduits and cable ducts shall be made as unobtrusive as possible and painted to blend with the supporting station structure and environment.

Refer to TS 05178.63 where a guards indicator is to be post mounted. In addition to the details in TS 05178.63 the guards indicator post shall have a cable termination box located at the base of the post.

Guards indicators are maintained with the use of a 2 m step ladder placed behind the yellow safety line on the platform.

Guards indicators mounted onto a station building or awning should be clamped to the building; drilling or welding for mounting is to be avoided.

Where a guards indicator is mounted to a building or associated structure then permission from the building or structure owner shall be obtained.

8.2 Warning lights

Warning lights may be attached to any convenient structure provided it is not on a heritage listed building and provided that the warning light will not block or detract from the driver's observation of any signal.

A warning light shall not be located where it can be seen illuminated with a signal on the same track.

9 Buffer stop lights

Buffer stop lights are usually mounted immediately to the left of, and in line with, the face of the buffer stop. All buffer stop lights shall use LEDs for illumination. Buffer stop lights assist the train driver in identifying the position of the buffer stop in darkness or poor visibility.

The signal design shall specify if a buffer stop light is required at a buffer stop as not all buffer stops are designed with buffer stop lights.

In areas (most of the MRA) where trip fitted trains approach the buffer stop, a fixed train stop may be specified by the signal design prior to the buffer stop. The positioning of the fixed train stop before the buffer stop will be specified on the signalling plan. In this case, the buffer stop light shall be located adjacent to the left of the fixed train stop.

Refer to TS 05178.63 for details of the red buffer light post and mounting arrangements for the red buffer light and the additional white buffer light that may be specified by the signal design.

Where possible, buffer stop lights shall be fitted to a free-standing post at a horizontal distance of 1800 mm from the running face of the rail.

The buffer stop light mounting post shall be capable of supporting a 150 kg horizontal load applied at 1500 mm above ground level with deflection of less than 10 mm.

The post shall be secured, into the ground or otherwise, so that it is capable of resisting a pull out force or 250 kg plus the specified horizontal loading without movement.

Where metal buffer stops are provided, any metal work for the buffer stop light shall be insulated from the buffer stop frame itself or separately mounted and insulated, to avoid any voltage touch potentials between the metal buffer stop frame and the buffer stop light.

Refer to TS 05333.1 for configuration details of buffer stop lights.

10 Train stops

Train stops are fitted in the MRA and are an important safety sub system which is used to automatically apply the brakes on trip gear fitted trains if the train passes a signal at stop or exceeds the target approach speed on a designated section of track.

The train stop is mounted trackside and is connected to the signalling system. When the trip arm of the train stop is in the raised position it will engage physically with the trip lever hanging down from the train and when it strikes the train trip lever the emergency brakes of the train will be applied. The train stop arm face is 150 mm wide and 75 mm high. The top of the train stop arm face in the raised position shall be 102 mm above top of the rail level. The centreline of the train stop arm face in the raised position shall be 546 mm from the running face of the adjacent rail.

When the trip arm of the train stop is in the lowered position the train stop will not engage with the train trip lever as the train passes the train stop. The top of the train stop arm face in the lowered position shall be 10 mm to 25 mm below the top of the rail level. It is therefore critical to this safety function that the train stop is correctly positioned and mounted securely beside the track.

The train stop shall be mounted in the position shown in Figure 2.

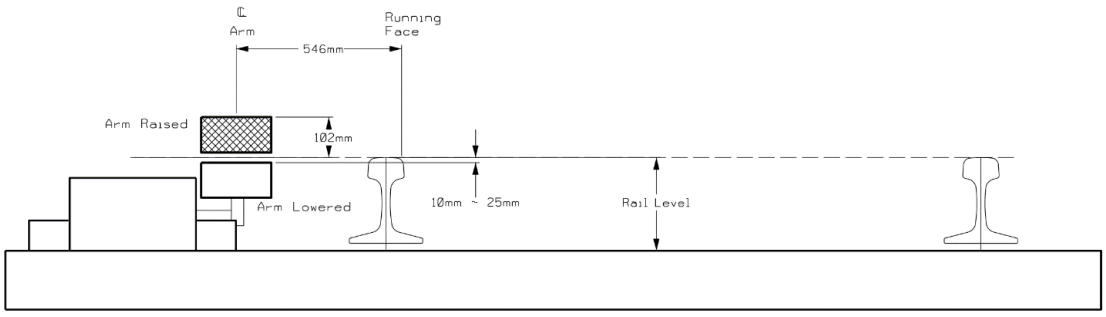

Figure 2 – Train stop arm face relative to rail level

Pneumatic or electro-hydraulic train stops shall be cycle tested for a minimum of 20 operations per hour for 24 hours prior to installation in the track. For electro-hydraulic train stops, this shall be followed by a hold clear test of a minimum of 6 hours duration to test the valve and ram seals. The trip arm shall not move more than 4 mm towards the stop position during this test.

Attachment of train stops to mounting brackets shall be in accordance with TS 05196.27 and TS 05196.28.

Train stop mounting brackets shall be installed on concrete sleepers in accordance with TS 05196.27 and TS 05196.28 and mounted parallel to the rail and horizontal.

Train stops attached directly to timber sleepers shall be fixed with 20 mm galvanised steel coach screws which penetrate the timber for at least 100 mm. Flat washers shall be provided under coach screw heads.

The location of the arm in the raised position shall be tested with a train stop gauge prior to commissioning the train stop into service. A trainstop gauge is shown in TS 05196.22.

The train stop gauge is used to check that the installed trainstop trip arm face edge in the raised position is 467 mm to 473 mm from the running face of the rail. The train stop gauge is used to check that the top of the train stop trip arm face in the raised position is 102 mm with an allowed tolerance range of 99 mm to 103 mm above the top surface of the adjacent rail. Figure 3 shows the train stop gauging dimensions.

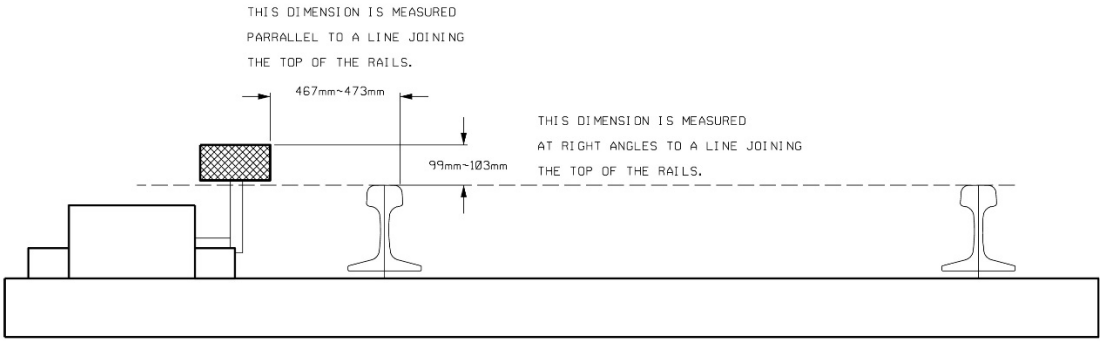

Figure 3 – Train stop gauging dimensions

The relative position of the trainstop in relation to its controlling signal and the vehicle detection system is important to ensure that the train stop operates in accordance with the design.

Where the vehicle detection system is a track circuit with IRJs it is preferred to place the train stop immediately adjacent to the IRJs and the signal. Figure 4 shows this preferred arrangement.

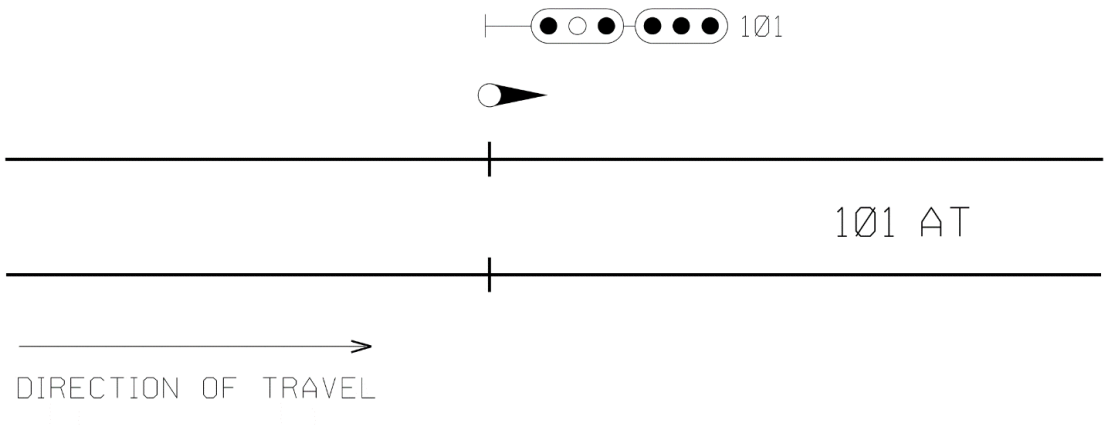

Figure 4 – Relative preferred positions – train stop, signal and IRJs

It may not be possible to place the train stop immediately adjacent to the IRJs. In this scenario the placement of the train stop and position of the signal shall be brought in front of the IRJs as shown in Figure 5. The train stop shall not be placed past the IRJs in the direction of travel as this could result in the train stop raising and tripping trains before the train has past the signal. The train stop shall be placed up to 1000 mm past the signal in the direction of travel. The signal shall be placed up to 2500 mm in front of the IRJs in the direction of travel.

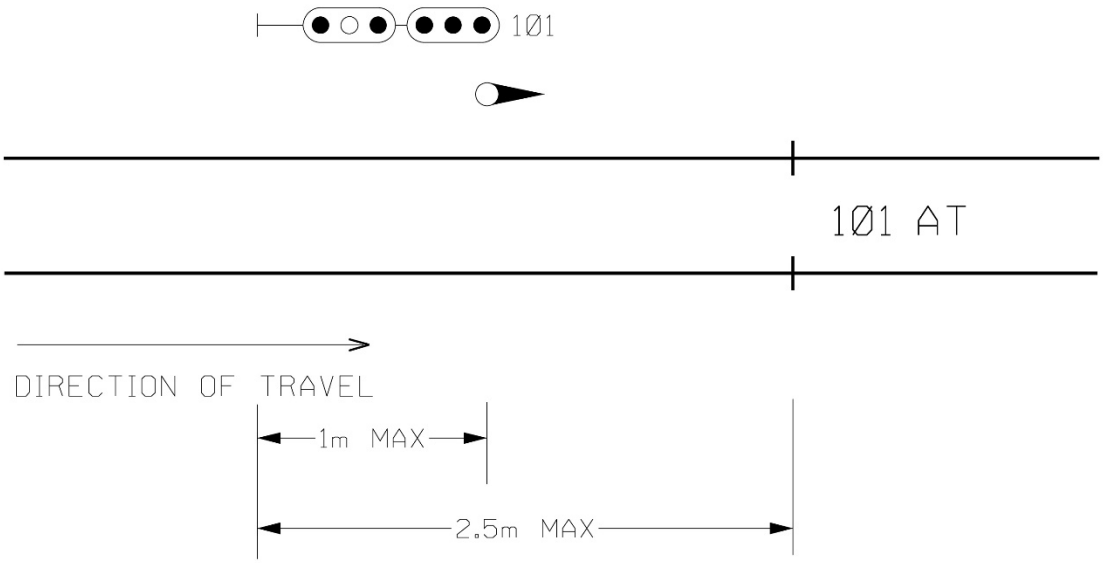

Figure 5 – Relative alternate positions – train stop, signal and IRJs

Notes:

1 – Trainstop shall not be placed past the IRJ in the direction of travel.

2 – Trainstop may be placed up to 1 m past the signal position in the direction of travel.

3 – Signal may be placed up to 2.5 m in front of the IRJ in the direction of travel.

Where the vehicle detection system is a track circuit with jointless track circuits using tuned loops than place the train stop immediately adjacent to the designated rail vehicle detection point. This rail vehicle detection point is positioned 3500 mm past the tuning unit (TU) in the direction of travel. The signal controlling the train stop is placed immediately adjacent to the train stop and the rail vehicle detection point. and the signal. Figure 6 shows this preferred arrangement.

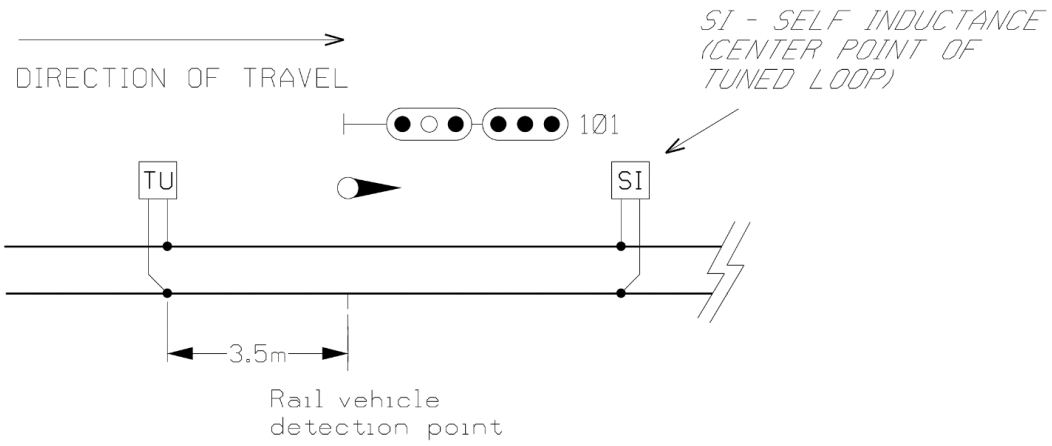

Figure 6 – Relative preferred positions – train stop, signal and tuned loop rail vehicle detection point

It may not be possible to place the train stop immediately adjacent to the rail vehicle detection point. In this scenario the placement of the train stop and position of the signal shall be brought in front of the rail vehicle detection point as shown in Figure 7. The train stop shall not be placed past the rail vehicle detection point in the direction of travel as this could result in the train stop raising and tripping trains before the train has past the signal. The train stop shall be placed up to 1000 mm past the signal in the direction of travel. The signal shall be placed up to 2500 mm in front of the rail vehicle detection point in the direction of travel.

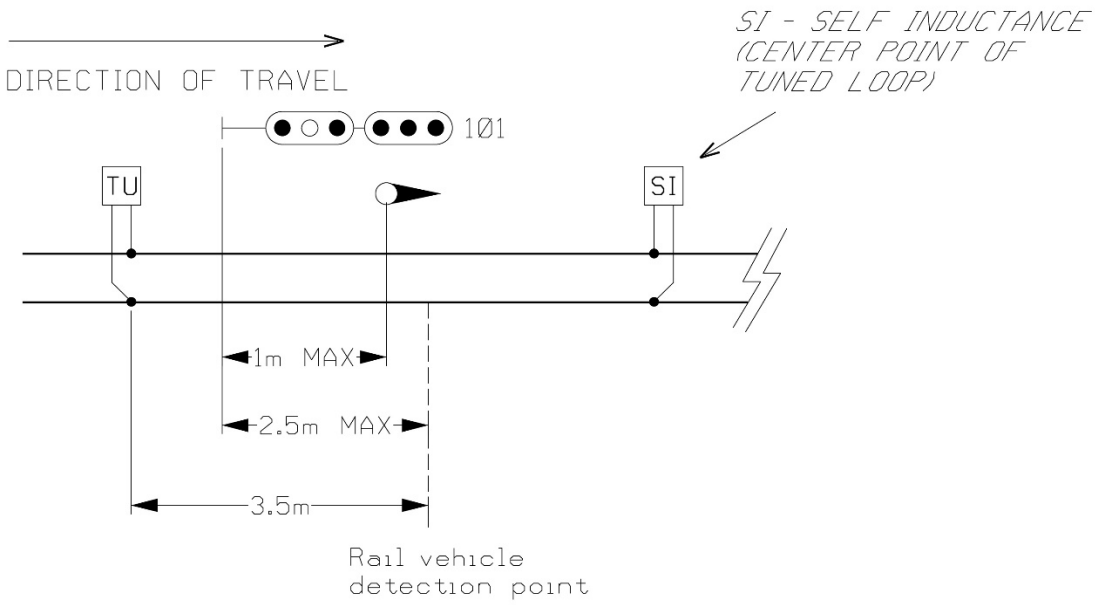

Figure 7 – Relative alternate positions – train stop, signal and tuned loop rail vehicle detection point

Notes:

1 – Trainstop shall not be placed past the rail vehicle detection point in the direction of travel.

2 – Trainstop may be placed up to 1 m past the signal position in the direction of travel.

3 – Signal may be placed up to 2.5 m in front of the rail vehicle detection point in the direction of travel.

Cabling connections to the train stop shall be multi-core cables in accordance with TS 05269.

The buried cable route portion of this cable connection and conduit requirements shall be in accordance with TS 05164.

The cabling connection where it rises to the surface out of the buried cable route in fixed conduit shall be 4 m or less from the train stop connection point.

A heavy duty orange, flexible PVC conduit shall be laid along the surface ballast or slab track between the fixed conduit coming up to the surface and the train stop at a distance of 4 m or less. This flexible PVC conduit must be securely attached and sealed to the buried cable route fixed conduit where it rises to the surface.

The heavy duty orange, flexible PVC conduit shall be securely fixed to the train stop conduit coupling. Where the end of the flexible PVC conduit enters a location case or signal base it shall be securely anchored and installed so that it offers complete physical protection to the multi-core cables.

The cable entry to the train stop between the flexible PVC conduit and conduit coupling shall be sealed with neutral cure silicon sealant after cable termination to prevent moisture entry.

If a train stop is installed but not commissioned into service the train stop arm shall be securely fixed down to the sleeper and the return spring disconnected from the train stop, or the arm removed, until the train stop is required to be brought into use. A wedge shall not be installed between the arm and arm stop.

If the return spring is not able to be disconnected from the train stop than alternatively, a sleeve, secured by bolt or other means shall be fitted over the extended ram shaft (pneumatic or hydraulic) to prevent retraction.

Where a ram shaft is to be held in the extended position for more than 30 days, it shall be protected against corrosion. The corrosion inhibitor shall not in any way be detrimental to the hydraulic or pneumatic seals on the ram or cylinder.

Train stops which have been taken out of use but not removed shall also have the arm securely fixed down or removed.

The train stop deflection plate shall be secured to the train stop mounting brackets or to the sleeper in advance of the train stop in the normal direction of travel. The train stop deflection plates are manufactured in accordance with TS 05196.12, TS 05196.25 and TS 05196.33.

On tracks signalled for operation in either direction, train stop deflection plates shall be provided on both ends of the train stop.

If a train stop is not in use and fitted to a running road, a retro-reflective white cross that is visible to drivers shall be fixed to the cover of the train stop.

11 Track circuits, traction bonding and impedance bonds

11.1 Track circuits

Track circuit types, characteristics and applications in the MRA are specified in TS 05306.

Track circuit types, characteristics and applications in the CRN are specified in TS 01337.

Insulated joints shall be installed in accordance with the track insulation plans. TS 05333.17 provides the requirements for determining the location of insulated joints.

The minimum track circuit length shall be 20 m to ensure that the wheel sets of a rail vehicle cannot straddle the whole track circuit and not be detected.

Junctions between rails of different sections shall not be used for insulated joints.

Wiring to connect track circuits to both control equipment and to rail shall be as specified in TS 05166.

Maintenance access shall be made available to tuning units, matching units and so on of jointless track circuits and terminal cases of impulse track circuits. Planning for maintenance access needs to consider proximity of the danger zone and plan for safe access for maintenance staff. Where these are mounted on the edges of drains or cesses which are likely to be water filled or in which staff cannot stand, a suitable standing area formed by either filling or by installing a fabricated platform, shall be provided.

11.1.1 Bootleg risers

The bootleg riser is used as an interface between the surface mounted rail or track connecting cables and the connecting local cables (buried) to connect the track circuit back to the equipment relay room or equipment location case.

The bootleg riser is a small termination box mounted on a 50 mm hollow steel post or pipe with a steel or concrete base. The incoming cable from relay room or location case to the bootleg riser shall pass through the base and inside the pipe into the termination box.

The most common application of bootleg risers is for track circuits – AC and track circuits – DC.

Bootleg risers shall be installed at a minimum of 2500 mm from the nearest rail face and the top of the terminal box shall be 300 mm to 400 mm above ground level except where site conditions do not allow. Where track centres do not allow for this position, the riser shall be placed centrally between tracks and the top of the box shall be at least 50 mm below rail level.

11.1.2 High voltage impulse and jointless track circuits

The posts and trackside equipment shall be installed opposite the applicable IRJ or track connection position to avoid excessive length on the track connecting cables.

When the high voltage impulse or jointless track circuit trackside equipment can be installed within 3 m of the rail, surface mounted track connecting cables may be run directly between the rail and the trackside equipment. If the high voltage impulse or jointless track circuit trackside equipment is further then 3 m from the rail additional protection of the surface run cables shall be provided. This additional protection could include burying of the cables within conduit.

Design life of the posts, the method of securing in ground, and conduits and cable supports shall be a minimum of 40 years.

Posts used for mounting high voltage impulse (Jeumont Schneider) and jointless track circuit (CSEE, ML and Westinghouse) trackside equipment and boxes shall be of sufficient cross section to support the box plus a load of 150 kg applied horizontally at the top of the post 1000 mm above ground level with less than 20 mm deflection. In addition, the post shall have sufficient torsional rigidity to deflect less than 5 degrees under a torque of 300 Nm applied at the top.

The posts shall be secured into the ground so that there will be no movement of the base of the post with a load of the box plus 150 kg applied vertically to the post plus the load of 150 kg applied horizontally at the top of the post or with these loads applied individually. The post shall also withstand a pull out load of at least 250 kg. Concreting of any post shall be weather domed and smooth around the post to prevent water pooling.

The posts shall be 2500 mm horizontally from the running face rail of the track and the top of the track circuit case/interface box mounted on the post shall be 800 mm above ground level.

Incoming cable from location case to box shall be protected by either passing through the post or by a rigid conduit securely fixed to the post. Cables to the track shall be supported by clamping to the post to minimise weight loading on the cable and provide stress relief on the cable terminations.

Cable entries into tuning units shall be sealed to prevent entry of moisture.

11.2 Traction bond cabling

Traction bond cabling shall be installed in accordance with bonding plans of TS 05166 and TS 05168.

An anti-seize compound shall be used between the stainless steel nuts and stainless steel bolts or studs where traction bond cables are attached to rails or impedance bonds. The anti-seize shall not be permitted to contaminate the current carrying surfaces between cable lug and welded stud on the rail.

The current carrying surfaces of cable lugs and the welded stud boss welded to the rail shall be cleaned (with solvents or abrasive products if needed) prior to assembly.

Traction bond cables shall be suitably protected and clipped to sleepers on the side of the sleeper furthest from oncoming rail vehicles using mounting or protective plates in accordance with TS 05221.89 and TS 05221.90 and kept as short as practical.

Traction bond cables shall be installed to avoid damage from track tampers and dragging equipment. Where these tails cables are installed in tunnel environments and on walkways these tail cables shall be shrouded to prevent tripping hazards and damage from dragging equipment.

11.3 Impedance bonds

Impedance bonds shall be mounted in accordance with the manufacturer's requirements.

Size, type, quantity and connection requirements for side lead and neutral conductors to rails and impedance bonds shall be as specified in TS 05166 and TS 05168.

Side lead and neutral conductor cable terminations shall be accessible for examination and disconnection with the bond lid or cover in place but not unduly exposed to damage. Cables shall be mechanically supported to reduce the load on the termination point and cable lugs.

The side leads to one rail shall be equal in length and configuration to the side leads to the other rail.

All cable connections to bonds shall be made using stainless steel fastenings. An anti-seize compound shall be applied to the fastenings during installation. No anti seize compound shall be permitted to come between cable lug face and bond termination plate.

The mating surfaces of cable lugs and of the impedance bond terminals shall be cleaned (with solvents or abrasive products if needed) prior to assembly.

12 Axle counters

Axle counters are rail vehicle detection system that counts vehicle wheels entering and departing a defined section of track to determine if a rail vehicle is present or not present on that defined section of track.

12.1 Wheel sensor positions

Wheel sensors are positioned in a similar way that a track circuit section is defined using insulated joints to create the track sections required for the required interlocking functions for rail vehicle detection.

Wheel sensors shall be positioned on the rail in accordance with the signalling plan design, which will indicate which rail the wheel sensor is to be fitted in accordance with the OEM instructions.

In the MRA wheel sensors associated with signals shall be located immediately adjacent up to a maximum of 2500 mm beyond the signal.

In the CRN wheel sensors associated with signals shall be located immediately adjacent up to a maximum of 1000 mm beyond the signal.

Wheel sensors shall also be located 1000 mm away from large metal masses. For example, train stops, point machines or check or guard rails. Practically, wheel sensors cannot be attached where the rail has been joined by welding or where cables are attached (for example, spark gaps) and shall be at least one sleeper bay away from these constraints.

Wheel sensors shall be placed on the rail that keeps the maintainer closest to a safe place and avoids maintainers crossing tracks.

In double track areas, typically this means that down track wheel sensors shall be on the down rail and p main track wheel sensors shall be on the up rail.

On single lines if safe access is not a determining factor, the wheel sensor shall be placed on the outer rail of any curve.

Where possible wheel sensors shall not be placed in difficult to access locations such as tunnels, culverts and platform tracks.

12.2 Track connection box and wheel sensor tail cables

Axle counter wheel sensor tail cables shall be terminated in a TCB. The TCB shall be installed clear of the ballast shoulder and at least 2500 mm from the rail running face immediately adjacent to the wheel sensor on the side that the wheel sensor is fitted.

The TCB shall be the OEM supplied product. If a custom built TCB is required than It shall be type approved to ensure it meets the performance requirements. In a tunnel environment the TCB may need to be installed on the tunnel wall in a stainless steel enclosure.

The tail cables shall be surface run between the wheel sensor and the TCB, and suitably protected and clipped to sleepers on the side of the sleeper furthest from oncoming rail vehicles using mounting or protective plates in accordance with TS 05221.89 and TS 05221.90 and kept as short as practical.

Tail cables installed in tunnel environments and on walkways shall be shrouded to prevent tripping hazards and damage from dragging equipment.

12.3 Axle counter section length

Track section length is measured from wheel sensor to wheel sensor (for the same axle counter section). The minimum track section length allowed for axle counters or track circuits is 20 m. The minimum track section length of 20 m from wheel sensor to wheel sensor shall be ensured through turnout portions of track. If the OEM requirements require a longer minimum axle counter section to meet timing requirements or response requirements to ensure reliable rail vehicle detection than the minimum length can be extended from 20 m to the OEM required minimum length.

12.4 Axle counter to track circuit interface

Axle counters are insulated from the rail and are not part of the traction return system. Wheel sensors are drawn on the signals track insulation plan (TIP) for reference purposes only.

Special care shall be taken when an axle counter section is installed adjacent to a track circuit to ensure that bonding for the track circuit and traction return current is correct. Correct bonding for the track circuit and traction return current prevents incorrect track circuit return paths that would allow a track circuit to become falsely energised or fail.

The axle counter track section and the track circuit shall fully overlap to ensure continuous train detection is maintained at interfaces to track circuits.

The jointless track shall be terminated with a direct short across the rails where a jointless track circuit is used.

The axle counter track shall completely overlap the entire tuned loop, as the shunting point of the tuned loop can be anywhere within the tuned loop.

Axle counter wheel sensors shall not to be placed within jointless track circuit tuned loops.

Axle counter wheel sensors shall not be placed within 15 m of a jointless track circuit transmitter connection to rail to avoid any possible interference between the axle counter and track circuit. The 15 m separation may be reduced if the OEM suppliers of the track circuit and the axle counter allow for this reduction.

12.5 Axle counter traction return bonding

Axle counters provide the opportunity for all rails under overhead traction lines to be utilised for traction return current and the removal of traction return impedance bonds.

13 ETCS (automatic train protection) equipment

13.1 ETCS balises

ETCS balises are required for spot transmission of ETCS telegrams from trackside to the train. Balises are generally required at signals and are positioned in the four foot on the track.

Balises may be of either fixed or controlled type. A controlled balise is connected by a cable to a lineside equipment unit (LEU) which determines the telegram the controlled balise will transmit.

All balises that are installed but are not commissioned shall be prevented from affecting operating services by muting (either by a metal cover or electronically).

Refer to the signalling plan for balise placement and kilometrage details.

13.1.1 Signal balise group

Refer to TS 05204.07 for details of standard placement of a balise group at a signal.

Note: Where a DPU is encountered at a signal, the DPU is treated as per IRJ.

13.1.2 Non-standard stopping locations – at signals

Non-standard stopping locations that is, where the standard balise group requirements cannot be installed at the signal, are described in TS 05333.31. Refer to MN S 41606 for more information on balise group installation.

13.1.3 Station areas

The centre of the car marker location shall be no closer than 600 mm on the approach side of the controlled balise for balise groups located at platform starter signals.

Refer to TS 05204.12 for guidance.

13.1.4 Temporary speed warning balise groups

The TSW balise group consists of two fixed type balises.

The balise group for a TSR shall be positioned at the warning TSR sign in the normal direction being protected. The balise group for a TSR should be located adjacent to the TSR warning sign. If required due to installation constraints it is permissible to install the balise group for the TSR up to 30 m beyond the TSR warning sign.

Balise pairs making up the TSW balise group shall be spaced as close as practicable to each other depending on sleeper spacing, but never closer than 2500 mm between the BRMs.

The TSW balise group shall not be located closer than 1000 mm from any other balise on the same track.

The TSW balises shall be installed using an approved spreader beam fixing system that is easily installed and removed using tools.

The TSW balise group shall be relocated where a guard rail or other object is encountered in the four foot. As a simplified requirement, the balise shall not be any closer than 10 m from guard rails, point's equipment or any large objects (containing metal) in the four foot.

13.2 Balise installation

One of the following three types of balise mounting methods shall be used:

- on-sleeper spreader beam that clips to rail fasteners(eClip, FastClip or similar)
- direct fixed (typically bolted direct to sleeper or slab)
- between-sleeper universal mount spreader beam (for example, for TSW or where the normative balise permanent mounting methods are impractical due to the infrastructure constraints).

Balises shall be secured in a manner that allows repeated removal and re-fixing using tools, by authorised personnel. Removal and re-fixing shall be done without damaging the integrity of the anchor or the balise or the structural integrity of the sleeper or slab.

Balises shall be secured by a minimum of two approved fixing points.

Balise on sleeper and between sleeper spreader beams shall be insulated between their ends to ensure when used the beam does not short the rails together.

Balise mounting brackets, fixings, spacers, spreader beams and associated cabling shall meet the following requirements:

- be fully removable from the track
- be manufactured from materials resistant to UV radiation, oil, corrosion, weather and abrasion
- have a minimum design life of 40 years.

The preferred order for balise mounting is as follows:

- on-sleeper spreader beam (such as eClip, FastClip or similar) for concrete sleepers and slab track
- direct fixing for timber sleepers, where guard rails are installed or on slab track where the on-sleeper spreader beam cannot be used
- between sleeper universal mount spreader beams shall be used where the on-sleeper spreader beam or direct fixing is not possible.

13.2.1 On-sleeper spreader beam

The on-sleeper spreader beam mounted balises shall be fitted in accordance with TS 05204.69.

13.2.2 Direct fixing

Direct fixed balises shall be mounted on a rubber mounting pad, refer to TS 05204.00 for manufacturing details.

Rigid balise spacer mounts used with direct fixing shall not be installed, except where required to bring the balise up to within the required vertical design limits.

Balise mounting anchor holes shall be protected by fitting a flush mounted, plastic slotted plug when the balise has been removed for track maintenance.

13.2.3 Concrete sleepers or slab track

For concrete strata, direct fixed mounted balises shall be fitted in accordance with TS 05204.02.

Where balises are to be direct fixed to concrete, two flush mount M10 female 316 grade stainless steel anchors shall be fitted into the concrete and two A4 70 316 grade stainless steel M10 bolts.

Anchors shall be of either mechanical-set type or chemical-set type depending on concrete material compatibility with the anchor. For concrete sleepers mechanical-set anchors are generally required. In the case of slab track, where the concrete is weaker than 40 MPa or the strength is unknown or the concrete is weakened, chemical-set anchors may be used.

Balise fixing points shall be located along the centre line of the sleeper.

Cup washers and thread-retaining or anti-galling fluid shall be used to secure parallel thread bolts in place.

13.2.4 Timber sleepers

For timber strata, direct fixed mounted balises shall be fitted in accordance with TS 05204.01.

The balise shall be fixed using two galvanised steel coach screws of 12 mm diameter and at least 150 mm in length together with 316 grade stainless steel cup washers.

In order to ease future removal of steel coach screws in timber, lanolin grease or other approved environmentally friendly product shall be used for lubrication in a pre-drilled hole before insertion of the screw.

Heavily degraded timber sleepers shall not be used for balise installation and shall be considered for replacement. A chemical anchor shall be used in accordance with the installation procedure detailed on TS 05204.02 where the timber degradation is not structural (surface degradation only) and it is not practical to replace the sleeper. When drilling a timber sleeper for

a chemical anchor, undercut the hole to ensure that the chemical (resin) plug cannot be easily pulled out of the sleeper.

13.2.5 Universial spreader beam installation

The universal beam mounted balises shall be fitted in accordance with TS 05204.48.

For a permanent balise installation the universal beam shall not be used where any other approved permanent method can be used to mount the balise and relocation is not practical.

Thread-retaining or anti-galling fluid shall be used to secure the bolts in place.

13.3 Balise identification permanently fixed

Each balise shall be fitted with a balise ID name plate.

Refer to TS 05204.46 for manufacturing details of the ATP and ASDO balise ID plates and TS 05333.31 for naming conventions used for the text on the balise ID plates. Manufacturing material and information to be shown on ID plates are in TS 05204.46.

Each balise location shall be fitted with a balise location ID name plate.

Identical information shall be provided on the balise ID name plate and its respective balise location ID name plate.

The naming convention of balise ID name plate examples shown on TS 05204.46 only applies to ATP and ASDO balises.

13.3.1 Balise ID

Balise ID name plates shall be affixed by mechanical means to the balise. Balise ID name plates shall be able to be removed without damage so that the label from a damaged balise can be relocated to a new replacement balise of the same model. The label fixing arrangement shall be such that the label remains secured to the balise when the balise has been removed from the track.

The balise ID name plate engraved surface, shall be positioned on the top surface of the balise and visible from a standing position when walking along the track.

Each balise shall display its own manufacturer's ID label in addition it its own balise ID name plate. The manufacturer's ID label shall include the following information as a minimum:

- manufacturer or supplier details
- model or part number
- version details
- serial number.

Other traceability information such as, description of product, manufacturing date, expiry date, batch number and so on should be provided where applicable.

13.3.2 Balise location identification

Balise location ID plates shall be affixed to the sleeper or concrete slab immediately adjacent to each balise in accordance with TS 05204.44.

The balise location ID plate shall be aligned with the balise ID name plate.

For concrete slab track or sleepers, the balise location ID plate shall be screwed down and aligned with the balise ID name plate.

For timber sleepers, the balise location ID plate shall be both screwed and glued to the sleeper.

ATP and ASDO balise location ID plates shall be manufactured in accordance with TS 05204.24.

13.3.3 Balise identification temporary speed warning

Balises from different TSW balise groups shall not be mixed. TSW balise group pairs shall be kept together in respective pairs.

Each balise in a TSW balise group pair shall be fitted with an ID plate manufactured of the same material, have the same form and the same mounting as the standard balise ID plate (refer to TS 05204.65 for material and dimensional details).

Each balise in a TSW group shall have a unique balise identifier made up as follows:

- Each TSW balise group pair shall be uniquely numerically identified for example, 1, 2, 3 and so on.
- The first balise encountered in the relevant running direction shall be colour coded blue. The balise position in group identifier for this balise shall be 0, and identification plate engraving shall include “First TSW balise in direction of travel” as well as the position in group letter ‘A’ identifier.
- The second balise encountered in the relevant running direction shall be colour coded amber (or yellow). Balise position in group identifier for this balise shall be 1, and identification plate engraving shall include “Second TSW balise in direction of travel” as well as the position in group letter ‘B’ identifier.

13.3.4 Big metal mass

A geographic survey shall be carried out to identify any BMMs. A balise shall not be installed within 30 m before or after a BMM.

13.4 ETCS trackside junction box

An above ground ETCS trackside junction box shall be provided to allow jointing of controlled balise tail cables and balise trunk cables. This is similar in function to the bootleg riser used for track circuits.

The ETCS trackside junction box shall be positioned adjacent to the controlled balise so that the balise tail cable is perpendicular to the rails.

The ETCS junction box shall be constructed in accordance with TS 05204.04. The ETCS junction box shall be cabled or wired in accordance with TS 05204.11 and secured with a padlock.

The incoming balise trunk cable from the location case shall be typically protected by a rigid 63 mm heavy duty conduit securely fixed to the junction box in-ground post. Stainless steel strapping shall be used to secure the conduit to the post.

The balise tail cable, enclosed in an electrical hose, shall be secured to the junction box in-ground post with half saddles.

Design life of the ETCS junction box shall be a minimum of 40 years.

13.5 ETCS tail cable

The balise tail cable is a single pair, surface run cable connected to the ETCS trackside junction box at one end and terminated to the balise at the other end.

The balise tail cable shall be sleeved with approved orange flexible electrical hose over the length of the cable to provide mechanical protection and to improve visibility.

Balise tail cables shall be installed so that they are secured in such a way to positively locate and protect cables within the danger zone, making the installation compatible with the operation of track tampers and ballast regulators.

Where the balise is mounted on a sleeper, the balise tail cable shall be secured to the sleeper on the side furthest from the direction of approaching rail vehicles using cable protector plates. Refer to TS 05221.89 and TS 05221.90 for details of the cable protector plates and securing the plates to a sleeper.

Where practicable, the installation arrangement for the balise tail cable should be designed to minimise damage to the ETCS trackside junction box should the tail cable be caught up in track machinery or a rail vehicle.

Refer to TS 05204.07, TS 05204.10, TS 05204.12, TS 05204.44 and TS 05204.58 for installation details.

Where these tails cables are installed in tunnel environments and on walkways these tail cables shall be shrouded to prevent tripping hazards and damage from dragging equipment.

When assessing an existing conduit route, balise tail cables shall not be run with air lines.

13.5.1 Balise installation constraints

13.5.1.1 General

Balises shall be positioned clear of any DTRS train radio transponders, track circuit DPUs and train stop magnets in accordance with TS 05333.31.

For all permanent balise positions where the original design nominated balise position is unable to be installed due to other track obstructions (such as impedance bonds or DTRS transponders) the obstruction shall be removed or a request for a revised design to relocate the balise position to a location that is not obstructed shall be made.

In the MRA where ETCS fitted rollingstock is operating with trackside ETCS refer to MN S 41604 for the storage of rail and how to avoid degeneration and crosstalk of balise information.

13.5.1.2 Balise alignment

Balises shall be positioned and aligned in accordance with TS 05204.03.

Balises shall be mounted transversally to the rails, unless there is existing infrastructure in the four foot, such as guard rails or check rails which will require a longitudinal mount.

The longitudinal mounting method is shown in TS 05204.45. The transverse mounting arrangement is shown in TS 05204.01 or TS 05204.02.

Balises at guard rails shall be fitted in accordance with TS 05204.58.

13.5.1.3 Metal masses

The presence of metal masses within close proximity of a balise may cause degeneration of the message or cross talk between balises.

Balises shall not be located on or adjacent to metal objects in the four foot unless infrastructure constraints interfere such concrete slab track, guard rails, concrete derailment plinths, checkrails and so on.

A geographical survey shall be carried out to identify metal mass locations. Once identified, exclusion zones shall be provided and maintained around the balise location.

Installation of a balise between guard rails shall be done in accordance with TS 05204.58 where the guard rail feet are 440 mm to 630 mm apart.

Installation of a balise on or above a concrete slab or plinth shall have steel reinforcement of the slab greater than 210 mm from the balise side BRM.

The installation of a balise on a derailment plinth shall be greater than 500 mm in the horizontal plane from the balise top BRM.

All modifications to guard rails, check rails, concrete derailment plinths and the like, shall be in accordance with track and civil design standards.

A concrete derailment plinth shall only be removed or cut after design approval has been granted from the TAO responsible for the civil and signal engineering design aspects. Design approval tasks shall include, a site inspection, consultation with the asset manager and an engineering report to assess the hazards and residual risk being mitigated by the plinth.

13.5.1.4 Cable exclusion zone

A balise shall not be located within 1 m of cables in the horizontal plane.

A balise shall not be located within 1 m of cables directly below.

This 1 m exclusion zone applies to the currently supplied Alstom balises. Refer to the supplier for balise cable exclusion zone requirements for other brands of balise.

14 Points and ground frames

14.1 Points

Where a standard design layout drawing is not able to be used, a custom design for a suitable layout shall be prepared and submitted for type approval. For type approval s refer to TS 06178 in the MRA and TS 01257 in the CRN.

All bolted connections that are not adjustable shall use nyloc nuts.

All safety critical elements shall be evidenced as unlikely to fail or shall be provided with redundancy, for example, double secured pins.

Any work involving drilling switches and stock rails shall be carried out in accordance with the manufacturers and RIM requirements for drilling of switches and stock rails. There are often special requirements or restrictions when drilling switches or stock rails to ensure possible rail flaws or faults are not introduced.

Where individual set screws or plain nuts are used, medium strength thread locker shall be used to ensure nuts do not come loose with vibration. Nyloc nuts are to be used wherever possible.

If stainless steel bolts are used with stainless steel inserts in the sleeper, an anti-seize lubricant compound paste which is silver, thick, metallic heavy-duty, high temperature and nickel-based shall be applied to the bolts.

Once final adjustments and setup is complete all nuts, bolts shall be tamper detection marked so that loose fasteners can be easily identified.

Connections between the machine and switches shall be to details referenced on the standard points layout drawing. Where the referenced details are unsuitable, detailed designs for the connections are to be prepared and submitted as part of the type approval submission.

Protection ramps shall be installed ahead of the electrical detectors and rodding.

Local power and multi-core cables to points machines and associated equipment shall be in accordance with TS 05269 and TS 05270 in the MRA and TS 01333 in the CRN. The local power and multi-core cables shall be installed in heavy duty, orange flexible PVC conduit laid on the ballast or track slab. If the length of the local power and multi-core cable exceeds 4 m it shall be buried in accordance with the requirements for buried cable routes in TS 05164 in the MRA and TS 01263 in the CRN.

Flexible conduits shall be securely fixed to the point machine cable entry and to the cable entries of associated equipment. Flexible conduits shall be sealed with a neutral cure sealant after cable termination to prevent moisture entry.

14.2 Point indicators

Mechanical point indicators shall be attached to extended timbers with coach screws for wooden sleepers or fixed to a separate steel or concrete base for concrete sleepers.

Electrical point indicators shall be in accordance with the requirements of this standard and TS 05164 for horizontal or vertical shunt signals.

14.3 Point machines

Point machines shall be installed so that during normal operation no part infringes the structure gauge.

14.3.1 Electric

All electric operated point driving and locking mechanisms shall be in accordance with TS 05303 in the MRA and TS 01335 in the CRN.

During manual operation of the point machine it is permissible for hand throw lever or crank handle to infringe on the structure gauge while moving the point machine.

Where there is insufficient space to locate the switch machine without some infringement of structure gauge then a concession or waiver is required.

Back drives shall be provided as shown on the standard layout drawing or where not available, a suitable design shall be prepared by the TAO.

14.3.2 Electro-pneumatic mechanisms

For conventional electro-pneumatic points operation the components making the complete setup shall be installed in accordance with standard points layout drawings. The components detailed in the standard points layout drawing include pneumatic points motors, economical movements, facing point locks, indication boxes, electrical detectors, baseplates, cranks and rodding.

For claw lock or Spherolock (or similar) operation, motors, claw lock or Spherolock (or similar) mechanisms, and detectors and back drives shall be installed in accordance with the standard points layout drawing.

All bolts through timber sleepers shall have nuts secured with thread locking compound.

Protection ramps shall be installed ahead of the electrical detector in the normal direction of travel.

Local multi-core cables from the location case or termination box to control valve, detector, motor and, where applicable, facing point lock and indication box shall be installed in individual heavy duty orange PVC conduits laid on the ballast from the point where the cables leave the fixed cable route.

Airline connections and terminations shall be as specified in TS 05171.

Conduits shall be securely fastened to the cable terminators provided on each piece of equipment.

14.4 Ground frames

The general layout of ground frames and rodding shall be as shown on M10-302.

The layout of ground frame and channel rodding runs, including compensation, if it differs in any way from the layout shown on M10-302, shall be drawn up and submitted for TAO approval.

Tangential type turnouts and large conventional turnouts shall be assessed for suitability for use with hand operated ground frames or levers.

14.5 Identification of points and catchpoints

One hundred millimetre cast aluminium or enamelled steel numerals coloured white shall be fixed to the sleeper either in the four foot or adjacent to the switch machine giving the point (turnout) number and, if there are multiple ends with the same number, the end identification, A, B and so on for example, 441A, 441B.

N and R letters shall also be provided to indicate the normal and reverse positions.

The identification shall be glued to the bearer, using a suitable concrete to metal adhesive rated for temperature extremes and outdoor use when concrete bearers are in use.

When in-bearers are in use or it is otherwise not possible to fit to the A beam, the identification shall be provided on the A1 sleeper (the beam preceding the tip of the blades).

15 Equipment locations and platforms

Equipment location cases, walk in equipment locations and platforms cases in the MRA shall be installed in accordance with TS 05167 and TS 05164. Location cases and platforms in the CRN shall be installed in accordance with TS 01264 and TS 01263.

Direct access for maintenance staff shall be provided from the equipment which is serviced by the location case (for example, track circuit units, axle counter unit, points machines and so on) to the location case. In this context direct shall mean the following:

- the equipment location case and equipment are not separated by a cess or drain which is too deep to walk through or subject to standing water or flooding
- the equipment location case is not at the foot of a steep embankment
- the equipment location case is not at the top of a steep cutting.

Walkways, steps, ladders or bridging over drainage ditches or cesses shall be provided where required.

Walkways, steps and landings for safe access by maintenance staff shall comply with AS 1657.

Handrail posts shall be bolted to masonry surfaces with stainless steel expanding anchors or stainless steel chemical anchors. The minimum anchorage depth shall be such that the strength of the anchorage is equal to or exceeding that of the post.

Handrail posts (where not welded to the structure) shall be bolted to steel structures with galvanised bolts with spring washers and nuts. The strength of the fastenings shall be equal to or exceeding that of the post.

15.1 Alterations within existing equipment locations

When installing new signalling equipment such as signal interlockings, axle counters, ETCS equipment and communications equipment, it is preferable to use a new equipment location or equipment cupboard to ensure performance, reliability, life cycle costs and full standards compliance are achieved.

However, to save costs (compared to using a new equipment location) there may a proposal or a design to install new signalling equipment in an existing signalling equipment location. A number of key items need to be assessed and stakeholders consulted to ensure the required performance, reliability, life cycle and standards compliance can be achieved.

A signal project proposal or a new signal design reusing an existing location shall ensure the following:

- final configuration is logical and able to be maintained
- proposed design is able to be constructed and staged from old to new signal system is achievable
- additional cable trays and equipment racks (if required) are able to fully meet current standards (including heat load/ventilation) and still align to existing racks and cable trays
- consolidation and removal of redundant equipment and cables are achievable
- final removal of redundant signalling equipment can be completed without disturbing or requiring disconnection of the newly installed signalling equipment
- final arrangement of the new signalling equipment meets requirements (design life remaining) and achieves standards compliance.

16 Notice boards and signage

In the MRA refer to TS 05333.6 for details of signs which are outside the scope of this standard and refer to TS 00012 for signage used with the railway safe working systems.

Notice boards and other signage shall be installed on 50 mm nominal bore galvanised steel pipe posts at a distance of 2500 mm from the running face of the nearest adjacent rail. The pipe shall extend at least 450 mm into a concrete foundation of at least 200 mm diameter. Concreting of any post shall be weather domed and smooth around the post to prevent water pooling.

The height of the sign shall be not more than 1600 mm above the level of the formation to ensure that the sign does not become a hazard by being at head height. For visibility by the train driver the lower edge of the sign shall not be more than 2000 mm above the top of the rails. Where the formation falls away and the sign would be too low for reasonable train driver visibility, the sign height may be increased, but in such cases the lower edge of the sign shall be installed well above 2200 mm. When longer posts are required the post size shall be 65 mm nominal bore and shall extend at least 600 mm into the concrete footing in the ground.

Where these requirements cannot be met due to site constraints and local requirements, the matter shall be referred to the signal design TAO to determine a position of the notice board or sign.

Signs that are required to be mounted low to clear structure gauge, between tracks, such as yard limit, end yard limits (EYLs), shunting limit boards and so on shall be located low down on similar posts. If needed, the post can lay back up to 30 degrees so that the sign is more easily readable by train drivers. Such posts shall not protrude above the sign by more than 50 mm.

All posts shall be fitted with pipe caps.

16.1 Trackside safe working operational signs

16.1.1 ETCS level 2 marker boards

The ETCS level 2 marker boards used on ETCS level 2 signalled lines are symbolic and comprises a yellow arrow on a blue background.

ETCS level 2 marker boards shall be positioned on the left side of the track for normal direction running rail vehicles. ETCS level 2 marker boards are used in degraded mode operations at a maximum speed of 40 km/h to provide positional information. The sighting distance requirements for ETCS level 2 marker boards are significantly less than a signal.

ETCS level 2 marker boards shall be positioned at a design distance measured from the operational stopping point and confirmed with the marker board sighting form.

The ETCS level 2 marker board drawings and details are specified in TS 00012 and are used on ETCS level 2 signalled lines. There are horizontal and vertical ETCS level 2 marker boards. The horizontal ETCS level 2 marker board shall be used unless space limitations mean that a vertical board is required to fit the limited space available.

ETCS level 2 marker boards shall be installed on a galvanised steel pipe post bolted to the foundation at a distance of 2800 mm from the running face of the nearest rail. ETCS level 2 marker boards shall be 2700 mm vertically from the top of rail to the centre of the arrow (the arrow is on the marker board).

In tunnels and cuttings where clearance to structure gauge defined in TS 03500 is limited the ETCS level 2 marker boards shall be the vertical type.

ETCS level 2 vertical marker boards can be mounted on vertical galvanised posts or on custom brackets.

ETCS level 2 marker boards are sighted in a similar way to the signal sighting process using a specific ETCS level 2 marker board sighting form to show consultation between signal designer and the train driver representatives to determine the required type and position of ETCS level 2 marker boards.

16.2 Trackside non-operational signs

16.2.1 Track circuit equipment labels

Refer to TS 00012 for character type and spacing requirements.

Figure 8 shows horizontal and vertical examples of trackside track circuit equipment labels.

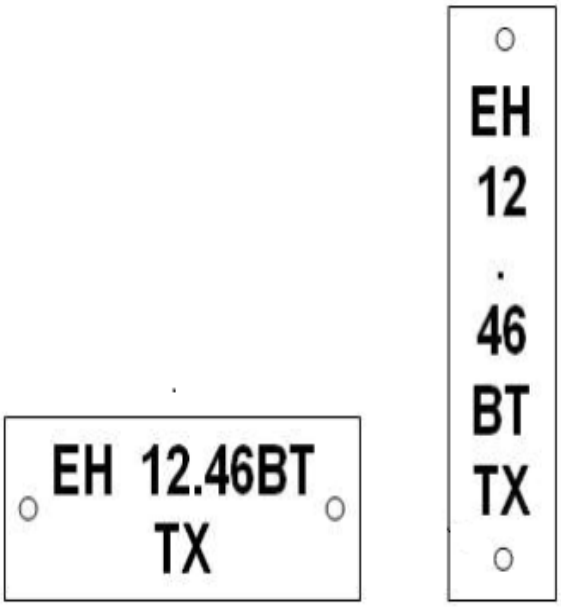

Figure 8 –Track circuit equipment labels

Table 1 lists the specifications for track circuit equipment labels.

Table 1 – Track circuit equipment labels specifications

Parameter	Horizontal label	Vertical label
Manufacturing detail drawing number	Case mount version	Support post mount
Sign width	90 mm	30 mm
Sign height	45 mm	30 mm
Plate thickness	2 mm	2 mm
Character size, type and spacing (where specified)	12 mm, series DN in accordance with AS 1744, 5 mm spacing	12 mm, series DN in accordance with AS 1744, 5 mm spacing
Character material	Laser cut or engraved black paint filled	Laser cut or engraved black paint filled
Background material	Natural anodised aluminium	Natural anodised aluminium
Mounting detail drawing number	Screw or rivet	Screw or rivet

16.3 ETCS level 1 plates

Refer to MN S 41604 for additional information on ETCS level 1 plates.

16.3.1 Alstom balise identification name plates

Figure 9 shows the Alstom balise ID name plate where WWW is the location code, XXXXXXXX describes the signal name, points number or appropriate balise group kilometrage, where YYYY

describes the line name, where Z is the balise position in group number and where T is the balise type. Refer to TS 05204.46 sheet 1 for details.

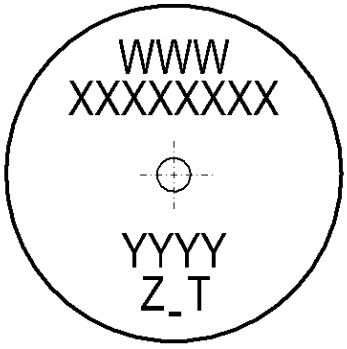

Figure 9 – ATP ETCS level 1 Alstom balise ID name plate

16.3.2 Balise location identification plate

The balise design position is identified by a stainless steel plate fitted to the horizontal surface of a sleeper or slab. Figure 10 shows the normative ETCS level 1 balise location ID plate.

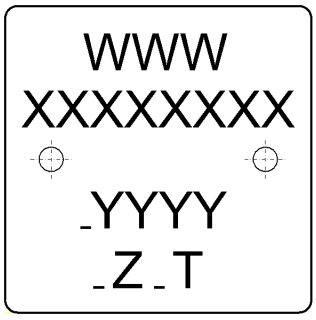

Figure 10 – ETCS level 1 balise location ID plate

Figure 11 shows the alternative ETCS level 1 balise location ID plate where the plate cannot be mounted immediately adjacent to the balise. Refer to TS 05204.24 for details.

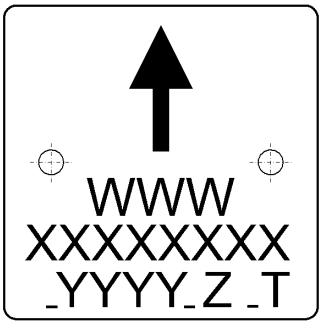

Figure 11 – ETCS level 1 balise alternative location ID plate

16.3.3 ASDO Alstom reference balise identification plate

Figure 12 shows the ASDO Alstom reference balise ID plate for an Alstom balise where X is the platform number and where YZ defines the balise group position in relation to the platform. Refer to TS 05204.46 sheet 2 for details.

Figure 12 – ASDO reference balise ID plate

16.3.4 ASDO reference balise marker plate

The position of the ASDO reference balise marker plate, is identified by a stainless steel plate fitted to the vertical face of each ASDO enabled platform. Figure 13 shows the horizontal and vertical ASDO reference balise marker plates. Refer to TS 05204.73 sheet 1 for details of the vertical plate and TS 05204.73 sheet 2 for details of the horizontal plate.

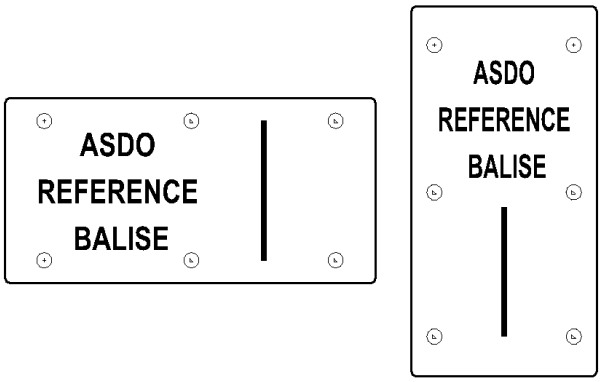

Figure 13 – ASDO reference balise marker plate

16.3.5 ASDO platform limit marker plate

The position of the ASDO platform limit marker plate is identified by a stainless steel plate fitted to the platform horizontal surface. Figure 14 shows the ASDO platform limit marker plate.

Refer to TS 05204.76 for details.

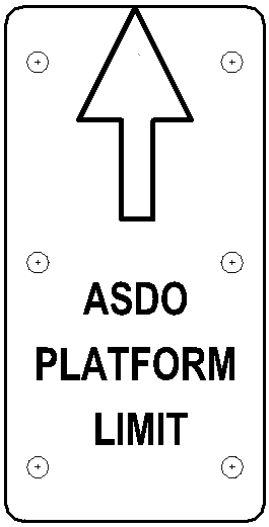

Figure 14 – ASDO platform limit marker plate

17 Level crossings

For level crossing installation works in the MRA refer to TS 05267, TS 05172 and TS 05164 for cable route installation, equipment and equipment installation.

For level crossing installation works in the CRN refer to TS 01336 and TS 01261 for cable route installation, equipment and equipment installation.

Alignment (focusing) of level crossing warning lights shall comply with TS 05172 in the MRA and TS 01261 in the CRN.