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Section 12: Level Crossings

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Amendment Record

Amendment Version #	Date Reviewed	Clause	Description of Amendment
1.0	05 Feb 23		First issue of document
1.1	May 2025		Synchronized Table 12-5: Level crossing general inspection criteria and Table 12-6: Level crossing general inspection assessment with changes in ETS1200F-01 General Inspection of Road Level Crossings

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12 Level Crossings

12.1 General

12.1.1 Reference Documents

The following documents support this procedure:

- AS 1100.401 Technical drawing — Engineering survey and engineering survey design
- AS 1742. 7 Manual of uniform traffic control devices, Part 7: Railway crossings
- AS 1743 Road signs — Specification
- ALCAM Level Crossing Assessment Handbook
- ETD-00-01, Drawing Standard for Plans Showing Horizontal Alignment

12.1.2 Definitions

The following terms and acronyms are used within this document:

Term or acronym	Description
85th percentile (road) speed (V85 km/h)	The speed at or below which 85 percent of vehicles are observed to travel under free-flowing conditions past a nominated point. A vehicle is considered to be operating under free-flowing conditions when the preceding vehicle has at least six seconds headway and there is no apparent attempt to overtake the vehicle ahead.
ALCAM	The Australian Level Crossing Assessment Model (ALCAM) is a national assessment tool used to identify key potential risks at public level crossings, assist in the prioritisation of crossings for upgrades and support the decision-making process when determining cost-effective treatments.
Approved by ARTC	Where this terminology is used a decision may be approved by the business unit without an engineering waiver
Basic Level Crossing	A level crossing with unsealed road surface across the track(s) (e.g., ballast or loose fill) and as defined in 12.2.4.2.
Ideal Level Crossing	A level crossing with sealed road surface across the track(s) including formed gravel (e.g., formed gravel, panel, or asphalt) and as defined in 12.2.4.2.
Level Crossing	A location where the railway line and a road or pedestrian walkway cross paths on the same level.
Modular Level Crossing Surface	A level crossing manufactured in concrete, rubber, steel, etc. modular sections and assembled on site.
Multi-lane roadways	Roadways comprising two or more traffic lanes in either direction
New Level Crossing	A level crossing installed on ARTC's rail network where none previously existed.
Private Level Crossing	A level crossing that is for a specific and often limited use, generally to provide access within a private property, or between a private property and a public road.

Term or acronym	Description
Public Level Crossing	A level crossing provided to maintain continuity of a public thoroughfare. It is located on state, local council or Crown road and is available for the use of the public.
Relocated Level Crossing	A new level crossing installed at an adjacent or nearby location to replace an existing level crossing that is removed.
Restricted Access	Level crossings that are for authorised use only (such as service crossings, temporary crossings etc.).
Road Authority	That body (State or Local Government) vested with the care, control and management of the road concerned.
Road-rail access point	(Primary) A location provides access for road-rail vehicles to get on and/or off railway track(s) that is not used for the purpose of crossing the track(s). It is also known as a take-off. (Secondary) All level crossings can be used as a road-rail access point.
Service Level Crossing	A level crossing provided for authorised persons to cross the track. Service level crossings may be provided in field situations for maintenance access, and in station yards.
SSD	The distance at which an approaching road vehicle driver must be able to see the primary control device at the level crossing to stop in time. Calculated as S1.
S1	Minimum distance of an approaching road vehicle from the nearest rail when driver must be able to see an approaching train in time to stop if necessary, before reaching the crossing (protected by Give Way control).
S2	Minimum distance of a train from the crossing at which a road vehicle driver at distance S1 from the crossing can proceed at speed and safely clear the crossing (protected by Give Way control) ahead of that train.
S3	Minimum distance of an approaching train from the centre of the crossing, when the driver of the road vehicle who is stopped at the Stop or Give Way line must first see an approaching train in order to safely cross the track(s).
Temporary Level Crossing	Temporary level crossings may be installed to facilitate or support construction works in the rail corridor or used for derailment or disaster recovery, which will be removed at the end of the service.
Upgraded Level Crossing	An upgrade to the existing level crossing where it is re-designed (e.g. a site specific design process as per EGP-04-01).

12.2 Design

A level crossing is where a railway line crosses a road or a pedestrian path at the same level. Level crossings can potentially present significant safety risk to passengers, train crews, pedestrians, and road motor vehicle occupants.

Before undertaking the design and installation of a level crossing, all alternative means of access must be considered. Grade separation, repurposing of existing infrastructure or closure in the case of existing level crossings shall be vigorously investigated and sought. The design of a level crossing shall be undertaken only after the safety risk and all other factors have been assessed and resolved.

The design requirements of this standard shall apply to new, relocated, and upgraded passive level crossings. This standard also applies to active level crossings where the requirements are not covered by ARTC signalling standards.

A level crossing should:

- Warn users (rail, road and pedestrian) of the existence of a level crossing.
- Allow for the safe passage of pedestrian, specified road and rail traffic
- Provide sufficient warning or sighting for road and pedestrian users to cross safely

The design of public level crossings shall be based on relevant Australian Standards and performance requirements specified in this Standard, which covers private and service level crossings. The Australian Standard takes precedence where there is any discrepancy on design requirements for public level crossings.

The design of pedestrian level crossings shall be based on the requirements specified in ETS-12-01.

Road-rail vehicle access points that are only accessible from a single side of the track are not considered to be a level crossing, however they shall meet the requirements of protective measure in 12.2.1.5.5 of this Standard.

12.2.1 Protective Measures

The type of level crossing control and road traffic arrangements to be deployed at a level crossing should consider the rail and road traffic arrangements within the vicinity of the level crossing. Guidelines used for determining the potential hazard at level crossings are based on the potential for conflict between road and rail traffic and should be assessed on the basis of below:

- Visibility
- Geometry
- Traffic types (road)
- Traffic volumes (road and rail)
- Traffic speed (road and rail)
- Usage of livestock (trespass in the rail corridor)
- Weather and environmental factors
- Heritage factors if applicable (including considerations for sightseeing visitors etc.)
- Collision and near-collision history

- Engineering experience (both rail and road)
- Local knowledge of driver or pedestrian behaviour
- Social and economic assessment
- Standards and international best practice

When assessing the type of protection at a level crossing, the existing conditions (i.e. data and site information etc.) are usually best evaluated by following the order below:

1. Closure or relocation
2. Grade Separation
3. Active Control
4. Passive Control

Optional measures that may be applied to improve safety, as discussed in 12.2.5, should be considered while assessing a level crossing.

12.2.1.1 Closure or Relocation

Where closure or relocation of the level crossing is considered to be the most appropriate option, the situation should be negotiated with the relevant Road Authority.

Closure or relocation of a level crossing should be considered under any of the following circumstances:

- Location requirements cannot be met (refer to 12.2.2).
- Physical aspects render reliable and effective protection by passive or active controls difficult or not reasonably practical to achieve.
- Level crossing is part of a road and land use planning scheme whereby closure of the level crossing is or can be achieved.
- Existing adjacent level crossing where traffic can be diverted to.
- Existing level crossings with a consistently high accident rate.
- Private landowner has more than one level crossing accessing their property, or reasonable alternative road access to the property is available.

Note: *Any closure of existing public level crossings will adhere to state legislation to ensure relevant issues have been considered along with adequate consultation.*

RISSB Guideline – Consolidation of public level crossings, may be used for the process of closing or relocating public level crossings.

12.2.1.2 Grade Separation

Grade separation shall be considered if closure or relocation cannot be achieved. The treatment type should be based on an assessment to reduce the risks so far as is reasonably practicable (SFAIRP).

12.2.1.3 Active control

Active control is the control of the movement of vehicular or pedestrian traffic across a level crossing by devices such as level crossing flashing signals, gates or barriers, audible warning devices, or a combination of these, where the device is activated prior to and during the passage of a train through the level crossing.

12.2.1.4 Passive control

Passive control is the control of the movement of vehicular or pedestrian traffic across a level crossing by only signs and devices of which none are activated during the approach or passage of a train, and which rely on the level crossing user detecting the approach or presence of a train by direct observation.

The primary requirement at any passive control crossing is for there to be sufficient sight distance for a vehicle stopped at the railway crossing to be able to start off and clear the crossing before the arrival of a previously unseen train.

Level crossings with passive control shall be treated with Give Way or Stop sign incorporated into RX-1 or RX-2 assemblies together with advance signs unless Minimum Treatment conditions are applicable (see 12.2.1.5). The application of Give Way or Stop sign control at a public level crossing shall follow AS 1742.7 Clause 4.2.1. Sight distances guidance for public, private and service level crossings are introduced in 12.2.4.

If the primary requirement for a passive control crossing cannot be met, risk assessment shall be taken case by case to decide if further risk mitigations are required, refer to 12.2.8.

Note: A public crossing with sufficient sighting distance for Give Way sign control may be reduced to Stop sign control where a risk assessment determines it is appropriate. This may be achieved with Road Manager's support.

12.2.1.5 Minimum Treatment Crossings

12.2.1.5.1 Public level crossings

The absolute minimum treatment required at a public level crossing shall be the RX-1 (Give Way) or RX-2 (Stop) assemblies. The application of Give Way or Stop sign control shall be determined by the sight distance requirements in 12.2.4. Additional control such as advanced warning signs should be considered in accordance to requirements in AS 1742.7.

Note: This minimum treatment shall apply to single tracks only.

Refer to AS 1742.7 Table 4.1 for application limitations. Public level crossings not meeting the requirements shall follow the full treatments for passive.

12.2.1.5.2 Private level crossings

The minimum treatment required at a private crossing shall be the RX-2 (Stop) assembly.

12.2.1.5.3 Service level crossings

Service level crossings shall be protected by

a. Adoption of the same protective measures as private level crossings, or

b. The use of gates or similar devices to restrict access (e.g. STD-C0029 in Appendix B), or

c. Alternative arrangements approved through a suitable site specific risk assessment

12.2.1.5.4 Temporary level crossings

Temporary level crossings shall be assessed case by case and protected by arrangements approved through a suitable site specific risk assessment. The following shall be considered for the assessment:

- Road vehicle types including construction machinery (e.g. frequency and speed),
- Rail traffic types (e.g. tonnage, frequency and speed)
- Work duration, and
- Level of access restrictions (warning signs, gates etc.).

12.2.1.5.5 Road-rail access points

Road-rail access points with access via both sides of track shall be treated as a service crossing.

Road-rail access points where access is only available from one side of the track is not considered as a level crossing and shall be signed to indicate “Road-rail access point only” or use gates or similar devices to restrict access. Alternative arrangements may approved through a suitable site specific risk assessment

12.2.2 Location Considerations

All new level crossing location decisions are to give due consideration to situations that influence the sight distance requirements.

All level crossings should be located clear of:

- The length of track occupied by trains standing at railway signals,
- Turnouts and insulated joints,
- Existing installations which restrict sight distance (e.g. queueing road traffic at an adjacent level crossing),
- Near sidings or loops, where masking of a train can occur when trains standing in the siding or loop obscure visibility of a train passing on the main line (passive crossings only), and
- Crossing multiple railway tracks (with exceptions on service level crossings or active level crossings).

12.2.3 Sighting Angles

No new passive level crossing shall be permitted if the sighting angles specified in AS 1742.7 Appendix D5 are exceeded, as show in Figure D1 and D2 of AS 1742.7-2016.

Approaching a Give Way sign controlled crossing, the maximum angles shall be

- To the left (X_{1L}) – 95 degrees; and
- To the right (X_{1R}) – 110 degrees.

Stopped at any passive control crossing, the maximum angles shall be

- To the left (X_{2L}) – 110 degrees; and
- To the right (X_{2R}) – 140 degrees.

Preferred practice is to approach a crossing at 90 degrees to the track from the appropriate viewing point (i.e. at a safe point on the approach and up to the Stop line).

12.2.4 Sight Distance

All public and private passive level crossings shall have sufficient sight distance S3 for a design vehicle to start off and clear the crossing. The required S3 is determined by the multiplication of vehicle crossing time and train speed.

Where a required sight distance S3 greater than 750m is required, a site-specific risk assessment shall be undertaken to determine if additional controls are required, these controls may include;

- Rerouting classes of vehicles
- Provision of active control
- Closure or relocation of the crossing
- Reduction in train speed

Note: AS1742.7 notes that 100% of motor drivers could identify a train at 750m, at a distance of 1450m this reduces to 85%. Risk assessment may suggest that any perceived increase in risk does not justify the implementation of further risk controls. See AS 1742.7 Appendix D for details.

12.2.4.1 Public Level Crossings

Sight distance design requirements for public level crossings that are new, relocated and upgraded shall comply with AS 1742.7 and supplements in this section.

Level crossings shall have sufficient stopping sight distance (SSD). Sight distance S1 and sight distance S2 (Give Way sign controlled only) shall allow the road vehicle driver to see an approaching train in time to stop if necessary before reaching the crossing.

12.2.4.1.1 Road traffic type

Class 2 PBS 30m (NHVR) vehicles should be considered as a design vehicle for new crossings.

The design vehicle shall not be less than the largest approved vehicle along the route as assigned by the Road Authority.

Note: Design vehicle for public crossings shall be determined in consultation with the Road Authority.

12.2.4.1.2 Road traffic speed

The 85th percentile road vehicle speed (V85 km/h) shall be considered for sight distance calculation. Where speed data information is not available the road speed limit plus 10% may be used.

12.2.4.1.3 Rail traffic speed

Use the highest applicable speed board for any track through the level crossing in either direction.

In circumstances where all trains cannot achieve the normal speed board speed, it may be reasonable to use the highest reduced speed.

12.2.4.2 Private Level Crossings

Different level crossing conditions at private level crossings shall be considered for the sight distance calculation. A mixed consideration of crossing surface and combined road grade from each side shall be given when designing sight distance. The following method shall be based on when determining a private level crossing condition.

Table 12-1: Private level crossing – Crossing surface conditions

Crossing Type based on site condition[2]	Sealed or formed gravel crossing surface[1]	Unsealed crossing surface
≥ 12% Combined Grade[3]	Basic	Basic
< 12% Combined Grade[3]	Ideal	Basic

Notes:

1. *Includes modular panels such as steel, rubber, concrete etc.*
2. *Crossing surface refers to the surface between the two stop lines / signs.*
3. *The combined grade is to account for reduction in velocity that occurs when a vehicle has to climb over level crossing that protrudes from a road surface. It is not related to the humped factor in ALCAM assessment which relates to risk of a vehicle bottoming out.*

   The combined grade shall be taken as the sum of the grades either side of the crossing from outer rail to the stop line at the lane centre, or 3.5m where there is no stop line. If required refer to ALCAM combined grade measurement.

Service level crossings that have the same protective measures as private level crossings shall follow this section for sight distance requirements. Authorised Access Sign should be installed at service level crossings with insufficient sight distance, refer to STD-C0030 in Appendix B for details.

The following methods shall be applied when determining sight distance S3 for a private level crossing.

Table 12-2: Applied Sighting Equation based on Crossing Configuration

Crossing Configuration	Ideal Level Crossing	Basic Level Crossing
Standard Vehicles in AS 1742.7	AS 1742.7	Equation 12-1 [1] [2]
Non-standard Vehicles	Equation 12-1 [2]	Equation 12-1 [2]

Note:

1. *Vehicle performance shall be based on the limiting speed of a rigid truck and the acceleration provided by AS 1742.7, grade correction factors shall be per AS 1742.7.*
2. *Equation 12-1 is based on the assumption that the time taken to reach limiting velocity is less than the total crossing time. AS 1742.7 equation should be followed (with appropriate substitutes where required) if the design vehicle accelerates constantly while crossing.*

12.2.4.2.1 Revised Equation of Sighting Distance

Equation 12-1 below is a revised equation intended to reflect vehicles that are not provided for in AS 1742.7. Design vehicle parameters used for the calculation are tabulated in Appendix A. These values may be substituted with alternate values where reasonably supported.

$$S_3 = \frac{v_T}{3.6}\left(J + \frac{v_L}{a_E} + \frac{\left(\left(\frac{W_R}{tanZ}+\frac{W_T}{sinZ}+2C_V+C_T+L\right)-\frac{V_L^2}{2a_E}\right)}{v_L}\right)$$

Equation 12-1: Revised S3 equation

a) $a_E = \frac{a}{G_S^2}$

b) v_T = the speed of the train approaching the crossing (km/hr)

c) J = sum of the perception time and time to depress clutch. General case = 2.0 to 5.0 seconds [1] [2].

d) v_L = limiting speed over the crossing (m/s)

e) a = average acceleration of the design vehicle in starting gear (m/s^2) [1]

f) G_S = grade correction factor [3]

g) W_R = width of the travelled way (portion of the roadway allocated for the movement of the vehicles) at the crossing (m). General case = 4.5m.

h) W_T = width, outer rail to outer rail, of the rail tracks at the crossing (m). General case = 1.5m.

i) Z = angle between the road and the railway at the crossing (degrees)

j) C_V = clearance from the vehicle Stop line to the nearest rail. General case = 3.5m

k) C_T = safety margin from the vehicle Stop line on the departure side of the crossing. General case = 5m

l) L = length of design vehicle

Note:

1. *For standard vehicles in AS 1742.7, Table D1 should values be applied.*
2. *2.5 seconds should represent most vehicles. Vehicles with hydraulic controls (e.g. harvesters) should use 5 seconds unless otherwise determined by risk assessment.*
3. *For NHVR Class 1 vehicles and Light vehicles use Gs=1. For other vehicles use the most appropriate value from AS 1742.7 based on the vehicle performance and length.*

12.2.4.2.2 Road traffic type

All vehicles known to access the crossing shall be considered when designing a private level crossing.

A B-double may be used as the design vehicle if large vehicles are expected but actual vehicle information is unknown.

Where a private crossing is accessible from a public road the design vehicle shall be the largest approved vehicle along the route as assigned by the Road Authority unless otherwise approved by a risk assessment.

Design vehicles that are not listed in Appendix A shall be assessed case by case to make the appropriate assumptions for the calculation. Acceleration and velocity should be assessed based on the vehicle length and performance (NHVR classification description should be considered when categorising a vehicle type).

12.2.4.2.3 Rail traffic speed

Use the highest applicable speed board for any track through the level crossing in either direction.

In circumstances where all trains cannot achieve the normal speed board speed, it may be reasonable to use the highest reduced speed.

12.2.4.2.4 Vehicles unable to achieve suitable crossing time

Where a vehicle has a sight distance requirement that is unable to be achieved, a site-specific assessment must be undertaken to ensure that risks to safety are managed so far as reasonably practical, this assessment may determine the perceived risk does not require further risk controls or result in further steps to control the risk such as.

- Rerouting of the vehicle
- Gaining agreement to remove authorisation for the vehicle
- Reduction in track speed
- The addition of operational controls

12.2.5 Other Safety Considerations

12.2.5.1 Whistle Boards

Whistle boards shall be installed where required by Network Rules.

12.2.5.2 Sealed Road Approaches and Crossing Surface

On unsealed roads, sealing the approaches to the level crossing will reduce dust and improve visibility of the crossing and in most cases reduce the required sight distance. This also will improve the maintenance life of level crossing asset. Where the approach is sealed, it should be sealed for at least 7m on each side of the rail track(s) including the shoulder area.

12.2.5.3 Street Lighting

The provision of street lighting at level crossings may be considered where there is a perceived accident risk from:

- Trains standing on the crossing during the hours of darkness.
- Shunting or through movement over the crossing during the hours of darkness.
- Potential pedestrian use at a road crossing during the hour of darkness

- Road traffic during the hours of darkness

Each case should be assessed separately in conjunction with the appropriate Road Authority and local government authority on issues of design and funding.

12.2.5.4 Integration of Road Traffic Signals

At road intersections, adjacent to or over railway crossings, where road traffic signals exist or are proposed, the road traffic signal and railway active warning device layout and controls should be integrated to ensure that road vehicles cannot inadvertently queue over the level crossing.

Furthermore, on the approach of a train to the crossing priority should be given to those road traffic signal phases that would clear any road traffic encroaching on the tracks while preventing road traffic movements entering the level crossing area.

12.2.6 Signage

Signs used at each level crossing shall follow the requirements in 12.2.1.5. All signs are to be manufactured in accordance with AS 1743 and AS 7632. Level crossings formed by private roads may be managed in accordance with the conditions of the licence between ARTC and the crossing licence holder.

12.2.6.1 Passive control devices

The commonly used sign assemblies are tabulated in Table 12-3. Refer to STD-C0039 and STD-T0005 in Appendix B for details. Additional or alternate signage may be introduced in conjunction with relevant Road Authorities if applicable.

Table 12-3: Assemblies used under passive control

Assembly	Designation	Signs incorporated
Railway crossing Give Way assembly	RX-1	R6-25, W7-2-2, R1-2
Railway crossing Stop assembly	RX-2	R6-25, W7-2-2, R1-1, G9-48
Railway crossing ahead	W7-7	W7-7(R), W7-7(L)
Railway crossing diagrammatic warning assembly	RX-3-1	W7-8, G9-48
	RX-3-2	W7-9(L), G9-48
	RX-3-3	W7-9(R), G9-48

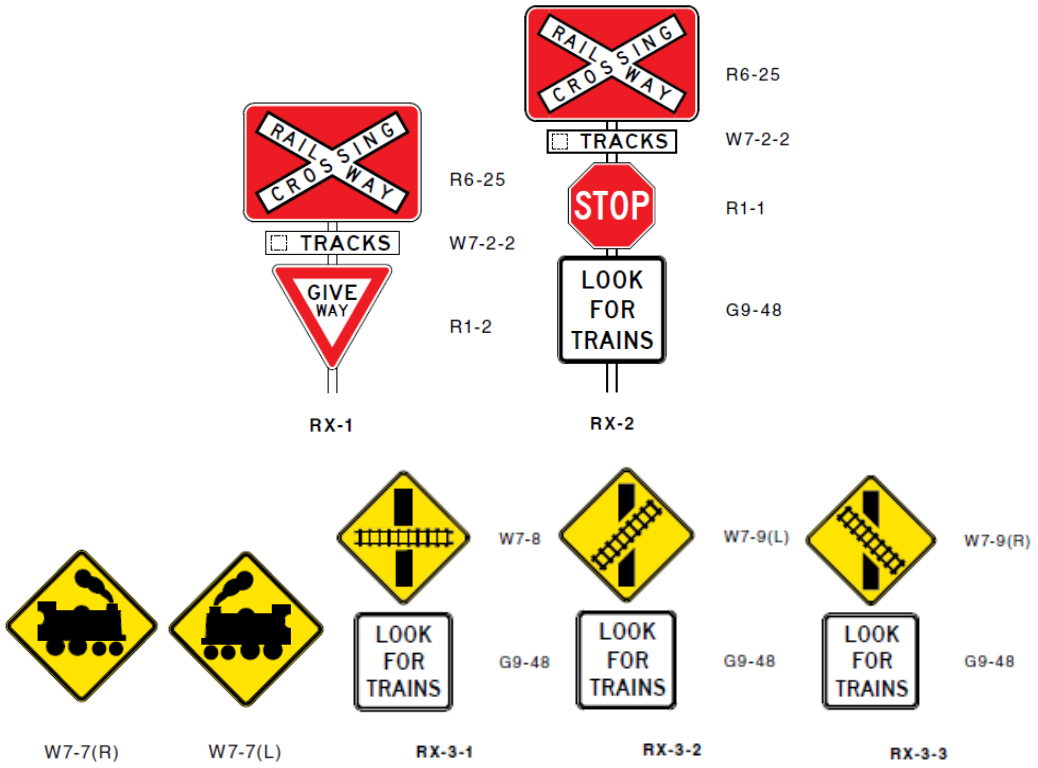

Figure 12-1: Assembly examples for passive control level crossing
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Notes: *W7-2-2 at passive crossings shall be used at multiple track crossings.*

Larger signs may be used as per Appendix C in AS 1742.7.

Existing signs that are not aligned with the latest standards are permissible (e.g., the use of R-24, W7-2-1 etc.). However, the signs shall be upgraded to the above types where replacement is required.

AS 1742.7 takes precedence if there is any discrepancy on sign naming or design for public level crossings.

The Railway Crossing and Width Marker (RX-9) assembly should be used where the conspicuity of the crossing needs to be enhanced, typically on high-speed rural road approaches and should be considered where any of the following conditions applies. They are located immediately in advance of the RX-1, RX-2 or signalling assemblies.

- At Give Way signed crossings on all main roads.
- At other passive crossings on any roads where basic signs are considered inadequate.
- At any other crossing (passive or active) where it is necessary to emphasise the position of the crossing or its restricted width.

At level crossings where it has restricted access, an appropriate “restricted access sign” shall be provided. Refer to STD-C0029 and STD-C0030 in Appendix B for details.

Active control devices refer to AS 1742.7 Section 2.

12.2.7 Civil Requirements

The civil design at a level crossing shall be based on AS 7658 with the supplements in this section.

Designs are to include:

- provision of a suitable wheel flangeway
- track and road surface drainage (including spillage of hazardous chemicals or fuels)
- Road width alignment suitable for vehicle type

Refer to level crossing cross section drawing STD-C0043 in Appendix C for details.

12.2.7.1 Track

Level crossings should have minimum flangeway clearance of 60mm width and 40mm depth.

Where guard rails are installed, the length of the guard rails should be the design width of the road plus the design width of the two road shoulders, plus 600mm for each tapered end (run-in) of the guard rail. The top of the guard rail should be level with the top of the running rail.

Rail shall comply with the requirements of T&C COP Section 1: Rail.

12.2.7.2 Crossing Surface

The crossing surface shall be no higher than the rail level by design or during the service life of the level crossing. The skid resistance should be similar to the value for the adjacent road surface.

For multiple tracks, the level crossing surface should be coplanar between each adjacent pair of rails.

Modular level crossings are commonly used on ARTC network. Only type approved level crossing panel systems shall be used.

Selection of the level crossing surface type may be based on the following considerations.

- road vehicle type, volume, speed and weight
- use of road by cyclists
- presence of impact initiators such as vertical dips in the road
- angle of attack of road vehicles
- road surface grip under all conditions
- surface and sub-surface drainage
- compatibility with the adjacent road surface
- durability
- resistance to UV and chemical attack
- rail traffic volume, speed and axle load
- track configuration
- road configuration
- electrical resistance
- stray currents

- track maintainability requirements including ease of removal for track maintenance
- effect of Level Crossing components on track component wear and corrosion
- life cycle cost

Note: Not every level crossing surface is ideal for every operational scenario.

Modular panels may be ideal in high tonnage environments where access to track for tamping etc is more frequently required and can be aligned with panel maintenance, however may create significant maintenance effort on low tonnage lines as panel maintenance may far exceed track maintenance requirements.

12.2.7.2.1 Public Level Crossing

All new public level crossings should have sealed crossing surface (e.g. concrete or modular panels etc.) across the track(s) extending for a sufficient distance that vehicles can safely use the level crossing.

12.2.7.2.2 Private Level Crossing

The minimum requirement for the road surface across the track(s) shall be a formed ballast topped with 50mm compacted road base. It shall be flush with the top of rail and planar between the two rails. The crossing length shall not be shorter than the road width.

12.2.7.3 Approach Road Configuration

12.2.7.3.1 Public Level Crossing

The minimum clear width should be at least equal to the approach road traffic lanes plus shoulders or shall accommodate the largest vehicle authorised to use the crossing, whichever yields a larger value. For sealed approach road, the minimum clear width provided through level crossings should be equal to the width of all the traffic lanes plus 1.5 m each side; that is, the carriageway width plus 3 m.

The approach road should be designed to not compromise the ability of vehicles to safely enter and exit the level crossing at the design speed. The surface of the approach road shall be designed case by case (e.g. some states have requirements specified in their lease). Road markings are required on sealed approach road and shall comply with AS 1742.7.

Vertical curves and changes of grade on the approach road and through the Level Crossing are to comply with the Road Authority’s road design standards to the extent possible.

Where the configuration of the approach road or the body of the level crossing does not permit a smooth transition of the road gradient through the level crossing in compliance with the Road Authority’s standards, the maximum allowable speed of the road traffic approaching and passing through the level crossing should be reduced accordingly.

Where the clear width at an existing public level crossing is narrower than the approach road design width, the taper of the road should designed in accordance with the requirements established by the local Road Authority.

12.2.7.3.2 Private and Service Level Crossing

New or upgraded private level crossings should be designed to meet the requirements of an ideal crossing as per Table 12-1

The minimum design width of road surface at a private or service level crossing shall be 4.5m or shall accommodate the largest vehicle using the crossing, whichever yields a larger value.

The approach road should be designed so as to not compromise the ability of vehicles to safely enter and exit the level crossing at the design speed.

The minimum requirement is a formed gravel road extending from the track either 7m or to the rail corridor boundary, whichever distance is the shortest.

Note: If the minimum design width cannot be achieved, the width of the crossing shall be determined in consultation with the stakeholders.

The road approach may be sealed to improve vehicle performance, where a road approach is sealed it is recommended to seal at least 7m from the nearest rail

12.2.7.4 Fencing and Barriers

12.2.7.4.1 Public level crossings

The risk of stock entering the rail corridor at level crossings on fenced lines should be assessed. Where risk assessment determines that they are necessary, cattle stops should be provided.

12.2.7.4.2 Private level crossings

At private level crossings where the corridor is fenced, gates or cattle grids shall be placed in the boundary fence.

12.2.7.4.3 Service level crossings

New service level crossings are to undergo risk assessment to determine whether barriers need to be installed to obstruct the use of the crossing when required protection is not available (e.g. where a crossing is used during working hours under the control of worksite protection personnel).

Such barriers are to be installed at service level crossings where risk assessment determines that they are necessary.

12.2.8 Risk Management

Where a new crossing is designed or there is a usage change (road and rail) that could affect the required sight distance, the level crossing risk profile and safety in design considerations shall be assessed based on the principles of AS 7658.

ALCAM or other suitable models may be adopted to assess risk profile and treatment types. The risk assessment process shall reduce safety risks SFAIRP.

12.2.8.1 Risk Assessment

The safety risk assessments for each level crossing should consider relevant factors affecting risk such as:

- Accident / Incident history
- Train type, frequency, and speeds. This is particularly relevant to routes where high-speed passenger trains operate, because of the increased risk to passengers and train drivers in a high-speed collision
- Road traffic frequency and mix. The mix of traffic is important in assessing the type of vehicle to be nominated for crossing time calculations considering the worst case scenario.
- Any sighting distance shortfall and to what proportion of vehicles this applies to
- Livestock usage
- Road grade and condition

The following are examples of changes which are likely to change the level crossing risk profile and may require re-assessment of risk:

- Configuration changes (road width, number of rail tracks, road or rail alignment)
- Change to level crossing controls as a result of classification change
- Change in approved design vehicle
- Repeated incidents at level crossing
- Change in level crossing environment (nearby buildings, business activities etc.)

In the case of risk at interface, ARTC may approach the relevant Road Authority on specific safety criteria that may include, but not restricted to the following:

- Positioning of signs and signals at level crossings
- Positioning of approach signs
- Provision of road markings
- Improving visibility
- Accident statistics
- Road traffic densities
- Determination of sight conditions (refer to 12.2.4).

12.2.8.2 Moderating Strategies

When a passive level crossing protected by Give Way signs has inadequate sight distance S2 or frequent incident reports, it should be protected with a Stop sign assembly (RX-2).

The following options may be considered if further risk controls are required for level crossings with compromised sight distances.

- Extra protection warning sign at and/or before a level crossing
- Restrictions on the type of road vehicles (including rerouting classes of road vehicle)
- Active control
- Closure or relocation of the crossing
- Grade separation
- Operational controls (where agreed)
- Reduction of train speed
- Any other control considered appropriate by the assessment team

The following are possible approaches to assist the implementation of the above options to reduce safety risks at level crossings.

- Consult with Road Authority to reach agreement on treatment of crossing
- Establishing load limits similar to road overbridges, but targeting longer, slower vehicles for prohibition
- Agreement with landholders on usage

12.3 Construction and Maintenance

12.3.1 Construction Requirements

12.3.1.1 General

The installation of a new level crossing shall follow all relevant drawings for cross-sectional configuration and typical requirements for crossing surfaces in 12.3.1.7. Civil drawing STD-C0037 attached in Appendix C should be used if the above information is not available.

Rail, including any welds or joints shall comply with the requirements of T&C COP Section 1: Rail, with a level crossing considered as a fixed point.

12.3.1.2 Sleepers and Fastenings

All new level crossings on main line shall be constructed using concrete sleepers.

Sleeper spacing at level crossings should be a maximum of 500 mm through the crossing and 5m either side of the road verges.

Sleepers and fastenings shall be installed in accordance with T&C COP Section 2: Sleepers and Fastenings.

Fastenings through level crossings should be galvanised.

12.3.1.3 Ballast

Ballast selection and construction shall comply with the specifications in T&C COP Section 4: Ballast and the relevant design drawings.

The width of excavation shall be 3.5 m to 4 m, or 500 mm to 750 mm past the outer rails where multiple tracks are crossed.

The track ballast shall be separated from all finer material (including the base). This may be achieved by the use of a suitable geotextile.

Bottom ballast shall be compacted using a smooth drum roller or suitable alternative prior to placement of sleepers to reduce post construction settlement.

Note: Small amount of bottom ballast lift (e.g.10-20mm) may be applied to further mitigate post constriction settlement.

For level crossings where deviations are feasible, a period of 7 days shall be allowed between the initial tamp and application of the road surfacing materials. During this 7-day period the alignment and level shall be adjusted, and ballast cribs and shoulders compacted twice, once within the day prior to sealing.

For level crossings where detours or deviations are not feasible for 7 days following installation, the ballast shall be suitably compacted by use of plate compactor or other suitable alternative on the ballast in the cribs and shoulders after tamping and prior to application of road surfacing materials.

Compaction shall be carried out over the full length of the crossing base layer.

12.3.1.4 Drainage

The surface runoff shall be directed away from the track structure.

For all new level crossings, free drainage of the ballast should be achieved. Where this cannot be achieved (for example through geometric restrictions, the drainage shall be assisted through the use of slotted pipe drains (or equivalent) that shall be installed in accordance with the manufacturer's specifications.

The approach road construction shall not interfere with the existing track-side drainage. This may be achieved by installing appropriated under road drainage to ensure continuity of the longitudinal track drainage.

Note: Drainage systems for new installation sites shall be specified by the Designer or Contractor and agreed with ARTC.

12.3.1.5 Formation

The formation should be constructed or overhauled to ensure it is in accordance with the specifications in T&C COP Section 8: Earthworks.

12.3.1.6 Crossing Base

A 3% Cement Treated Crushed Rock (CTCR) base of minimum depth 200 mm shall be constructed.

The base shall extend 5 m past the edge of the road pavement. Where the road crossing has an adjacent pedestrian crossing the base shall extend 5 m past the pedestrian crossing.

The base shall be compacted in two layers and provide a minimum lateral crossfall of 1 in 50 to provide for drainage of the overlaying ballast layer. Where longitudinal drainage of 1 in 100 cannot be achieved the drainage shall be assisted by the use of slotted pipe drains (or equivalent) that shall be installed in accordance with the manufacturer's specifications.

12.3.1.7 Crossing Surface

12.3.1.7.1 Sealed Road Surface

Sealed road surface at crossing shall be installed with a uniform surface providing.

- Deviations of not greater than 5mm from a 3.0 m straight edge
- Drainage away from the road and track

Asphaltic concrete is commonly used to seal the road surface. The road surface levels should be constructed to the full rail height in a two-stage laying of asphalt concrete. Wheel flangeways should be formed and maintained to have a clearance of 60-75 mm wide and 40-50 mm deep. All surfaces in contact with the asphaltic concrete should be sprayed with bitumen emulsion. Refer to AS 1160 and Road Authority specifications for details.

Note: Where asphaltic concrete crossing surface are used for unsealed approach roads, the crossing road surface should extend a minimum of 2.5 m either side of the outer rail unless otherwise specified by the local Road Authority and agreed to by ARTC.

12.3.1.7.2 Unsealed Crossing Surface

The unsealed surface shall be constructed to specifications equivalent to the requirements of the adjoining Road Authority for the type and class of road crossing the track, or to the requirements of the licence conditions for private level crossings where applicable.

Unsealed road surface levels shall be constructed to the full rail height. Where road base containing any material that may contaminate the ballast is used it shall be separated from the ballast by a suitable geotextile (BIDIM A64 or equivalent).

All steel surfaces (eg. rail sides and fastenings) in contact with the road material should be sprayed with bitumen emulsion for corrosion protection.

12.3.1.7.3 Modular Crossing Surface

The installation and maintenance of modular units shall follow per manufacturer's instruction.

Only type approved modular crossing systems shall be used.

12.3.1.8 Approach Road Surface

The approach road surface shall be constructed to specifications equivalent to the requirements of the adjoining Road Authority for the type and class of road crossing the track, or to the requirements of the licence conditions for private level crossings where applicable.

12.3.1.9 Signage

Signs and markings shall be installed following the relevant design drawings. STD-C0037 and relevant drawings listed in Appendix B shall be followed if the above information is not available.

12.3.2 Maintenance Requirements

Road surface defects should be maintained and repaired in accordance with the following:

- The requirements in 12.3.1 with respect to surface material.
- To ensure that road-rail vehicles can safely use the level crossing as an access point.

All unsuitable material shall be removed and replaced including any surface breakdown which may allow water percolation into the track structure or road base.

Alternative materials may be used with the agreement of ARTC.

Where level crossing surfaces (material or panels) are removed the rail should be inspected for defects including corrosion along the rail. Where the crossing area has not been freely draining it is good practice to replace the rail/fastenings while the surface is removed.

For public crossings, the maintenance boundaries below are reference only and vary based on the individual State requirements (from the outer rail):

Table 12-4: ARTC Maintenance Boundaries (distance from the outer rail)

QLD	NSW	VIC	SA	WA
0.6 m	1 m	3 m	1 m	3 m

For private crossings, maintain road to railway corridor (boundary fence or up to 15m), unless otherwise stated in individual level crossing license / agreements where applicable.

ETW-12-02 should be followed when reinstating the flangeways through asphalt level crossing.

The repairment of modular crossing surface shall be as per manufacture's instruction.

12.4 Inspection and Assessment

12.4.1 Patrol Inspections

Patrol Inspections are intended to find obvious defects that affect the safe running of trains or material safety of the level crossing.

The interval between patrols of level crossings shall be at intervals as specified in the approved Technical Maintenance Plan or not exceed 7 days if not specified. Track patrols shall keep a lookout for defects and conditions (i.e. indicators of a defect) that may affect, or indicate problems with safe operations at a crossing, including:

- Flangeway obstructions
- Track geometry including approaches
- Crossing surface condition
- Trackside signage visibility or obvious damage
- Condition of walkways

Note: The inspection should be carried out at a speed consistent with the local conditions and the full scope of the inspection being carried out (e.g. the type and number of other infrastructure elements being inspected).

12.4.2 General Inspections

General Inspection are intended to observe deterioration of the condition of the level crossing from its new condition.

Scheduled general inspections shall be carried out in a manner appropriate to the level crossing type, condition, rate of deterioration, and other local and seasonal factors. General inspections shall be at intervals as specified in the approved Technical Maintenance Plan or not greater than 365 days if not specified.

General inspections shall include the tasks of the patrol inspection and in addition look for defects or changes in the conditions which may affect the function of the crossing, as set out in Table 12-5. Form ETS1200F-01 or the equivalent Ellipse form should be followed.

Table 12-5: Level crossing general inspection criteria

Element	Task
General	Inspect for damaged, loose, missing or broken components
	Observe track geometry including vertical alignment and approach into level crossings
	Check sleepers and fastening overall condition
	Check ballast condition, fouling and profile
	Check flangeways for obstructions and clean out if possible
Civil	Check for suspected gauge tightening / widening
	Inspect rail surface condition. Check for rail corrosion and rust flakes (tools may be used) through the flangeways
	Check for mudholes or drainage deficiencies

Element	Task
	Visually assess flangeway width and depth, measure where required
	Measure top of crossing surface level relative to the rail level (100mm from back of field side of rail). Check for evidence of wheel tread running on crossing surface
	Visually assess potholes at sealed crossing surface. Measure deformation depth, where required
	Unsealed crossing surface: Check for displacement of loose materials exposing rail head to road user
	Modular crossings: Check for damage, cracks, or any movements (lateral and vertical) along the track(s)
	If applicable, measure modular panel gaps where required
	Check for ineffective fastening system
	Check for vehicle clearance
	Check for damaged barrier/fences. Check for non-frangible materials used for ARTC barrier/fencing/signage
	Check road markings
Signage	Check for signage obstructions
	Signage is clear to read and intact, not faded or missing or non-standards.
	Check RX assembly parts
Sighting	Check for obstructions within the normal available sight distance. Record sighting conditions.
Others	Other defects that could affect the safety of train operations or public access

Note: Modular crossing surface shall be inspected and assessed in accordance with manufacturer's instructions.

Where level crossing components owned by others are found to be unsatisfactory, the Rail Infrastructure Manager or nominated representative is to forward this information to the owner (Road Authority or private owner) for appropriate corrective action.

12.4.3 General Inspection Assessment

All signs at level crossing shall be maintained in accordance with 12.2.6.

Level crossings civil components shall be maintained to the tolerances and condition defined in Construction and Maintenance and relevant ARTC standards.

The defects observed from general inspections shall be assessed in accordance with the table below.

12.4.3.1 General

Table 12-6: General assessment

ELEMENT	CONDITION	RESPONSE
Component Damage	Any component damaged, loose, missing or broken	Prioritise repair.
Track Geometry, Overall Condition including vertical alignment and approach into level crossings	Suspected faults Top, Twist, Line etc	If any condition present, respond as per ETS-05-00 5.4 table 5-15 or ARTC Track & Civil Response Booklet.
Sleepers and Fastening, Overall Condition	Missing Sleepers (where visible) Ineffective sleepers or fastenings (where visible)	If any condition present, respond as per Section 2 Sleepers and Fastenings 2.3 or ARTC Track & Civil Response Booklet.
Ballast profile and condition	Visual check for Ballast degradation, heave, fouled ballast etc.	If any condition present, respond as per Section 4 Ballast 4.3.2 or ARTC Track & Civil Response Booklet for Ballast profile at approaches.
Flangeways	Obstructions	Clean out if possible.

12.4.3.2 Civil

Table 12-7: Civil assessment

ELEMENT	CONDITION	RESPONSE
Gauge (Different restrictions apply based on track speed; look for signs of gauge widening or tightening)	Suspected gauge tightening / widening	If any condition present, respond as per ETS-05-00 5.4 table 5-15 or ARTC Track & Civil Response Booklet.
Rail Condition	Check condition of rail head. Look for RCF, Shelling, Squats, Wheel burns, Rail flow, Corrosion and Mechanical damage etc.	If any condition present, respond as per ETS-01-00 1.4.2 or ARTC Track & Civil Response Booklet.
Track Drainage (if applicable)	Evidence of mudholes or pumping of the crossing	If any condition present, respond as per ETG-05-04 Table 1.
	Drainage ineffective – fails to direct water from track	Prioritise Repair.
Flangeway Width (Unsealed Crossing Surface)	Width>85mm	Prioritise Repair.
	Width < 60mm	Clean out if possible.
Flangeway Width and Depth (In-Situ Concrete Surface, bitumen surface, modular surface) (For crossings using gap filler products (or similar)	Width>85mm	Prioritise Repair.
	Width < 60mm	PR Increase Monitoring, prioritise repair.
	Width < 60mm and evidence of back of wheel flange contacting the crossing surface parallel to the rail running face	P2 Repair.

ELEMENT	CONDITION	RESPONSE	
the minimum flange gap may not apply)	Depth < 40 mm	PR	Increase Monitoring, prioritise repair.
	Depth < 40 mm and evidence of wheel flange contact with crossing surface in the flangeway	P2	Repair.
Top of Crossing surface level relative to the rail level (100mm from back of field side of rail)	±10mm	P3	Increase Monitoring, prioritise repair.
	±20mm	PR	Increase Monitoring, prioritise repair.
	Evidence of wheel tread running on crossing surface	P2	Repair. Contact Engineering team if further assessment is required for remediation
Sealed Crossing Surface Pothole / deformation depth (measured with a 1 m straight edge)	20 mm to 40 mm	P3	Increase Monitoring, prioritise repair.
	40 mm to 60 mm	PR	Repair.
	>60 mm	P2	Repair.
Unsealed Crossing Surface	Displacement of loose materials exposing rail head to road user	P2	Remediate or monitor as determined by site conditions/usage.
Modular Crossing Surface	Panel damage, cracks, or movements (lateral and vertical) along the track(s)		Prioritise Repair.
	Modular panel gaps >15mm posing hazard including to cyclist (if applicable)	P2	Repair.
	Ineffective fastening system	Respond as per Section 2 Sleepers and Fastenings 2.3 or ARTC Track & Civil Response Booklet.	
Vehicle Clearance/Grounding	Vehicles drag marks or indications of road vehicles bottoming out on the approach and crossing surface.	Assess approach road surfaces and if any issues identified contact Engineering team for further assessment, Prioritise Repair	
Barriers/Fences (if applicable)	Damaged barrier(s)/fence at level crossing or around Ix equipment	P2	Repair or Replace barriers if within ARTC Maintenance Responsibility, advice Road Authority for non-ARTC barriers.
	Non frangible materials used for ARTC barrier/fencing/signage within 5m of road (e.g. Rail used as fencepost)	N	Prioritise Repair, routine scheduled inspection.
Road Marking (not applicable to unsealed road approaches) (e.g. stop line, giveway line)	Marking faded etc.	Prioritise Repair. Any observations outside ARTC Maintenance Responsibility – Record and notify Road Authority.	

12.4.3.3 Signage

Table 12-8: Signage assessment

ELEMENT	CONDITION	RESPONSE	
Signage Obstruction [Note] Note: not applicable to unsigned private / service level crossings	Signage Obstructions (e.g. vegetation etc.)	P1	Remove obstructions. Any observations outside ARTC Maintenance Responsibility – Record and notify Road Authority.
Signs Condition [Note] Note: not applicable to unsigned private / service level crossings	Stop or Give Way sign missing or unreadable	E	Notify network control immediately to apply CAN notification. (Additional controls e.g. Restricted Road usage subject to site risk) Repair or replace sign(s). (Otherwise 20km/h TSR until remediation is completed)
	RX assembly parts missing/ unreadable	P1	Repair or replace .
	RX assembly parts damaged /faded		Prioritise repair.
	Non-Standard Signage	N	Prioritise Repair, routine scheduled inspection.
Sign Condition (only applicable to unsigned private / service level crossings)	Missing Signage	N	Prioritise Repair, routine scheduled inspection.

12.4.3.4 Sighting

Table 12-9: Sighting assessment

ELEMENT	CONDITION	RESPONSE	
Sighting [Note] (e.g. trackside stockpiles, overgrown vegetation, temporary structures etc.)	Obstructions to normal available sighting distance	P1	Remove where obstructions present in the rail corridor
	Obstructions to normal available sighting distance (for service level crossings only)	P2	Remove where obstructions present in the rail corridor
			Liaise with the Road Authority (i.e. council or landowner) where the obstruction is outside ARTC Maintenance Responsibility. Contact Engineering team if further assessment is required for remediation.

Notes:

Signage *The maintenance of signs outside the ARTC maintenance responsibility is the responsibility of the relevant Road Authority.*

The relevant Road Authority shall be advised of locations where it is suspected that the sign condition impacts the visibility to road users.

The response times shown in Tables above are the absolute maximum. The actual response times should be as short as practicable, taking into account the risk profile involved.

Civil *Crossing surface details in unsealed roads shall be assessed generally in accordance with the table above, having regard to the average condition of the adjacent road surface.*

Any observations of issues outside ARTC maintenance boundaries shall be recorded in EAMS. Formal communication notifying the local Road Authority of the issue/s is to be sent via the ARTC Area Manager. The record in EAMS shall be closed following the notification to the local Road Authority.

Appendix A – Design Vehicles for Private Level Crossings

These values are based upon field trials undertaken by ACRI. These values may be substituted with alternate values where reasonably supported.

Design Vehicle Type[2]	Vehicle Length[1] m	Acceleration m/s²		Limiting Speed[1] m/s	
		Ideal	Basic	Ideal	Basic
Level 1 - Semi-trailer	20	Refer AS 1742.7	0.37	N/A	1.29
Level 2a - B-double	26		0.31		1.29
Level 2b - Pocket road train	30		0.3		1.29
Level 3a - Double road train	36.5		0.29		1.29
Level 3b - B-triple	42		0.28		1.29
Level 4a - AAB-Quad	53.5		0.22		1.29
Level 4b - AAB-Quad	60		0.21		1.29
(4WD) light vehicle	5.5	0.90	0.63	2.74	2.02
(4WD) light vehicle, <4.5t GVM + Trailer	11.1	0.61	0.47	1.96	1.64
(4WD) light vehicle, <4.5t GVM + Long Trailer	22.5	0.61	0.47	1.94	1.64
General Access Rigid truck, <26t and 12.5m	12.5	0.39	0.32	1.73	1.29
SPV-3 Pick and Carry Crane	6.9	0.65	0.45	2.49	1.6
Class 1 10-Combine Harvester	9.8	0.38	0.25	3.45	1.07
Class 1 11-Tractor < 4.5t + Trailing Device	10.1	0.31	0.31	1.24	1.24
Class 1 11-Tractor < 4.5t + Long Trailing Device	21.8	0.31	0.31	1.24	1.24
Class 1 11-Tractor > 4.5t + Trailing Device	14	0.31	0.31	1.24	1.05
Class 1 11-Tractor > 4.5t + Long Trailing Device	24	0.31	0.31	1.24	1.05
Excavator	6.6	0.16	0.16	0.66	0.66

Note:

1. *Design vehicle length and limiting speed is considered case by case.*
2. *For vehicles not covered use the Acceleration and Limiting Speed values are most appropriate and adjust for length.*

Appendix B – Level Crossing Standard Drawings

Title	Drawing Number	Applicability
Whistle Restriction Sign	STD-C0028	Network
Whistle Sign	ARTCS3060141	SA, NSW and WA
Whistle Sign	STD-C0042	VIC
Restricted Access Sign	STD-C0029	Network
Authorised Access Sign (Service Road)	STD-C0030	Network
Passive Level Crossing Signs	STD-C0037	Network
Passive Level Crossing RX Assembly Details	STD-C0039	Network
Sign Post Details	STD-T0005	Network

Appendix C – Civil General Arrangement